MACHINERY

Index to Vol. XVII

September, 1910, to August, 1911

Engineering and Shop Editions

Index to Vol. X

September, 1910, to August, 1911

Railway Edition

1911
THE INDUSTRIAL PRESS,
49-55 Lafayette St.,
New York

Index to MACHINERY

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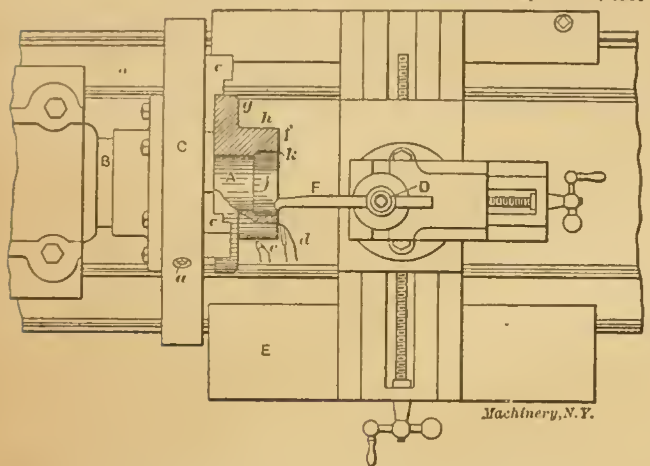
Supplement to MACHINERY, September, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Some Points on Lathe Work"

SHOP OPERATION SHEET NO. 145

W. S Leonard — MACHINERY, September, 1910



To Turn and Bore a Chuck-plate Casting

1. Place upon the spindle *B* of the lathe, preferably a three-jaw universal or self-centering chuck *C*. See that dirt does not prevent screwing the chuck tightly against the spindle collar.

2. Place the chuck-plate casting *A* in the chuck jaws *c*, with the hub out. Screw up the chuck jaws by applying a chuck wrench to one of the jaw screws *a* until the jaws have gripped the work, then turn the chuck and tighten each successive screw.

3. Start the lathe at a moderate speed and apply a piece of chalk to the face, and then to the outside of the casting, and note whether it runs true. If it does not, there is some slight unevenness on the part of the casting resting against one of the jaws. Loosen the jaws, turn the casting slightly, screw up the jaws and test as before.

4. In the toolpost *D* clamp a right-hand, bent side-tool having a rounded point and set as shown at *d*. Take a roughing cut over the face *f* of the hub and the face *g* of the flange. Regrind the same tool and take finishing cuts over the surfaces *f* and *g*, running the lathe somewhat faster for the finishing than for the roughing cuts.

5. Insert in the toolpost a half diamond-point tool having a rounded point, or other suitable roughing tool. Set the tool as shown at *e* and take a roughing cut over the hub *h*. Regrind the same tool and take a finishing cut over the hub *h*, leaving a fillet in the corner. Round the outer corner with a hand tool.

6. Replace the tool by an inside boring tool *F* set so that it projects far enough to pass through the hole to be bored. Take a roughing cut, and then a finishing cut, making the hole 0.010 inch larger than the diameter of the bottom of the thread of the spindle to which the plate is to be fitted.

7. With the same tool, reground if necessary, take roughing and finishing cuts in the recess *j*, finishing the hole so that it will just pass over the straight part of the spindle. The depth of the recess should be about 3/16 inch more than the length of the straight part of the spindle, and the corner *k* should be rounded if there is a fillet on the spindle.

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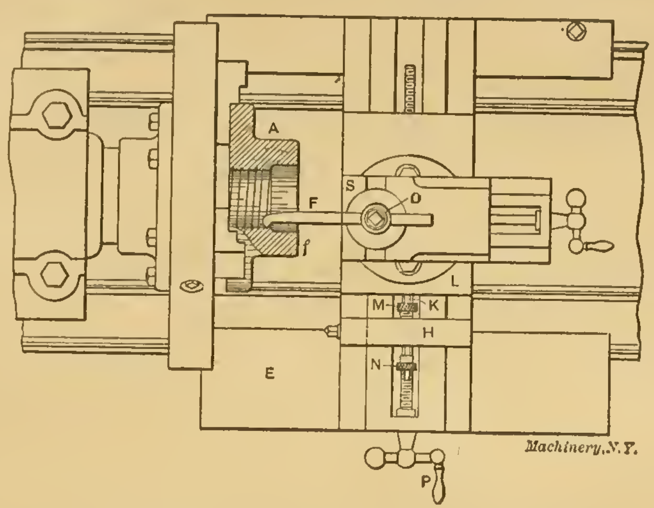
W. S. Leonard — MACHINERY, September, 1910



To Cut an Inside Thread in a Chuck-Plate Casting

NOTE.—The thread in the chuck-plate should be an easy fit on the lathe spindle, going on and off readily. The recessed portion of the bore should be a good fit on the straight part of the spindle

1. Ascertain the number of threads per inch on the spindle to which the chuck-plate is to be fitted. Select and put in place the proper change gears for cutting this number of threads. (See Shop Operation Sheets, 13, 14 and 15.)

2. In the tool-post *D* clamp the inside thread tool *F*, its point projecting far enough so that it will reach entirely through the casting before the compound rest comes against the casting *A*, and the cutting edges carefully set by a thread gage placed against the face *f* of the casting.

3. Clamp the thread stop gage *H* on the carriage *E*, with its screw *K* fixed to the slide *L*, and provided with the stop nuts *M* and *N*, on either side of the stop gage.

4. Connect the carriage *E* to the lead-screw by closing the lead-screw nut in the apron.

5. By the cross feed crank *P*, move the tool *F* until it is almost in contact with the inside of the hole to be threaded. Set the stop nut *M* far enough from the stop gage *H* to give the desired depth of cut.

6. Start the lathe forward, and take the first light cut, moving the tool back out of the cut, and reversing the lathe to its backward movement the moment the tool is through the casting.

7. Turn the stop nut *M* slightly to permit the tool to be drawn deeper into a cut, and take another cut as described in Step 6. Continue these cuts until the thread is finished to the required size, testing with a threaded plug gage, or with inside thin-pointed thread calipers.

NOTE.—If thread calipers are used for testing the size of the thread, the chuck-plate should be tried on the spindle to which it is being fitted before it is released from the chuck jaws, by removing the chuck with the plate attached.

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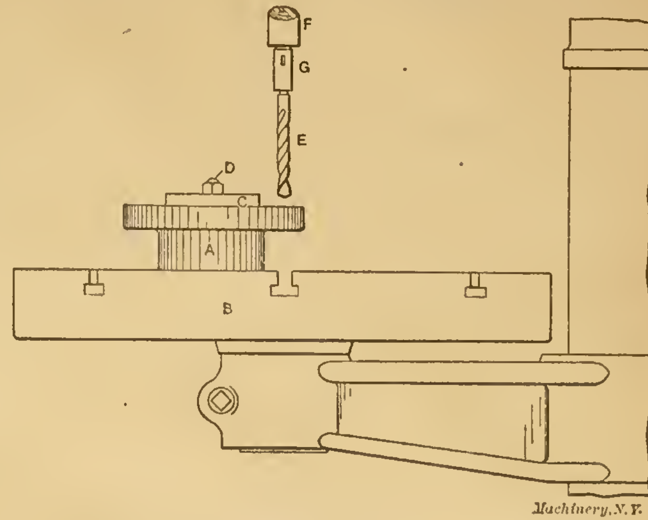

To Turn Flange and Drill Bolt Holes in a Chuck-plate Casting

1. Place the chuck-plate *A* on the spindle to which it was fitted. With a right-hand, bent side tool having a rounded point, take a roughing and then a finishing cut over its face.

2. With a half-diamond point tool, turn the outside diameter of the flange, making it a tight fit in the recess in the chuck to which the plate is being fitted. With a hand tool round the back corner.

3. Cover the bottom of the recess in the chuck with a coating of thick red lead. Place the chuck-plate in the recess, and pound on the end of the hub with a mallet or block of wood. Remove the plate, and the location of the holes will be indicated by the red lead.

4. Make prick punch marks around each circle, and with small dividers adjusted to the radius of each hole, locate the centers, prick punch them, and scribe circles equal to the diameter of the holes to be drilled. From these centers scribe a second set of circles about half the size of the first.

5. Using a heavier center punch, enlarge the centers for the point of the drill, being careful not to "draw" them.

6. Clamp plate *A* to the table *B*, of the drill press, by means of the strap *C* and the bolt *D*.

7. Select a twist drill *E* slightly larger than the body of bolts to be used, and place it in the drill spindle *F*, using the proper collet *G* for the purpose.

8. Start the machine, bring down the drill, and start one of the holes. As the drill cuts nearly to the diameter of the inner test circle, note whether it is concentric with it; if not, cut a slight radial groove with a narrow round point chisel on the side where the drill cuts farthest from the circle, and proceed until the hole becomes central with the circle. When the drill has cut nearly to the diameter of the hole, again compare with the outer circle, and if the cut is concentric with it, drill the hole. Drill the other holes in the same manner.

MACHINERY
September, 1910

MACHINE STOPS, TRIPS AND REVERSING MECHANISMS

By JOSEPH G. HORNER*

In recent years, stops, trips and reversing mechanisms have been applied to a vast number of machine tools. The stops employed vary from the simple adjustable stop, tappet or dog, to the mechanisms in which these are combined with cushion devices, means for reversing feed movements, etc.

It may be advisable at the outset to call attention to the difference between a "self-acting" and an "automatic" movement. Many machines which are not wholly automatic contain self-acting movements. A slide-rest is self-acting, though the lathe is not automatic, because the movements of the slides have to be thrown in and out by the operator. The greater number of turret lathes are semi-automatic or self-acting, as distinct from the automatic or "full automatic" screw machine. A number of gear-cutters and grinders, in which all the movements proceed without intervention from the attenaant, are also in the class with the fully automatic machines. It is in these classes of machines that the highest developments of the mechanisms to be considered are found.

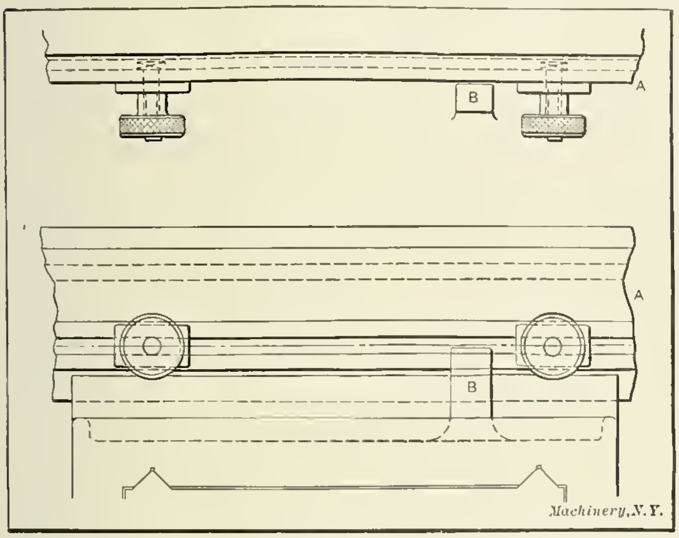

Fig 1. Dead Stops of a Type used on a Cutter-grinding Machine

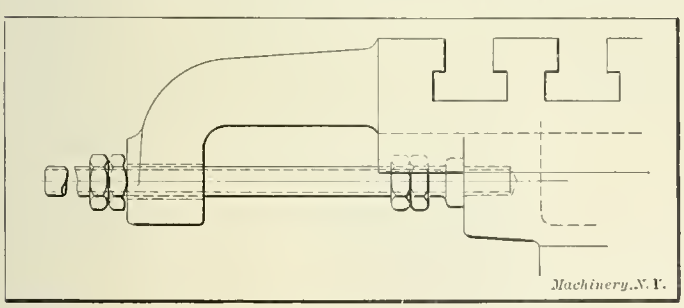

Fig 2. Efficient Type of Stop-rod for Turret Lathe Cross-slide

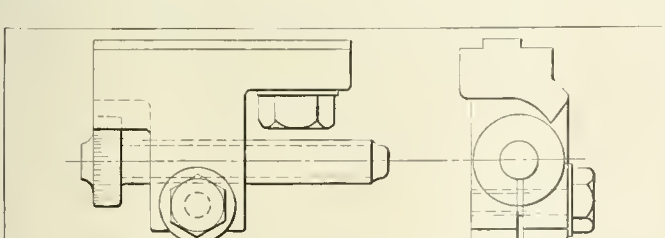

Fig. 4. Stop-screw with Micrometer Adjustment

There are two kinds of stops: "Dead" stops are those which positively arrest a movement, and gage a length or diameter in repetitive work; "trip" stops or "trips" throw out a movement, reverse it, or throw it in again. Dead stops alone are not sufficient to check a power feed or self-acting movement; some means must also be provided to throw out the feed. Then a dead stop may or may not be incorporated to form a positive check. In many cases the tools themselves, as in some turret-lathe work, constitute dead stops, and render the provision of additional stops unnecessary. A dead stop is used in hand-operated mechanisms to prevent the operator from moving the slide or other portion further than the predetermined limit, thus guarding against error, and insuring a duplication of dimensions without the need for measurement or gaging. Again, it is often possible to throw out a dead stop temporarily, and go past it for certain purposes, such as inspection, and again throw it in at the same setting as before. A number of dead stops may be located close together, to enable selection to be made at will or in regular rotation, as in the case of a turret—one for each tool-hole. Frequently duplex stops are arranged, to enable the choice of two distances for a single slide, one stop being thrown out of the way. Fine adjustment is in some cases provided for a dead stop, so that a very precise setting can be obtained.

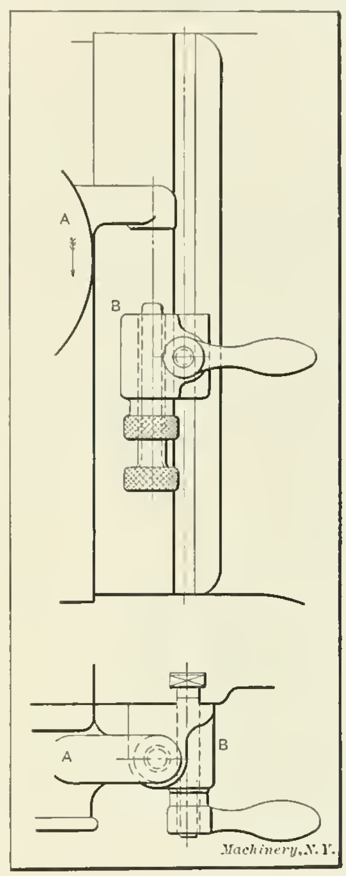

Fig. 3. Dead Stop used on a Vertical Milling Machine

An important point in the design of dead stops is that of rigidity; a solid abutment should always be used, and any excessive overhang tending to cause springing must be avoided; otherwise accurate results are impossible. In the operation of a hand turret lathe or other machine tool there is necessarily a great deal of banging and rough treatment, especially in the hands of a careless operator, and weak and badly-supported stops will cause unsatisfactory work. The binding arrangement for a stop must also be efficient, so that it will not slip and cause a batch of work to be turned out to wrong dimensions. The hardening

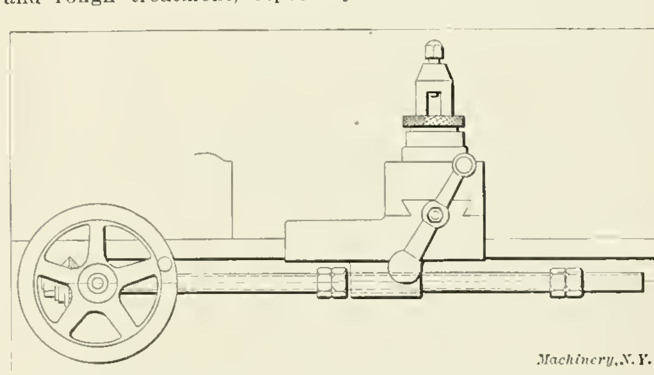

Fig. 5. Stop-rod passing through a Hole in a Turret Lathe Cross-slide

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of contact surfaces is also advisable for preventing wear and bruising that would affect the dimensions of work produced.

The position and method of attachment of a dead stop depends on the class of machine and the design. Where a sliding table has to be stopped, it is in many cases possible to attach the stops or dogs by means of a bolt and T-slot in the edge of the table, this being a very simple method and permitting easy adjustment; or a round rod may be held in bearings on the edge of the table, and adjustable dogs be clamped to the rod by set-screws, or by split ears or lugs. Another method is to have a fixed stop bolted to the table edge, and adjustable dogs attached to a rod in front, these being struck by the stop according to the movements of the table. A favorite device for short slides, such as the cross-slides of turret lathes, is to attach the stops to a rod or screw passing through a hole in the slide, the faces of the latter coming into contact on each side alternately with the stops. Plain cylindrical parts, if of small diameter, are often controlled by a collar or lug, clamped to them by means of a set-screw, and arranged to encounter the face of the bearing through which the part moves.

It is evidently impossible to show all the different kinds of stops which are in use on various machine tools, but the following selection of typical examples embodies the principles involved in the design of all stops. Slight modifications in form and location are made in different machines.

In Fig. 1 is shown the simplest possible kind of dead stop applied to the table of a cutter grinding machine. We have here a T-slot in the edge of the moving table *A*, receiving the heads of the bolts which clamp the two stop-plates through the medium of knurled nuts. The plates strike the block *B* on the transverse table.

Fig. 3 shows a modification of the same principle. In this case the sliding head *A* of a vertical milling machine is to be stopped in one direction only—the downward—and a projection stands out from the slide *A* to encounter the end of the stop-screw in the block *B*, which is clamped in a T-slot on the fixed head. After adjusting *B* approximately in position up or down in the slot, by the lever, the final adjustment is made by the knurled-headed screw, which is finally locked by its nut. The screw does not, however, provide a precise means of setting to any exact measurement. In some cases, therefore, such a stop-screw has a micrometer adjustment, Fig. 4. The head of the screw is graduated, so that the screw can be adjusted by a known amount—a manifest advantage in fine work. The body of the stop is split, thus providing positive means for binding the stop-screw.

An illustration of the stop-screw or rod passing through a hole in the moving slide is shown in Fig. 5. The example shown is that of a cross-slide of a turret lathe. The stop-screw in this case also serves the purpose of moving the rest along through the medium of the handwheel and the miter gears; frequently, however, a separate plain rod is used, parallel with the screw, and carrying split clamped dogs instead of the double lock-nuts, shown in Fig. 5. Another example of the use of double nuts is shown in Fig. 2, illustrating the rear end of a cross-slide for a turret lathe. The stop-screw is tapped into the fixed slide, and passes through an extension on the moving slide. This arrangement serves as a stop for both front and back tools. In modification, Fig. 8, two screws are used locked with nuts, the ends of the screws being struck by a pin screwed into the moving slide. The advantage of both these designs of stops is that they are perfectly central, and are therefore better than those classes of stops which are set at the side of the moving slide.

The combination of two stops, to provide the choice of two lengths, is common. A case of this kind is shown in Fig. 6, showing the rear end of a turret slide. The main screw *A*, with a locking nut, abuts against the back of the saddle or base, and forms one dead stop. An adjustable block *B*, bolted to the edge of the slide, carries a pivoted dog *C*, which when dropped down into the position indicated in the view to the left, strikes against a facing on the back of the base. A flat spring *D*, screwed to *B*, presses against the tail of *C* and main-

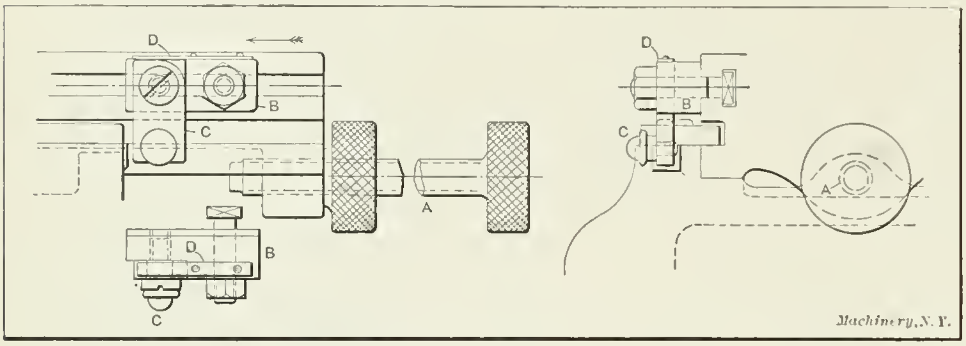

Fig. 6. Double Stops used on Turret Lathe, making it possible to obtain Two Lengths without the Necessity of readjusting the Stop-screw

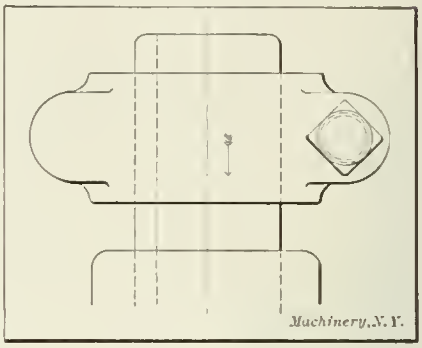

Fig. 7. Split Stop Collar used on Drill-press Spindle

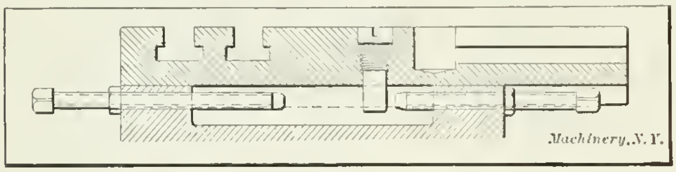

Fig. 8. Double Dead Stops

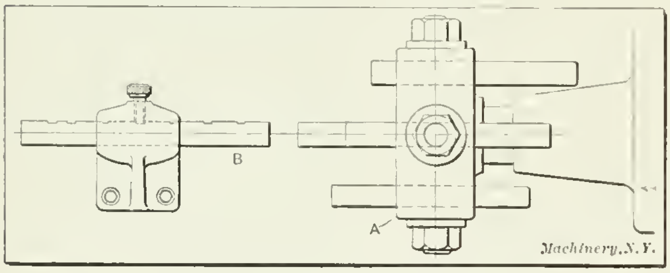

Fig. 9. Rotating Dead Stops used on a Turret Lathe Cross-slide

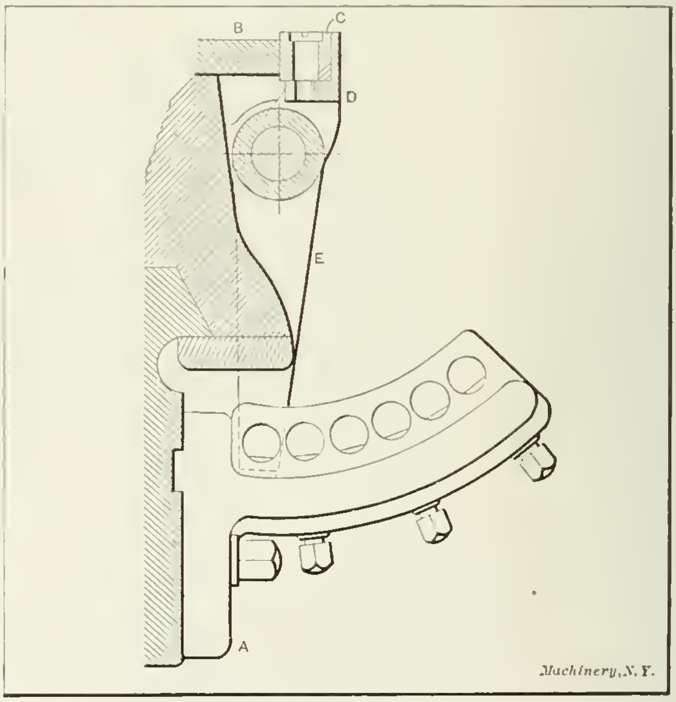

Fig. 10. Turret Lathe Stops used on the Pratt & Whitney Turret Lathes

tains it in position. If C is not required, it is swung up into the horizontal position, where the flat spring also retains it.

A simple kind of stop for round spindles is shown in Fig. 7. The example shown is used on a sensitive drill press, and consists only of a split collar, which arrests the downward travel of the spindle by striking against the top bearing.

One of the most valuable principles in stop construction is that of the rotary disk carrying several stops, any of which

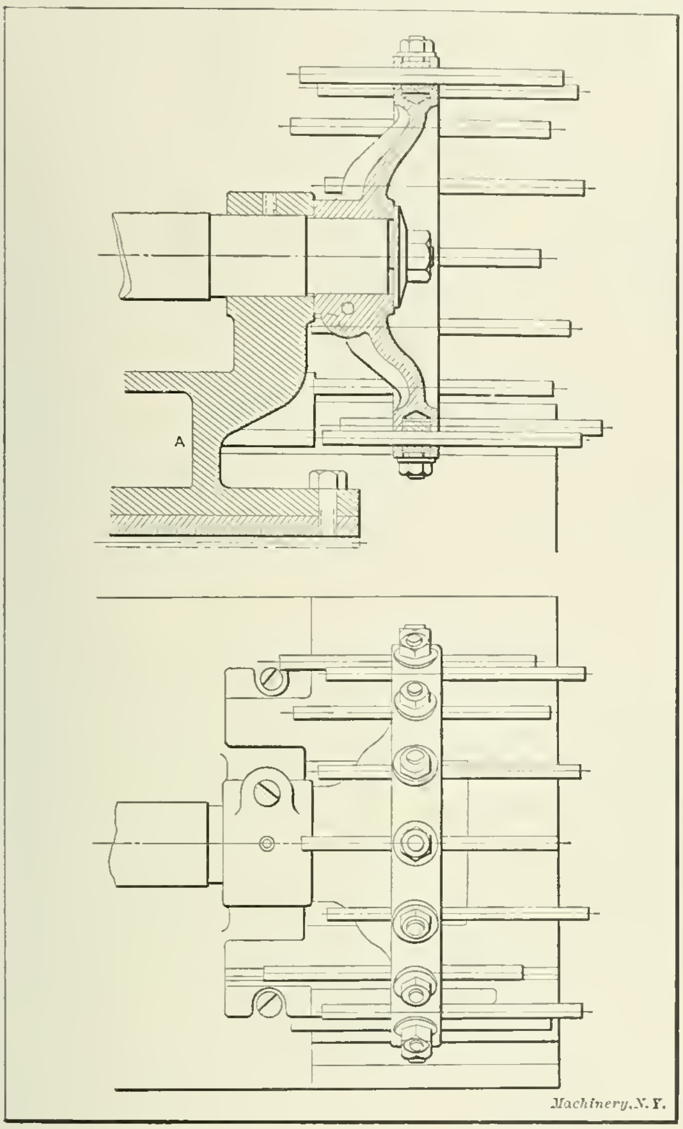

Fig. 11. Dead Stops used on a Turret Lathe of German Make

may be brought into action, either in a selective manner—that is, according to the wish of the operator—or in automatic fashion—one or more stops being made to act only for

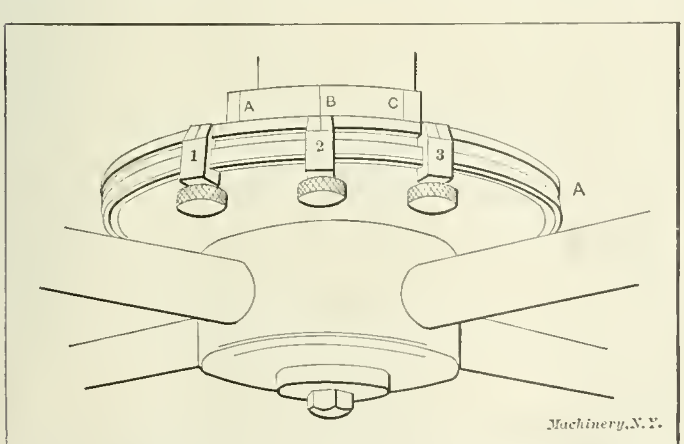

Fig. 12. Enlarged Detail of the Indicator of the Device shown in Fig. 13

a particular tool or set of tools. In this way compactness is secured, and the stops are in full sight and easily accessible, which was not the case with some of the older designs of multiple stops, such as, for example, a set of flat bars laid side by side and used for turret stops. Fig. 9 illustrates a rotating type of stop, adopted for the cross-slide saddle of the turret lathe, there being one stop-rod for each tool on the cross-slide turret. The head A is mounted on the end of a

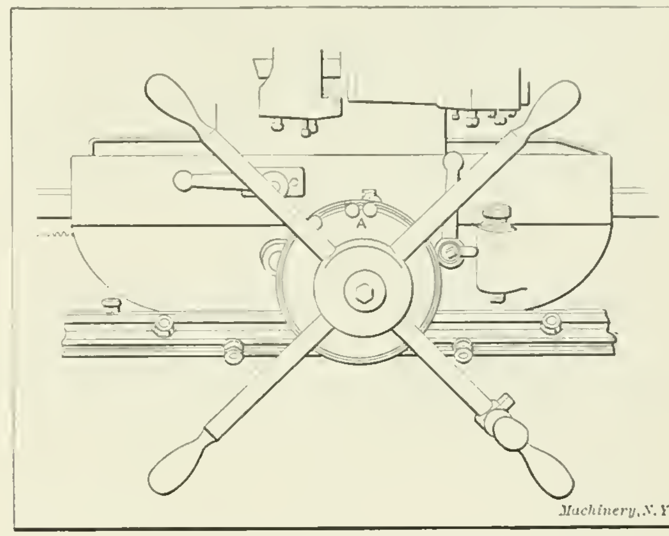

Fig. 13. Rotating Stop-bar and Accurate Indicator used on the Alfred Herbert Hexagon Turret Lathe

shaft that is rotated simultaneously with the turret, and each of the stop-rods is adjusted independently and secured with a nut, the rod passing through the body of the bolt. Each rod in turn abuts against the bar B, held in a bracket bolted to the front of the lathe bed. The adjustment of this bar is effected by loosening the set-screw and sliding it through the bracket;

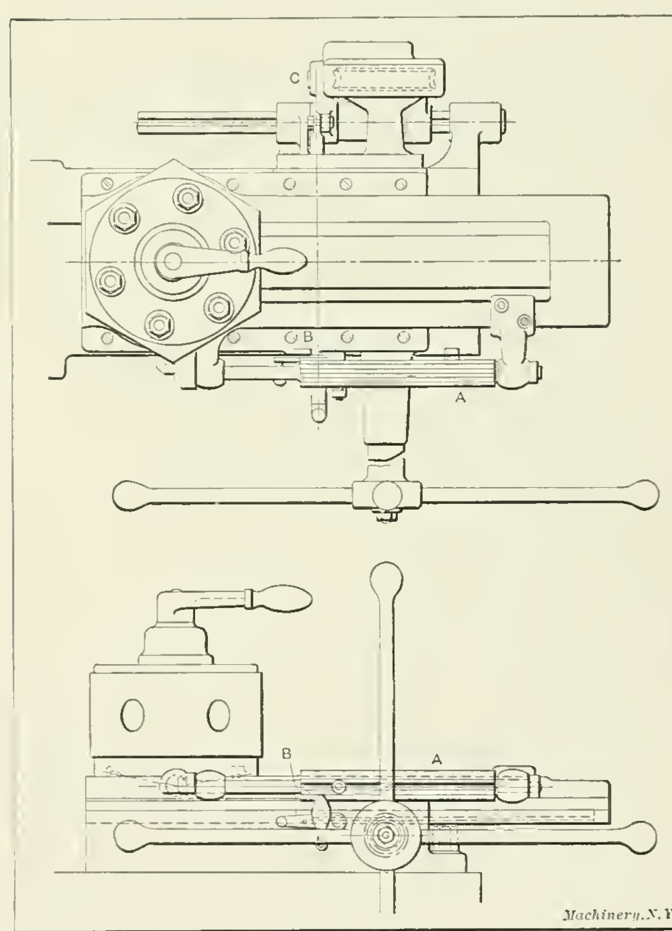

Fig. 14. Rotating Stop-bar used on Turret Lathe

on tightening the set-screw, it bears down on a flat milled on the bar, and forms a positive check to slipping.

Another application is shown in Fig. 11. This arrangement is applied to the rear end of the Pittler turrets, which are mounted on a horizontal axis. There are sixteen holes in the turret for tools, and a stop is provided for each hole. All the rods are held in the rim of a disk secured to the rear

end of the spindle, on the other end of which the tool disk or turret is secured. The turret slide A travels, bringing one stop-rod at a time against the fixed bed.

An arrangement of multiple stops, "selected" by a radial action, though not set in a circle, is used in the Pratt & Whitney turret lathes. Each stop-rod is held in an adjustable bracket A, Fig. 10, bolted to the front side of the bed, set-screws being used for clamping; three of these only are visible in the view. As the turret rotates, a cam B, cut on its base, operates a roller C mounted on a pivoted lever D, and thus brings the flat end of another lever E, which is secured to the shaft of D, into line with one or another of the stop-rods, corresponding to the position of the tool-holes in the turret. The lever E is backed up by a lug projecting from the turret slide (not shown), taking the thrust, and eliminating spring.

A type of rotating stop which has been extensively adopted by turret lathe manufacturers during recent years is illustrated in Fig. 14. The principle is that of fitting a rotating slotted bar A somewhere in front of the turret slide, and gearing it up to the turret to turn in unison with the latter, so that a new face of the bar will be presented for each turret face presented to the work. T-slots in the bar provide for the attachment of stop-blocks or nuts, any number of which may be used on one face. As the turret slide travels along, these nuts come against either a trip lever or a dead stop which lies in their path, and so throw out the feed, and generally also act as dead stops. In the illustration, the nuts which happen to be on the face nearest the turret are touched by the bar B, and, by forcing this down, operate a rod that passes through the case, thus dropping the worm-box C and stopping the feed.

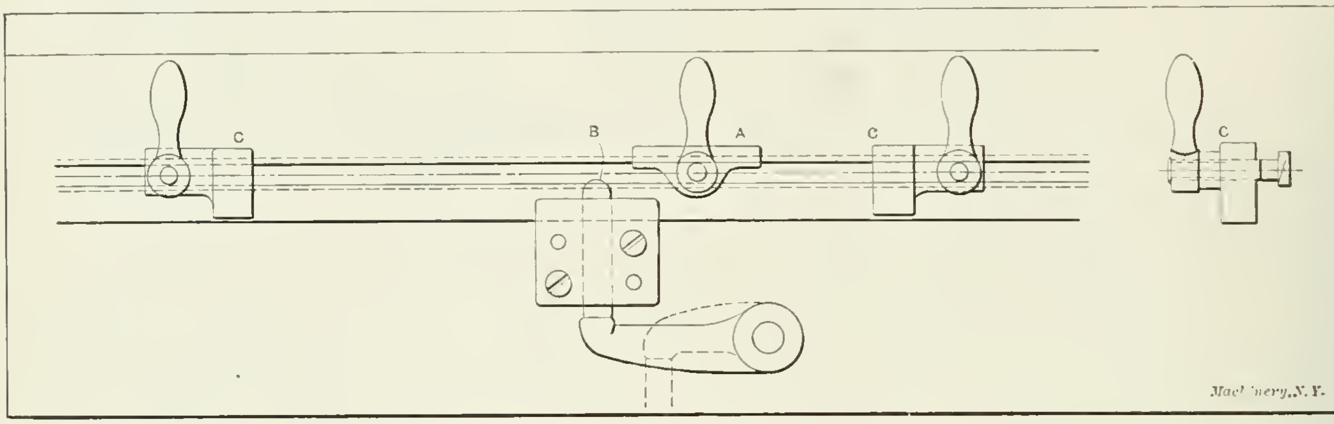

Fig. 15. Combined Trip and Dead Stops for Milling Machine Table

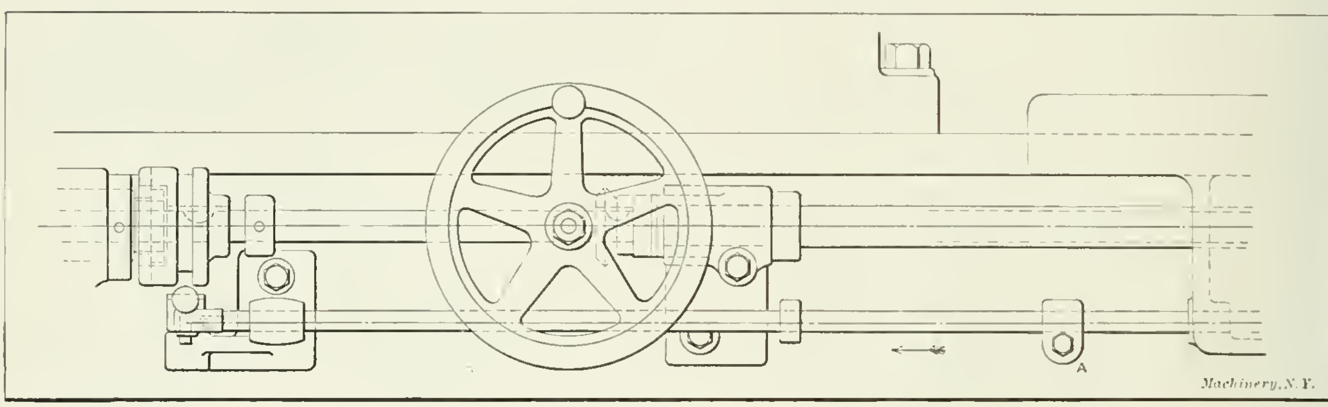

Fig. 16. Trip for Turret Lathe Cross-slide

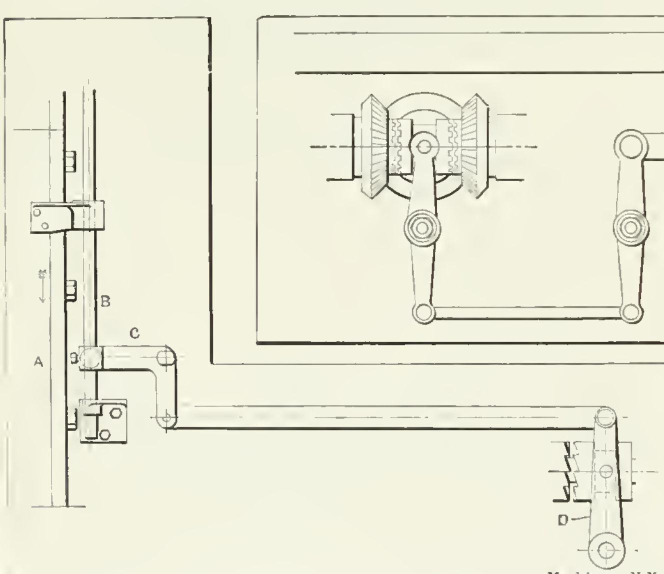

Fig. 17. Example of Single Trip without Reversal

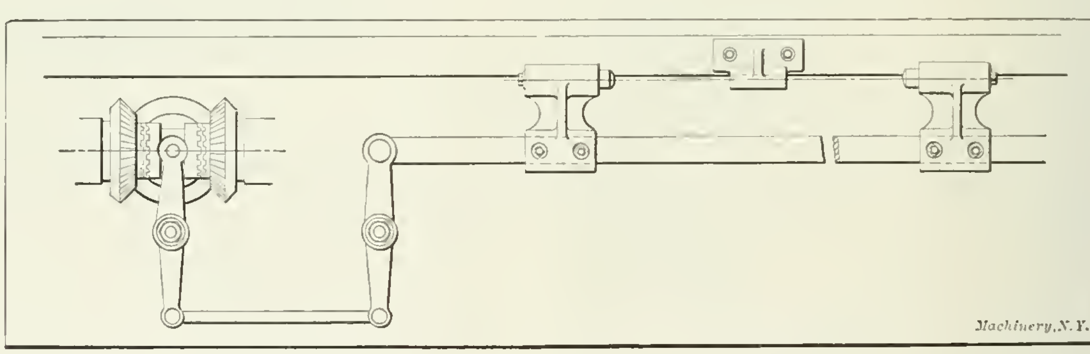

Fig. 18. Double Trip and Reversing Clutch for Grinding Machine

On the Alfred Herbert hexagon turret lathes a refinement of this type of stop is introduced for the purpose of obtaining the very finest limits in regard to length, by enabling uniform pressure to be put on the stops, independent of changes in the pressure on the cutting tools as they become dull. Fig. 13 shows the appearance of the saddle with the hexagon stop-rod in front, and the pilot handle or spider. In front of the latter is a disk A, rotating with the shaft, and carrying three adjustable dogs (see the detailed view, Fig. 12) with index lines upon them. The saddle has a fixed sector with three lines corresponding with those on the dogs. After the feed has been tripped by the contact of one of the stops on the bar with the end of the vertical plunger seen in Fig. 13, the saddle can be moved a short distance by hand up to a dead stop. When the saddle is hard up against this stop, one of the dogs

on the disk is set to come opposite one of the three index lines on the sector. The dog thus forms an accurate means of measuring the pressure on the dead stop. If more than one length is required the two other dogs may be brought into use.

The combined trip and dead stop is found in other machines besides turret lathes. Fig. 15 represents the front of a milling machine table, with a trip dog *A* which presses down the plunger *B*, and through a pair of levers throws out the feed. The stops *C* are set to abut against the block which receives *B*, and thus act as dead stops, positively arresting the table, so that dead lengths can be milled. If the milling cutter simply has to clear over the ends of the work, the dead stops need not be set, but if the travel has to be stopped at definite positions, they are brought into employment.

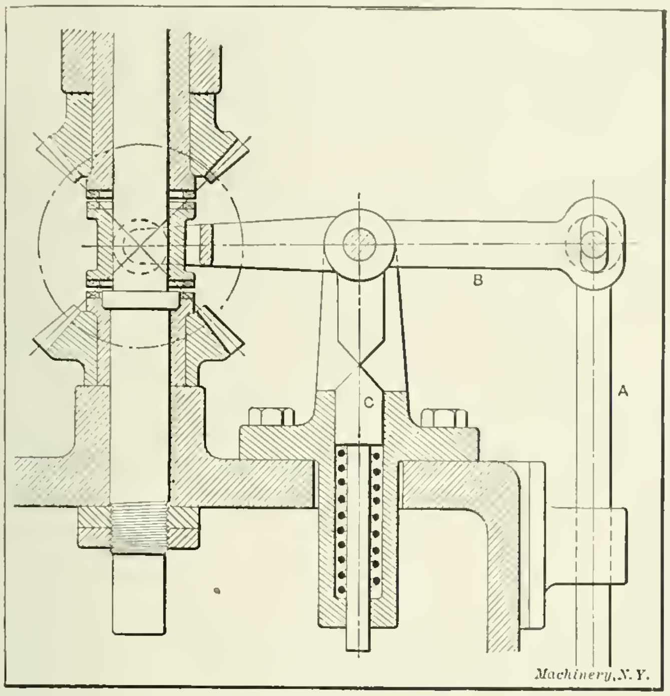

Fig. 19. Method of Locking Clutch by Spring Plunger

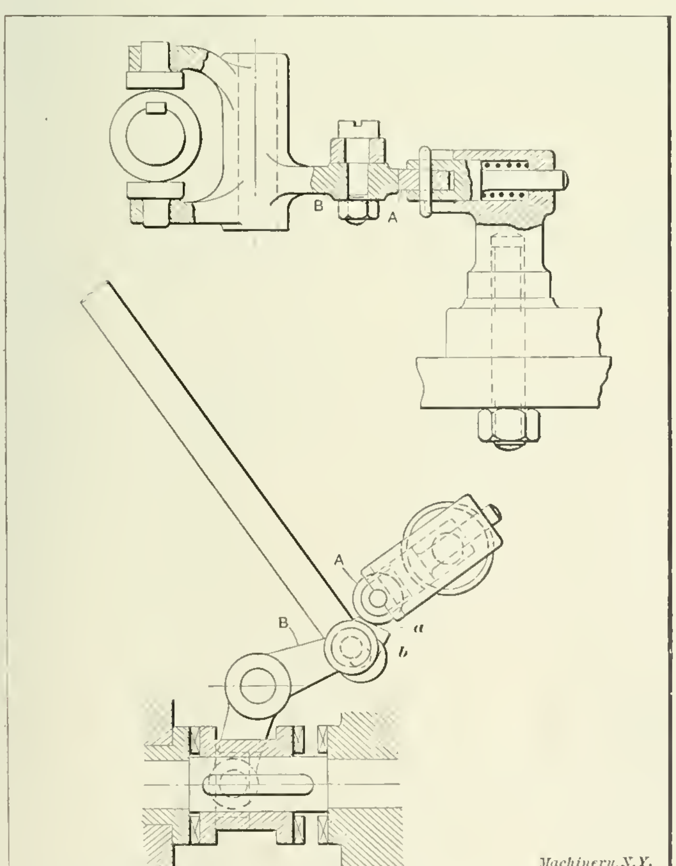

Fig. 20. Spring Plunger applied to Clutch-reversing Mechanism

When a feed has to be tripped, the actual medium by which it is thrown out depends on circumstances; it may be either through shifting belts, by sliding clutches—toothed or friction—or through a drop-worm. The difficulty with toothed clutches is that of insuring the re-engagement of the teeth. They are reliable enough, when hand-operated, but may fail when an attempt is made to render the mechanism self-acting, unless the clutches are actuated by springs or a lever. To render the action absolutely precise, an element must be included to cause both the release and the engagement to take place at an instant. A spring plunger is the device often adopted. A spring is compressed by the movement of the striking lever, which at the same time releases a trigger or catch, setting the spring free to push the clutch into engagement. This method is obviously capable of various applications. The springs may be actuated by a lever or by cams or by other means. A latch or latches lock the mechanism, rendering it impossible to throw any other movement in until they are released. This feature is worked out in various ways and is embodied in several gear-cutting machines to prevent interference between the indexing and cutting operations.

Two types of simple trips, operating clutches which must be re-engaged by hand, are shown in Figs. 16 and 17. The first is for a turret lathe cross-slide, the second for a gear-cutting machine. In Fig. 16 the saddle strikes the clamp-collar *A* on the stop-rod, moving the latter to the left, and actuating the lever which throws out the toothed clutch, stopping the feed to the saddle. In Fig. 17 the function is similar, in that the downward movement of the slide *A* is stopped; a bracket bolted to this embraces the rod *B* on the fixed part of the machine, and strikes the lever *C* which actuates, through a link, lever *D*, thus throwing out the clutch, and stopping the feed.

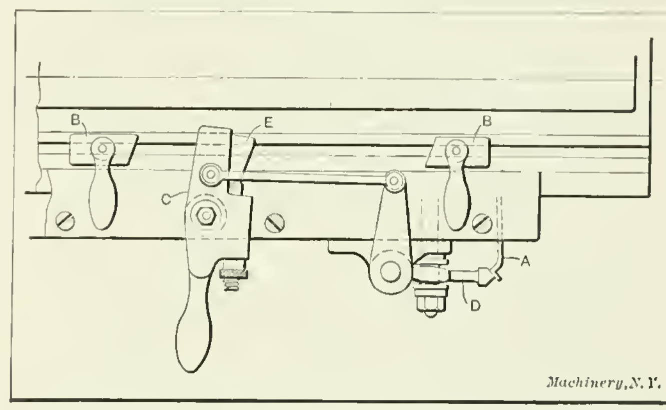

Fig. 21. Spring Locking Arrangement for the Shaper-reversing Mechanism

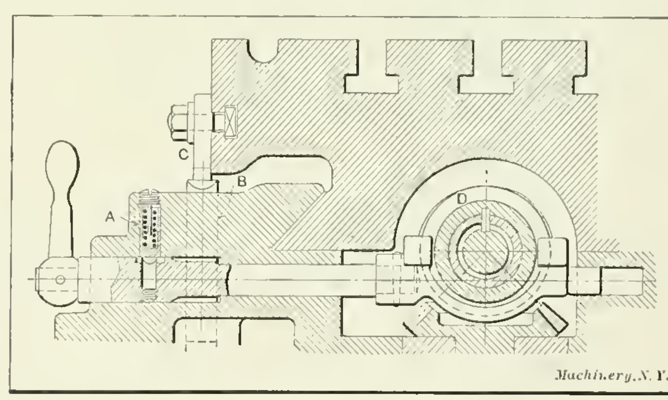

Fig. 22. Locking Mechanism for Clutch for Milling Machine Feed-screw

A double trip and reversing mechanism for a large grinding machine is shown in Fig. 18. In this arrangement the dog is bolted to the edge of the moving table, and strikes against adjustable dogs on the flat striking bar, which is connected by levers to the toothed clutch. In this design the table feeds and reverses so long as the driving mechanism is running. This brings us to the question of locking, that is retaining a clutch or other gear in mesh as long as it has to drive. Without some means of locking, there is nothing to prevent the clutch from disengaging under the effects of vibration. The simplest and most common method is to fit a spring plunger with a pointed end, or with a roller, which slips down along a beveled end on one of the levers, or into

recesses, there being many ways of accomplishing the desired result. Fig. 19 shows the principle applied to a toothed clutch set between miter gears, for reversing a grinding machine. When the stop-rod A is shifted endwise it moves the lever B over, and the left-hand end of B throws the clutch into mesh. Simultaneously the plunger C moves outward

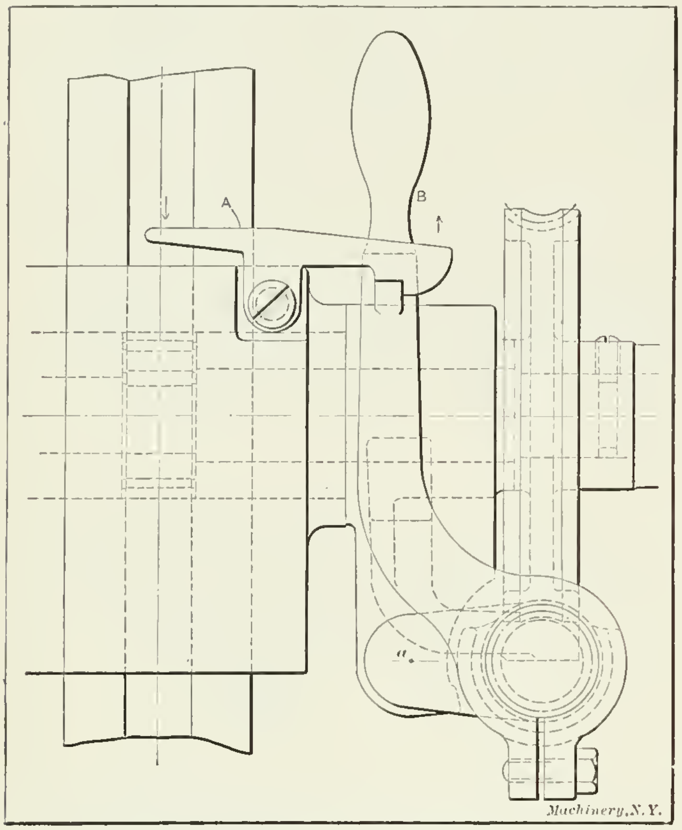

Fig. 23. Trigger Trip for Drop Worm-box

under the action of the coiled spring, and its beveled end locks with the beveled end of the short extension on B, thus

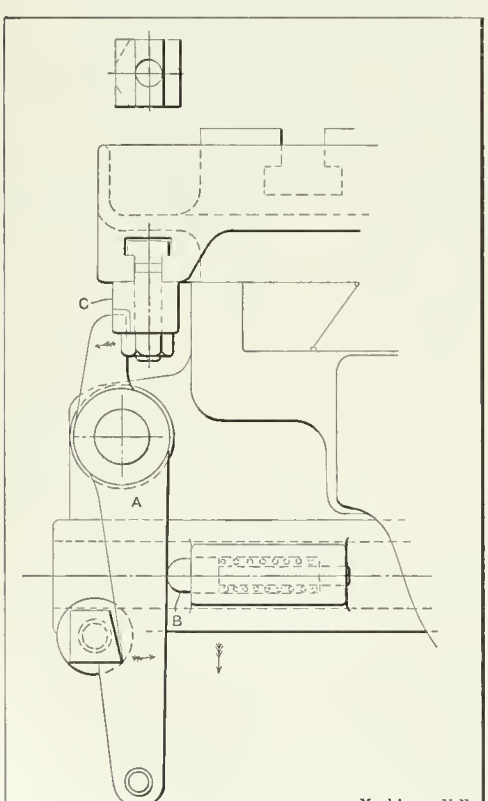

Fig. 25. Latch for Drop Worm for Milling Machine

forcing the clutch positively into full engagement, and holding it there until reversal again occurs. Another example of the spring plunger arrangement is illustrated in Fig. 20. This design is taken from the clutch-reversing mechanism of a special gear cutter. The locking is effected by a roller A mounted in a stup or plunger, and forced outward by a spiral spring contained in the holder. As the lever B is thrown over by the long lever pivoted to it, the roller is moved from the flat face a to the face b, thus retaining lever B in position.

Another method, see Fig. 21, utilizes the bent end of a flat spring A to lock the beveled end of a lever in its two positions. This example is taken from a shaping machine, in which the dogs B, bolted to the T-slot in the top of the ram, encounter the trip lever C and throw it over, thus actuating the two connecting levers which move the lever D, the lat-

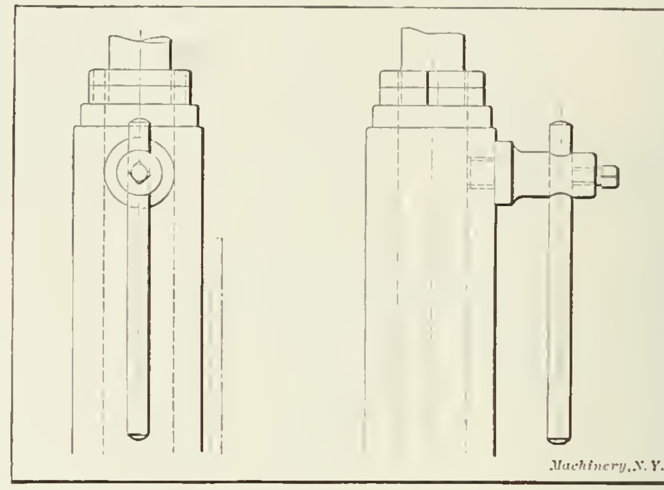

Fig. 24. Trip Rod Fitted to Drill Press Sleeve

ter sliding the rod which throws in the friction clutch inside the belt pulleys. E is a wedge, adjusted in either direction by the screw and knurled nut, by which fine adjustments in length of stroke are obtained while the machine is running.

In cases where a clutch is thrown over by the part rotation of a spindle, the latter may be utilized in connection with the locking as in Fig. 22, which shows a mechanism for a milling machine table. A plunger is situated at A, which catches in the stud inserted in the spindle below, and retains the latter

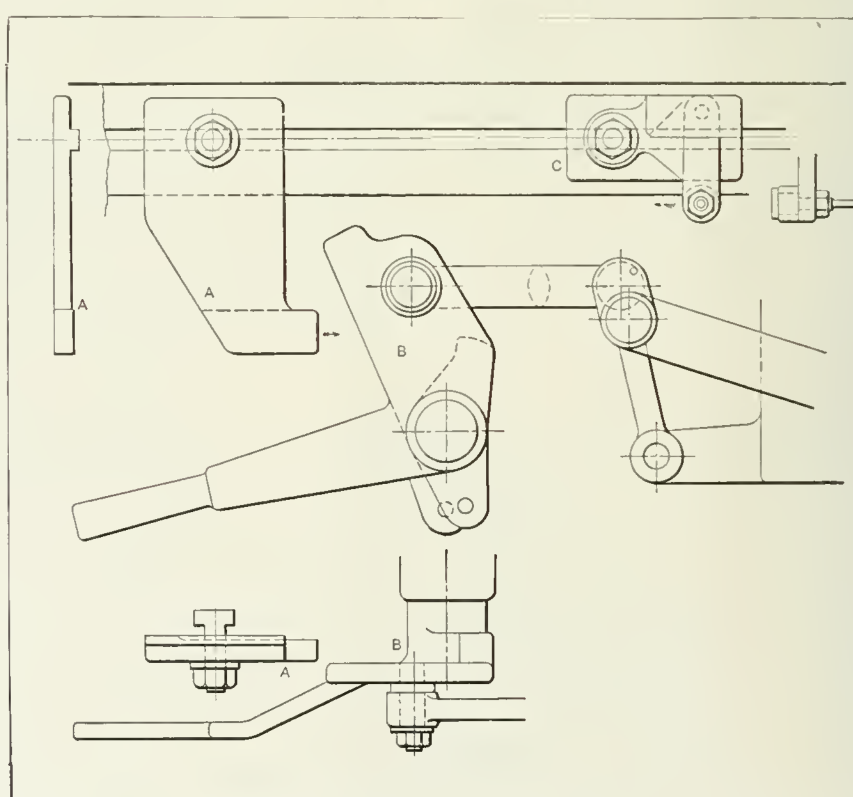

Fig. 26. Belt-shifting Mechanism for Planer

in position. The part rotation of the spindle is effected through a plunger rack B, meshing with the teeth cut on the spindle, and forced downwards by the bevel-edged dog C on

the edge of the table. *D* is the toothed clutch thrown into gear by the movement of the spindle, thus setting the table feed-screw into action.

Worm trips are very much in favor on account of their simplicity and their instantaneous effect. The box containing the worm is simply released and falls by the action of gravity, instantly disengaging the teeth from those of the wheel. Two examples of this mode of action will suffice. Fig. 23 is a trip applied to an upright drill, in which the end of a lever *A* is struck by the downcoming collar or rod on the spindle sleeve, raising the other end of the lever, which is formed as a trig-

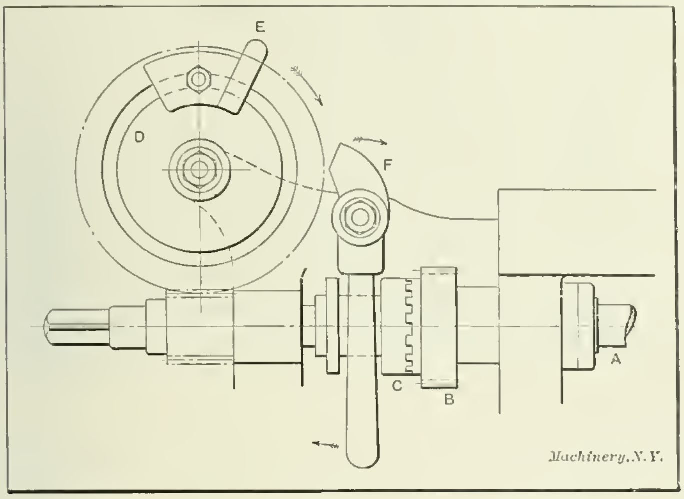

Fig. 27. Trip of the Disk Type used on a Boring Mill

ger, and releasing the handle *B*, which is clamped to the worm-box, pivoted at point *a*. The worm-box and handle turn on the axis passing through *a*, and thus the worm is allowed to fall away from its gear. The striking of the lever *A* is generally accomplished by an adjustable collar, clamped at any desired position on the spindle sleeve, or by a rod, as in Fig. 24, held in a stud projecting out from the sleeve.

Fig. 25 is a drop latch fitted to the table of a vertical milling machine, which drops the worm from engagement with the gear that turns the table screw. So long as the latch *A* remains in the position shown, maintained by the spring

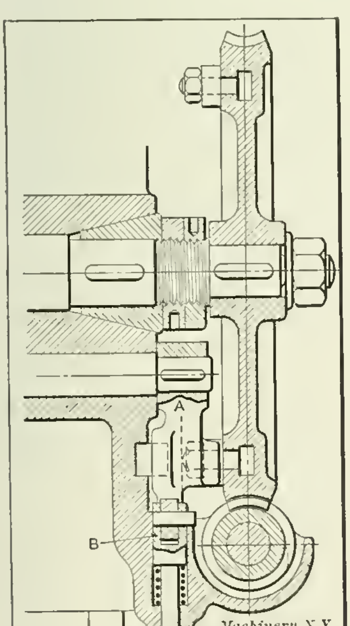

Fig. 29. Trip Actuated from Worm-wheel

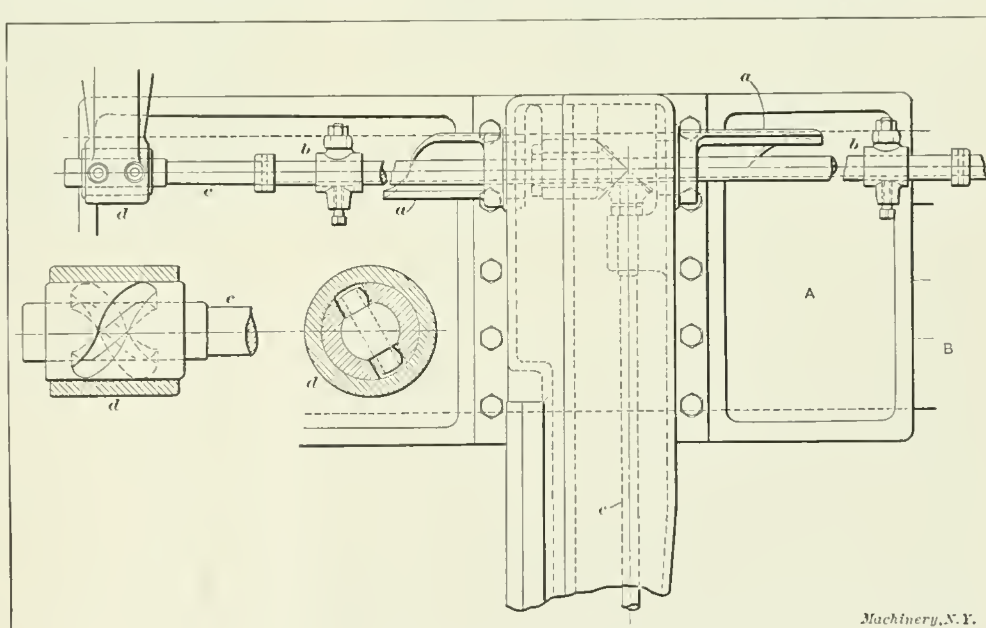

Fig. 30. Combined Reversing and Feeding Mechanism for Side Planer

plunger *B*, the shoulder cut in it retains the end of the worm-shaft bearing in place, but when dog *C* on the under side of the table comes against the short end of *A*, the latter is tilted, and the worm drops.

With regard to belt-shifting mechanisms, the difficulty of producing the necessary amount of belt travel with a small amount of stop lever movement is overcome by magnifying the effect of a cam plate and long belt levers. The operating tappet mechanism is comparatively simple, comprising in general a striking dog *A*, Fig. 26, which knocks over the lever *B*, connected by other levers with the belt-shifting mechanism. The return of the lever *B* is produced by the other dog or tappet *C*, the catch of which can be tipped up, out of the way.

The fitting of trip motions to disks is adopted in various ways, a stop-block being usually bolted to the disk so that at

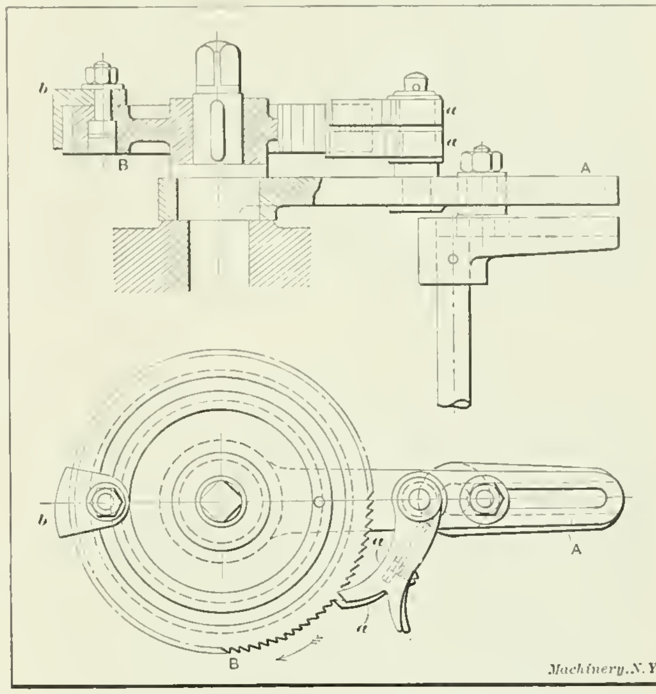

Fig. 28. Ratchet Feed Trip for Gear-cutter

a certain point in the revolution, the block actuates the trip gear and throws out a certain movement. Thus in Fig. 29, the worm-wheel has dogs bolted to a T-slot in its face, and these dogs strike a swinging lever *A*, thus imparting a partial rotation to the shaft on which it is keyed, and dropping, through a rack and pinion, a slide which carries a sector gear that has to be disengaged. The spring plunger and roller *B* keep the lever *A* in either of its two positions, the roller pressing on one or the other of the two slopes of the beveled end. Another interesting application of the disk trip is illustrated in Fig. 27, which shows the end of a boring mill cross-rail. When the clutch *C* is in gear, the feed-screw *A* is turned by a gear *B*, operated from other spur gears not shown. A worm-wheel *D*, with a T-slot in its face for carrying a dog *E*, is driven by a worm on the extension of the screw *A*. When, therefore, the clutch is in mesh, the wheel *D* con-

tinues to rotate until E comes in contact with the beveled end of the trip lever F, and the latter is pushed over, disengaging the clutch, and stopping the rotation of A. Dog E is set at any required position on the circle to trip the feed at the desired position of the cross-slide on the rail. Another variation of the same idea is shown in Fig. 28, illustrating a feeding device for a gear-cutter. A slotted lever A is rocked to and fro, and by means of the pawls a gives intermittent turning movements to the ratchet wheel B. This continues until the dog b comes in the way of the pawls, which are then thrust out of engagement with B, thus stopping the feed.

In certain cases the feed is engaged automatically at the same time that the reversal occurs, as in planers. An interesting device, applied specially to the Richards' side planing machines made by Geo. Richards & Co., Ltd., Manchester, is used for giving the down feed to the tool-box that is situated at the end of the long arm. When the saddle A, Fig. 30, travels along the bed B, propelled by its screw turned by belt pulleys with open and crossed belts, a pair of horns a, bolted

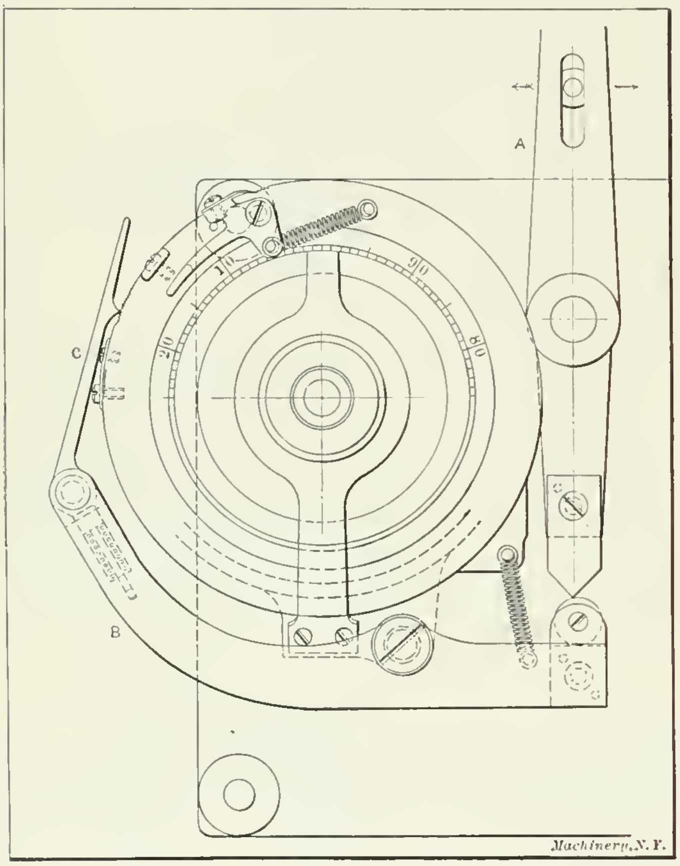

Fig. 31. Combined Reversing and Feeding Mechanism for Grinding Machine

to A, strike dogs b, mounted on a rod c, which by its longitudinal movement actuates the belt-shifting mechanism and produces the reversals, as in an ordinary planer. But the rod c is also given a twisting movement, in the following manner: Within the bearing d is a bushing, having cam grooves cut in its walls as shown in the enlarged detail, these grooves receiving rollers on the ends of a pin that passes through the rod c. When therefore c is slid endwise it must twist the rod, because the bushing cannot turn. Another rod e, through the medium of miter gears, imparts the down feed to the screw of the tool-box through a ratchet gear.

The combined reversal and feed is also applied to grinding machines, to feed the wheel a slight amount after each pass or stroke. One illustration of this class of mechanism as fitted to the Birch grinders is seen in Fig. 31. The rocking of the lever A in alternate directions when struck by the table dogs has the effect of rocking B up and down, and causing the spring-maintained pawl C to feed the disk, on the periphery of which fine ratchet teeth are cut. Hand adjustment is obtained by the small lever seen near the top. A somewhat more elaborate type of mechanism was shown in MACHINERY for May, 1909, in an article entitled "Machine Shop Practice—Cylindrical Grinding."

SPECIAL TOOL-ROOM APPLIANCES IN A RAILROAD SHOP

By RALPH E. FLANDERS*

The tool-room at the Juniata Shops of the Pennsylvania Railroad, at Altoona, Pa., is remarkable for the range in size and accuracy of the work it is called upon to perform. Not only do they make here the rough dies required for bulldozer and other machine forging operations, but the workmen are prepared at a moment's notice to break off on such work and undertake the building of the fine instrument parts for a locomotive test plant or a precision dynamometer car. Besides this ability to do fine work, there is a large fund of native ingenuity lying around loose in the organization. The tools and devices herewith illustrated and described will give ample evidence of the truth of this assertion.

Micrometer for Odd-fluted Reamers, etc.

Fig. 1 shows a simple special micrometer. It is used for measuring the diameters of counterbores, reamers, etc., with odd numbers of flutes. It performs this awkward operation in a simple and easy manner. As may be seen, the instrument resembles a vernier caliper, having a blade provided with a split hub for clamping to the tail center of the grinding machine; the usual adjustable jaw and fine adjustment slides are provided. There are, however, no scale or vernier graduations. What would ordinarily be the jaw carries a micrometer spindle instead.

To illustrate the use of this instrument, suppose it is desired to grind a counterbore, like that shown, to a diameter of 2.396 inches. First a standard 2-inch plug gage is set on the centers of the grinder, and the slide or jaw carrying the the micrometer spindle is adjusted until the graduations on the spindle read to zero when the point of the measuring screw is brought down against the surface of the plug. The micrometer spindle is now screwed back out of the way, and the work is set in place on the centers. The counterbore is to be ground to a diameter 0.396 inch larger than that of the standard plug, or to a radius one-half that, or 0.198 inch, larger. It is therefore ground until, when measured by the micrometer in the way shown in the engraving, the graduations on the barrel of the micrometer read 0.198 inch, which shows that the counterbore has been reduced to the required diameter.

Grinding Reamers with Eccentric Relief

Figs. 2 and 3 show an eccentric reamer grinding device, which is in almost constant use, owing to the immense number of straight and (particularly) taper reamers used about a railroad shop. This device grinds the reamers eccentrically, so that they are provided with a better relief at the top of the blades than is given with the old-fashioned straight or concave grinding. The action consists in rocking the reamer about a center, so set as to give the proper contour to the blade being ground. This rocking takes place rapidly and continuously, while the table is moving the reamer back and forth past the wheel by the regular reversing feed mechanism.

The device is operated by a belt from the countershaft, running over the pulley which is mounted on a shaft connecting the two heads C. The mechanism is identical in each head. The shaft on which the pulley is mounted is connected by an adjustable cam movement with the sleeves B in which the work centers are mounted. This mechanism rocks the sleeves rapidly, and with them the work. The centers in each head may be adjusted in their sleeves to the proper degree of eccentricity and to the proper position. Provision is likewise made for indexing the reamer from one tooth to the other, as each is completed. As shown in Fig. 3, this consists of a gage D, provided with a tooth-rest against which each blade of the reamer is lined up in turn, while it is being adjusted for sharpening. This rest is swung out of the way before the rocking mechanism of the attachment is started in operation.

All the various adjustments provided facilitate the operation of the grinding to such an extent that the device is practically as rapid in operation as the old style arrangement giving flat or concave relief; and at the same time it gives

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far superior results. The heads C can, of course, be set to any center distance, and the table of the machine can be set to any angle for taper reamers. All the other adjustable features of the standard grinding machine have also been retained.

The Thread Pitch Testing Machine

In Fig. 4 is shown what is in some respects the most interesting of the special tools which have been made and used at

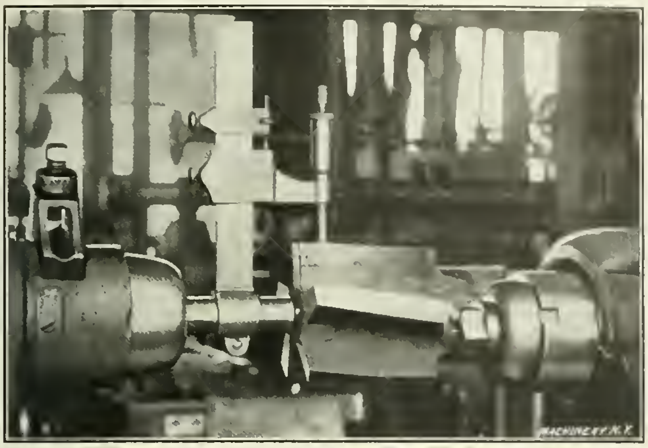

Fig. 1. Micrometer for Measuring Odd-fluted Counterbores, Reamers, etc.

this shop. This is a thread testing device, which finds steady and profitable employment in the measurement of taps, staybolts, lead-screws, etc. The device is mounted on a baseplate E, and is provided with head- and foot-stocks F in which centered work is mounted, and with V-supports G for uncentered work. These are shown in use in Fig. 6. The V-supports are provided with vertical adjustments for bringing the center

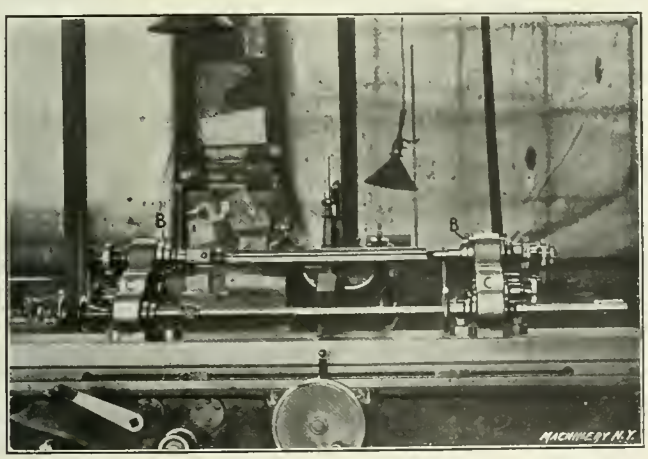

Fig. 2. Eccentric Grinding Device, for Straight and Taper Reamers

line of the work parallel with the base, and at the same height as the measuring points of the instrument.

The instrument or indicator itself is most plainly shown in the detail view in Fig. 5. It comprises a standard on which is pivoted a sensitive spring pointer H, and a stationary pointer J. The latter is mounted on a bar K, which may be minutely adjusted lengthwise by the adjusting screw L. The indications of pointer H are read on dial M, whose support may be adjusted in a circular dove-tailed slot about the center of the pivot of H, to bring the reading to zero whenever desired. This adjustment is effected by screw N, and is clamped by screw O. Spring stop-screws P limit the extreme movements of the needle.

The method of using this instrument will be readily understood from the engravings. One form of test which may be made with it is that of investigating the uniformity of the lead of a supposedly accurate screw. In Fig. 4, for instance, the points are adjusted to span any suitable number of threads, and the instrument is pushed up to the screw to be measured until the measuring points are firmly pressed into the threads. Scale M, see Fig. 5, is then adjusted until the pointer indicates zero. The instrument is then moved from one place to another, along the thread, and in all positions the pointer should evidently indicate zero, if the thread is uniform in pitch through its entire length. If it is not uniform, this will be shown in the variation from zero in one direction or the other of the pointer on the dial; and the amount of variation can be read, since the dial is graduated to thousandths of an inch.

Another use of this tool is in finding the amount by which threads are longer or shorter than the true pitch. In this kind of investigation the indicator is first set to zero, as previously described, on a model screw of known accuracy. The unknown screw to be tested is then put in place in the machine and measurements are taken at various points along its length. The readings given on the dial then show whether the pitch is long, short or irregular, and how much it is out in either case.

This instrument has the advantage of measuring on the sides of the thread at or near the pitch line. The indicating

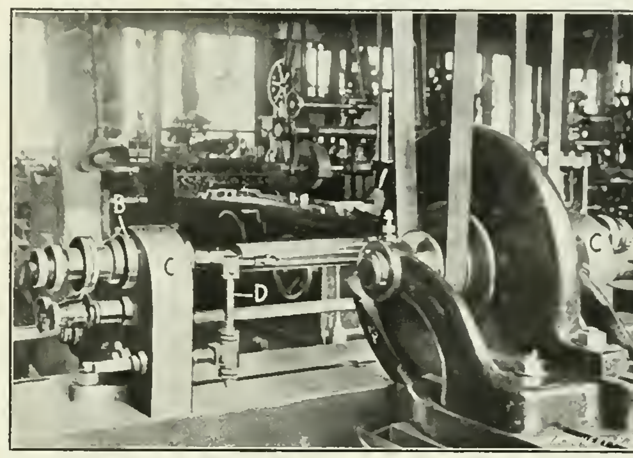

Fig. 3. Rear View of Reamer Grinding Attachment, showing Tooth Gage

points are given the shape of balls, and various sizes are provided to suit various pitches and shapes of threads. An extra set is shown at Q in Fig. 4. Various model screws for comparative measurements are also shown in this engraving at R, and bars of various lengths for carrying the fixed indicating point are shown at K_1 and K_2. The whole arrangement makes the instrument practically universal in application, since baseplates of any length may be used, or long lead-screws may be held on any plane surface, suitably supported with their center lines parallel with the base and at the right height for the instrument.

Results of a Campaign of Thread Testing

This apparatus made its debut in the work of testing the lead of stay-bolts and of stay-bolt taps. As every boilermaker knows, it is a matter of considerable difficulty to keep the pitches of the corresponding bolts and taps accurately to

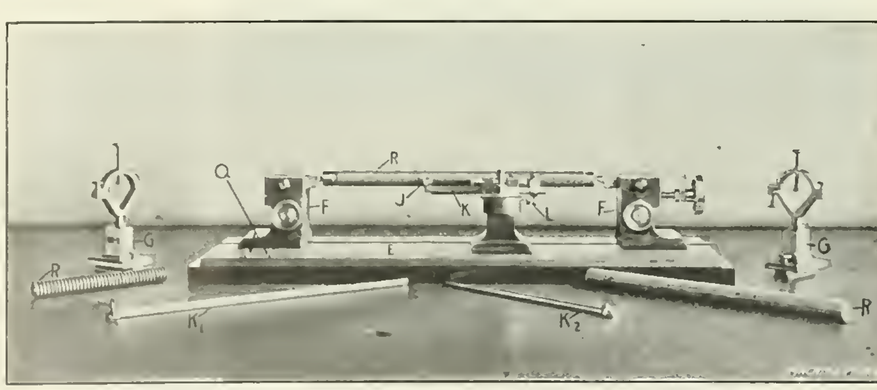

Fig. 4. Instrument for Testing the Accuracy of the Pitch of Screw Threads

standard. If they are not accurately to the standard pitch, the stay-bolt, when it is screwed into place, springs the fire-box sheets out or in, as the case may be. Thus some of the bolts are under initial compression, while their neighbors may be under initial tension, so the fire-box and side sheets in the

boiler itself are sprung out of true in every way, setting up dangerous internal strains which bring delay and danger in their train.

Two important reforms resulted from the investigations undertaken on these matters. One of these was the design of an automatic machine for cutting stay-bolts, in which the die was guided by an accurate lead-screw. This settled the stay-bolt trouble. The second reform made was the manufacture of stay-bolt taps in the tool-room of the Juniata shops, instead of buying them from commercial manufacturers. It was at that time found impossible to obtain commercial taps which came up to the limit of accuracy considered necessary for boiler work on the Pennsylvania Railroad. For a number of years, therefore, the tool-room has been making all the stay-bolt taps used, with satisfaction to all parties immediately concerned.

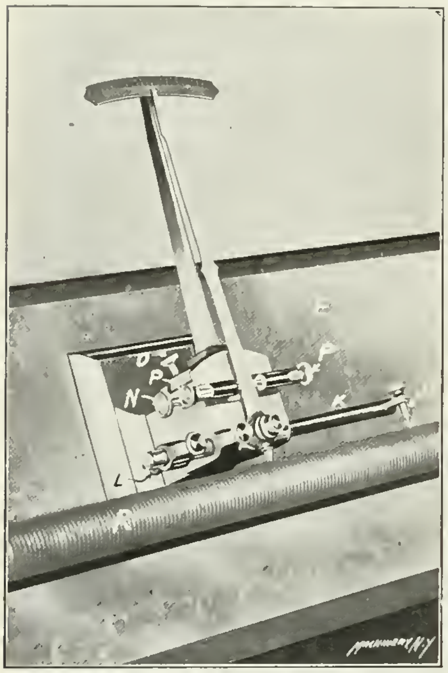

Fig. 5. Detail View of the Thread Testing Indicator

* * *

COMPARISONS BETWEEN ENGLISH AND AMERICAN LATHE DESIGN

In addressing the Sheffield (England) Society of Engineers on "Comparisons between English and American Lathe Design," Mr. G. W. Burley, of the Applied Science Department of the Sheffield University, stated that in almost every detail, lathes of English and American design differ. In regard to high-speed lathes, Americans are adopting gear-driven feed-rods, while English lathe designers are returning to the belt, their reason being that the belt acts as a safety valve and prevents breakage should anything occur to the tool causing it to refuse to cut. The main features of American lathes were stated to be handiness and facility of operation, while the main features of English lathes were strength and capacity.

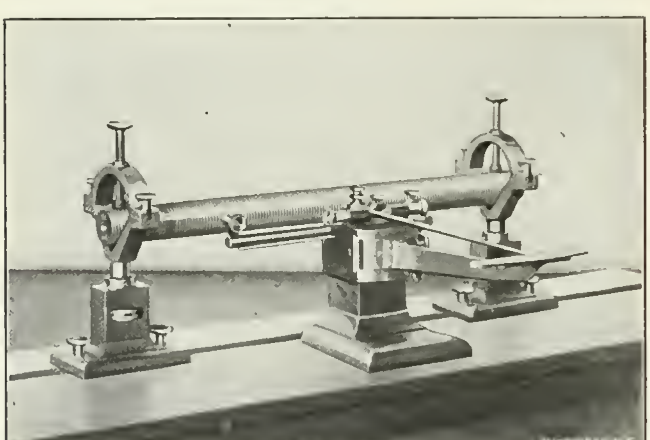

Fig. 6. Thread Testing Instrument with V-block Work-holders in Use

* * *

Investigations conducted in 1908 by Mr. A. Philip indicate that in order to obtain phosphor-bronze of a tensile strength of 38,000 pounds per square inch, with an elongation of not less than 20 per cent, it should consist of a mixture within the following limits: copper, 90 to 92 per cent; tin, 9.7 to 7.4 per cent; phosphorus, 0.3 to 0.6 per cent.

THE STATUS OF PROCESS INVENTIONS*

By E. D. SEWALL†

The laws of the United States provide for the grant of a patent to any one who has invented any new and useful art, machine, manufacture or composition of matter. An "art" within the meaning of the patent law is a way of accomplishing a result—a process, or a method.

The patent laws do not extend protection to all inventions. The Constitution authorized the enactment of such laws "to promote the progress of science and the useful arts." It is therefore clear that the subjects of invention for which patent protection may be had are limited to those that fall within the domain of science and the useful arts.

There are no doubts that new and useful machines, manufactures, and compositions of matter are subjects for patent protection, because inventions of such character clearly fall within the constitutional limitation. Machines and manufactured articles are concrete things cognizable both by the senses and the intellect. They are vendable commodities—products of the industrial arts. The doubts arise with respect to "art" or process inventions, which are abstract things, cognizable only by the intellect, although the results of such inventions may or may not be perceptible to the senses.

Judicial interpellation indicates that process inventions whose results can be apprehended only through the intellect are not patentable, while those that produce a change in the condition of matter that is perceptible to the senses may be patentable. Thus, a method of doing business, of training and educating animals, or of playing a game of cards is not patentable, while a way of making a chemical composition or a car wheel, developing power, or transmitting sounds may be patentable. The first three of the methods referred to are purely intellectual schemes producing no physical changes, while the last three effect perceptible changes in the condition of matter.

Thus, with respect to art or process inventions, arise the most fundamental doubts in the law of patents. And with respect to such inventions, even when clearly relating to the "useful arts" within the constitutional provision, the greatest uncertainty has prevailed throughout the history of patent law, both in this country and abroad. Courts, lawyers of long experience, and the Patent Office, have denied the protection of a patent to new and useful arts which were admittedly inventions. They have doubted the patentability of a process when apparatus was essential to its practice, or when no chemical reaction or "similar elemental" force took part in it.

Prejudice Against Process Patents

This prejudice against and this uncertainty with respect to processes, has resulted in injury to inventors as well as to the public. It has lost to inventors the full measure of protection to which their inventions entitled them, and has rendered so uncertain a large part of the property in inventions, especially the more fundamental ones, that the interested public hesitates to manufacture and use what seems to be unprotected by patent for fear of some unexpected construction by the courts.

The phrases "mechanical process" and "function of the machine" have been disastrous to many a valuable invention. It has been enough to say that a process is merely "manipulative," involving "no chemical or other elemental action," to deny its patentability. And the description and illustration of a machine adapted to carry out a wholly new and valuable process in an application for a patent for that process, have been sufficient excuse for refusing a patent for that process on the ground that it was the mere function of the machine illustrated and described. Also, patents have been refused for new manipulative processes of making old manufactures while, absurdly enough, claims have been allowed for the old manufactures defined by the way in which they were made. And, with equal absurdity, where claims for new processes

* For other articles on patents, previously published in MACHINERY, see: "Forfeiture of Patent Rights," December, 1908; "Unlawful Uses of Patented Machines," October, 1908; "Patents and Inventors," August, 1908; "Patents and Inventors," June, 1908; "On the State of the Patent Office," March, 1908; "Patentability of Inventions," November, 1906; etc.

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have been refused on the ground that they were the mere function of the machines set forth for practicing them, claims for the machines have been allowed in the bald terms of the several means for carrying out the successive steps of the denied process.

Assume it to have been generally perceived desirable to construct a car wheel with (1) a hard steel rim, and with (2) a soft steel hub and web, but that it was not known how it could be made and that an inventor discovers a way of making such a wheel. He applies for a patent for "a car wheel having a hard steel rim and a soft steel hub and web integral therewith," and also for the method of making it which consists in:

(1) Forming a rim portion having a circumferential groove in its inner periphery, (2) separately forming a hub and web portion in one piece of less diameter than the internal diameter of the rim, (3) centering the hub and web within the rim, and then (4) enlarging the diameter of the web by applying forging pressure thereto to thin and expand it into contact with the surface of the rim within the groove and (5) weld uniting the web and rim.

The claim for the article meets with rejection because it defines only a conception of a thing recognized in the art as desirable—a mere perception of a want, an obvious article, the problem of making which had not hitherto been solved. The process claim meets with rejection because for mechanical operations involving "no chemical or elemental action." But, in recognition that the applicant has accomplished something new, he is allowed a claim as follows:

A car wheel having (1) a hard steel rim with a grooved inner periphery, (2) a hub and web of soft steel which has been made of less diameter than the inner diameter of the rim and has been expanded into contact with the grooved portion of the rim by forging pressure and welded thereto.

It is quite obvious that this is a case of whipping the devil around the stump. The wheel continues to be merely a car wheel having a soft steel hub and web, and a hard steel rim, a patent for which was refused. The groove in the inner periphery of the rim has disappeared in the finished wheel and the web diameter is no longer less than that of the rim. The real problem before the inventor was how to make such a wheel, and the invention, if there was any, lay in the solution of that problem, *i. e.*, in the process.

Assume, again, that one who has been making large railroad spikes in a spike machine finds that he has to heat the bar repeatedly, because of the slow operation due to the heavy duty of the machine, thus consuming a lot of time and deteriorating the quality of the metal. He observes that the metal can be shaped by rolling much more rapidly than by forging. He therefore conceives of passing the heated bar rapidly through a pair of die rolls so formed as to rough shape the bar into a string of connected spike blanks, and then immediately feeding the bar to a spike machine, which may be geared to high speed because of the light work left to be done in finishing and cutting off the blanks. Thus he finds that he can forge an entire bar into spikes at one heat. He therefore makes application for a patent for:

The process of making spikes consisting in (1) heating a bar, (2) die rolling it into a string of connected partly-formed spikes, (3) cutting off and finishing the partly-formed spikes by forging.

The specification discloses a furnace, a stand of die rolls and a spike machine arranged in tandem relation so that the heated bar may be withdrawn from the furnace and fed between the rolls and into the spike machine in a straight path. The process claim is met with a rejection on the ground that the alleged process is merely the function of the machines shown. The applicant therefore claims:

The combination of a furnace, a set of die rolls and a spike machine

and the claim is allowed. Here it seems obvious that the real invention lay in the conception of the way of making spikes. Hot metal cannot be worked with the fingers. The furnace, the die rolls, and the spike machine were all well known instruments for working metal, and any mechanic would know well what instruments to make use of upon the mere directions of the inventor *how* to make the spikes, to wit: to heat the bar, die roll it, and then finish by forging the blanks. The allowance of the combination claim in this case is clearly another example of whipping the devil around the stump.

To the simple-minded it looks as if in each of the assumed examples the inventor had not received a patent for his actual invention, and could only be protected in the practice of it by the favorable construction of the court in case the terms of the specification were such that it could be so construed. And the chances are that having canceled the claims to his actual invention the patentee will not be allowed the same claim by construction, and that the thing actually claimed will be held unpatentable.

No Sound Reason for the Prejudice

It is impossible to draw from any person holding this prejudice against process inventions a sound reason for his attitude. The prevalence of it can hardly be explained except on the hypothesis of a blind inheritance of belief in erroneous premises adopted early in the history of the English law, strengthened in the minds of the case lawyers by dicta in certain decisions of our courts. That is to say, the prejudices against mechanical or manipulative processes have about the same kind of vague foundations as popular superstitions.

Our patent laws, although deriving their authority from the Constitution, yet derive their principles from the English law. In ancient times the monarch of England had a prerogative to grant monopoly patents. "The king," said Sir H. Finch, "hath a prerogative in all things that are not injurious to the subject; for in them, it must be remembered, that the king's prerogative stretcheth not to the doing of any wrong." This prerogative was in certain cases wisely exercised for the purpose of bringing into England and teaching to English subjects arts and trades of which the English people were ignorant. In the time of Elizabeth and James I especially this prerogative was stretched to the doing of wrong by monopoly grants giving control of industries and commodities already in possession of the people. For this reason Parliament enacted the famous statute of monopolies (21 Jac. 1, c, 3) declaring that all monopolies, grants, and letters patent

"heretofore made or granted, or hereafter to be made or granted......are and shall be utterly void.................... Provided also, and be it declared and enacted, that any declaration before-mentioned shall not extend to any letters patent or grants of privileges for the term of fourteen years, or under, hereafter to be made, of the sole working or making of any new manufacture within this realm, to the true and first inventor and inventors of such manufacture.............."

The statute of monopolies also excepted certain named existing grants such as the so-called smalt patents, which were for processes of making a certain blue dye and the product thereof, and Dudley's patent for a process of extracting iron from its ores by the use of sea coal.

English Court's Opinion on Watt's Alleged Process

In 1795 Watt's patent for a "method of lessening the consumption of steam and fuel in fire engines" came before the Court of Common Pleas. The specification set forth among other things, "My method of lessening the consumption of steam and consequently fuel, in fire engines, consists of the following principles: 1. That vessel in which the powers of steam are to be employed, to work the engine which is called the cylinder in common fire engines, and which I call the steam vessel, must, during the whole time the engine is at work, be kept as hot as the steam that enters it; first, by enclosing it in a core of wood, or any other materials that transmit heat slowly; secondly, by surrounding it with steam, or heated bodies; and thirdly, by suffering neither water nor any other substance colder than steam to enter or touch it during that time. 2. In engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam vessels or cylinders, although occasionally communicating with them; these vessels I call condensers, and while the engines are working, these condensers ought at least to be kept as cold as the air in the neighborhood of the engines, by application of water or other cold bodies." It is not necessary to quote further.

Watt's invention was the greatest of that time. The steam

engine was then known and in practical use, but was inefficient. Newcomen's engine and that of the Marquis of Worcester had no provision for keeping the cylinder hot and the steam which had done its work on the piston was condensed in the cylinder by injecting cold water. The cylinder was always kept cold, therefore, and the steam rapidly condensed as soon as it was admitted to the cylinder.

Watt's primary conception of ways was that the cylinder should be kept as hot as the steam so as to prevent the loss or heat and power, and his secondary conception of ways was to withdraw it alive from the cylinder and either condense it separately or allow it to exhaust and go to waste. As means to this way of keeping the cylinder hot, he covered it with a non-conductor of heat and also provided a steam jacket for it into which he conducted live steam; and as means to his way of taking care of the exhaust, he led it into a separate condensing vessel.

Heat and methods of generating it were known at that time. The cylinder of Newcomen's engine could be kept hot by building a fire under it, thus putting into practice fully Watt's primary conception of economizing steam without the use of any new means. Vessels and means to keep them cool, as well as valves and pipes for conducting fluids, were also well known at that time. So that Watt's secondary conception of ways of avoiding condensation in the cylinder could be carried out by known means.

At the trial it was persistently insisted on behalf of the patentee that the invention was a process and that he was entitled to cover under the patent any means by which the cylinder could be kept as hot as the steam and the steam condensed outside thereof. The defense urged that such contention could not be sustained, as to do so would be to sustain a patent for an abstract principle.

On the question of construction the court divided three to one, three of the judges holding the patent to be for an improvement in the construction of steam engines, while the chief justice alone held that the patent was for a process.

The majority of the judges held that the word "manufacture" in the Statute of Monopolies meant a means—a "vendible commodity"—although admitting that the term "manufactures" was commonly used to designate both the commodities made and the practice of making them. The argument seemed to take form in their minds something like this: (1) The word monopoly by derivation means an exclusive right to sell; a patent is a monopoly; therefore a patent is an exclusive right to sell. (2) Only commodities can be sold; a process is not a commodity but a principle—a mere abstract idea—therefore a process cannot be sold. (3) Conclusion—A patent can only be for a vendible commodity, and Watt's contention that his patent is for a method cannot be sustained since only vendible commodities are patentable. It must therefore be for a mechanical construction and not for a method.

Chief Justice Eyre's Opinion

On the other hand, the Chief Justice in his minority opinion wrote these wise words:

"Undoubtedly, there can be no patent for a mere principle; but for a principle so far embodied and connected with corporeal substances as to be in a condition to act and to produce effects in any art, trade, mystery or manual occupation, I think there may be a patent. Now this is, in my judgment, the thing for which the patent stated in the case was granted, and this is what the specification describes, though it miscalls it a principle. It is not that the patentee has conceived an abstract notion that the consumption of steam in fire engines may be lessened, but he has discovered a practical manner of doing it, and for that practical manner of doing it he has taken his patent.

"The substance of the invention is the discovery that the condensing of the steam out of the cylinder and protecting the cylinder from the external air and keeping it hot to the degree of steam heat will lessen the consumption of steam. This is no abstract principle; it is in its very statement clothed with practical application: It points out what is to be done in order to lessen the consumption of steam. Now the specification of such a discovery seems to consist in nothing more than saying to the constructors of fire engines, 'For the future condense your steam out of the body of the cylinder instead of condensing it within it, put something round the cylinder to protect it from the external air and to preserve the heat within it.'........ Any particular means of doing this, one should think, would hardly need to be pointed out, for it can scarcely be supposed that a workman, capable of constructing a fire engine, would not be capable of making such additions to it as should be necessary to enable him to execute that which the specification requires him to do.

"Some machinery, it is true, must be employed, but the machinery is not of the essence of the invention, but incidental to it."

The Chief Justice also pointed out that the language of the statute of monopolies defined a monopoly to be "the privilege of the sole buying, selling, making, working, or using anything within this realm," and that the statute excepts from condemnation privileges of "working or making of any new manufacture," which seemed clearly not necessarily to limit a patent monopoly to a vendible commodity.

This language of the statute received very little attention from the majority. They appear not to have considered that the royal prerogative was earliest exercised for the purpose of introducing new *trades* and "mysteries" into agricultural England, nor that the statute expressly excepted certain process patents such as those mentioned above.

Within the fifty years following the case of Boulton & Watt vs. Bull, the English courts passed many dicta, generally unfavorable to process patents. In Crane vs. Price, decided in 1842, it was finally definitely decided that a valid patent may be had for a process, without deciding that merely manipulative or mechanical processes were patentable. Even later, English law writers are found strenuously maintaining that processes, saving only chemical ones, are not patentable inventions.

No more accurate notion of the fundamental principles of the law governing the grant of patents for process inventions has been expressed than that of Chief Justice Eyre in the Watt case.

Opinion in the United States on Processes

The original United States patent act of 1790 defined the subjects of patentable inventions to be, "Any useful art, manufacture, engine, machine or device." This language is probably Jefferson's. He was thoroughly familiar with the history of monopolies and doubtless used the word "art" advisedly as the scholarly word to designate new trades, "mysteries" and industrial processes. It has persisted in successive statutes until to-day, and the courts have never had any hesitation in declaring that it means an industrial process, although they have had hesitation in declaring that all industrial processes are to be included under it.

In 1843 in the case of McClurg vs. Kingsland, the United States Supreme Court held valid a patent for "a mode of casting chilled rollers and other metallic cylinders and cones," which consisted in injecting molten metal into a mold tangentially, thereby imparting a rotary motion to it, which had the effect of concentrating the dross at the center. In 1871 in Mowry vs. Whitney, the same court sustained a patent for a process of making cast-iron car wheels which consisted in casting a wheel in a mold, removing it from the mold as soon as it had cooled sufficiently to hold its form, then subjecting it to heat to raise its temperature uniformly to a point a little below that at which it fuses, and then slowly cooling it, thus carefully annealing it in all parts. In 1876, in Cochrane vs. Deener, a process of bolting flour by passing it successively through bolting cloths of successively finer mesh and applying air currents close to the surface of the cloths to remove the finer impurities, was sustained. In 1880, in Tilghman vs. Proctor, a process patent for the manufacture of fat acids and glycerine from fats by the action of water at high temperature and pressure was sustained. Many patents have been sustained where the claim was for a chemical reaction to produce a new substance or an old substance in a new way. In 1888, Bell's patent was sustained for "the method of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds." In 1898,

the Supreme Court, in Westinghouse vs. Boyden said "it may still be regarded as an open question whether the patentability of processes extends beyond this class of inventions" (meaning by "this class of inventions" those "which involve chemical or similar elemental action." In 1909, the Golding patent for a method of making expanded metal lathing by slitting, stretching and bending the slitted portions into diamond-shaped meshes, was sustained by the Supreme Court after the same patent had been held invalid by the Court of Appeals of one circuit on the ground that it was for a mechanical method—the mere function of the machine used—and had been sustained by the Court of Appeals of another circuit. In this case the Supreme Court cited with apparent approval the decision of the Circuit Court in Paper Bag Co. vs. Paper Bag Co., sustaining a patent for a process of making paper bags by folding the paper in a new way, the process having been practiced commercially by an automatic machine.

In 1853 the Supreme Court held invalid the claim of Morse for making intelligible signs at a distance by the use of the galvanic current, on the ground that it was a claim for a principle, and covered all possible ways of attaining the result arrived at. Since then it has invalidated many process patents as lacking invention. In 1895, it rendered a decision in the case of Risdon vs. Medart that has done more than any other ruling to unsettle confidence in process patents. That decision contained dicta from which it was widely inferred that only such processes as involved "chemical or similar elemental action" were of a patentable character. The actual point of the decision seems to have been based on the assumption that the process was the mere "function of a machine," although several machines were in fact used in making the pulley, which was the product that the process aimed to produce. Following this decision it seemed to be sufficient that a process was not of a chemical nature to deny its patentability. What the "similar elemental action" may be, has never been judicially defined.

Supreme Court Never Invalidated Clear Process Inventions

From the above hasty glance at a few decisions of the Supreme Court it may be deduced that neither a principle of nature, a desirable result, nor all ways of attaining a desirable result or applying a principle of nature, nor the function of a machine, are patentable subjects in their opinion. Specified ways of applying principles to secure a result, if they involve "chemical or similar elemental action," are subjects for process patents. The patentability of chemical processes has not been questioned. In one case, sustained, "similar elemental action" was centrifugal force applied to casting molten metal; in another it was the effect of heat applied so as to overcome the strains due to unequal radiation of hot metal when rapidly cooled; in another it was the application of air currents to flour in a certain way, as it was passed through bolting cloths; in another the application of electrical undulations to set up sound undulations in air; in another the mere tendency of paper to retain its folded form when folded, and in another the ductility and malleability of metal.

It is believed the United States Supreme Court has never reached a conclusion on the validity of a process patent that is at variance with the fundamental principles of lawful monopolies. They have never denied patentability to any process relating to the useful arts that involved invention, although there have been dicta from which misleading inferences can be drawn. It is difficult to reconcile a belief that manipulative or mere mechanical processes are not the subjects of a patent, in the opinion of the Supreme Court, in view of the decisions sustaining a process of bolting flour by the aid of bolting cloths and air currents, of folding paper in making paper bags, in slitting, bending and stretching metal in making metal lathing; or, in view of the same decisions, that the Supreme Court holds a process patent to be invalid where mechanism is absolutely necessary to practice it.

The Philosophy of Process Inventions

Three classes of inventions corresponding exactly with the intellectual laws of invention have always been expressly recognized in the United States statutes. These three classes are (1) the product or thing produced—represented by the words "manufacture" and "composition of matter," (2) the way or method of producing the product, or of accomplishing an industrial effect (when the product of the process is not a concrete thing, as a form of energy), represented by the word "art," (3) the instrument used to aid in practicing the "art," represented by the word "machine."

The order of inventive conception is (1) the product, (2) the process of making the product, (3) the machine for carrying out the process. In answer to the question "What shall I make?" the inventor conceives the product; to the question "How shall I make it?" he conceives the process; to the question "By what means shall I practice the process?" he conceives the machine. He must have a clear notion of a product before he can devise a process of making it and must perceive clearly the process before he can build a machine to practice that process. Patents rank in value in the same order. The patent for a manufacture gives the broadest possible protection, since subject to it are all possible processes of making it. The next broadest protection is afforded by the process patent since subject to it are all possible machines whose *modus operandi* is the process. The protection afforded by the apparatus or machine is the most limited of all. Of course a machine or apparatus may be the product desired, and the process of making that machine will then be inferior in patent value to the machine. Or the ultimate result may be an effect, not resulting in a manufacture, produced by a process carried out by the aid of a product which in turn becomes an instrument inferior in value to the process. But always, in the relation of value and rank, the process is higher than the instrument used in practicing it, and the product is higher than the process by which it was made.

Higher still than any of the three kinds of inventions—product, process, and apparatus—stand effect, result, principle, which are not inventions. In accordance with natural law and with the fundamental principles governing monopolies, principle, result, effect, cannot be monopolized. They are the property of all equally, and become known by perception, not by invention. There can be no lawful claim for an effect or principle. A claim in a patent or application for patent for an invention in any one of the three statutory classes conclusively concedes pre-knowledge of that which stands higher in rank. A claim for a product concedes pre-knowledge of the mode of using it and of the effect or results designed to be produced by its use; a claim for a process conclusively concedes pre-knowledge of the principles utilized in the process, of the product made by that process; and of all instruments the use of which is made a part of the process; a claim for an apparatus concedes previous knowledge of the process it is designed to practice.

The principles just stated are fundamental and essential to be applied in testing any alleged invention. It must also be remembered that all invention lies in the mental conception. For obvious reasons the invention is not a patentable one until it has been made potentially available to the public. But in testing any claim for the presence or absence of invention, the inventive conception must be resorted to and the rank of that conception determined.

Suppose one desired to make a hole in a metal plate. The production of the hole is the effect, not patentable. One way to attain this effect is to remove the metal by cutting it away in detail; another is by displacing the metal by forcing a punch into it; another by burning it in the presence of pure oxygen. One person might have a patent for one method, and another person a patent for another method of attaining this effect. Obviously the patent for displacing by the punch would not conflict in any way with that for oxidizing nor with that for cutting the metal away in chips.

Assume that the method of chipping away the metal is adopted. As metal cannot be worked without instruments an instrument for cutting a hole by chipping away the metal has to be devised. The twist drill is conceived, which is one of several instruments that will carry out the method of cutting the hole. A method of making this drill is now sought. One conceives of making it by twisting a properly formed straight blank, another by forging spiral grooves in a round blank, another by removing metal to form spiral grooves. None of the processes conflicts with the others or derives any-

thing from the others, but all derive something from the drill, and would infringe the drill patent. A machine is then sought that will carry out the desired method, say of removing material to form the grooves. A milling machine is designed. This should not infringe a patent for another machine which removes the metal by planing, but both would be subject to the process patent. And so process, product, and apparatus may proceed indefinitely. The metal plate with the hole in it may be a product, and also an instrument in carrying out another process; and the machine for making the drill may again stand in the relation of product to some other process.

No valid product patent can be so broad in scope as to prevent the possible allowance of other non-infringing product patents designed to secure the same effect. No valid process patent can be so broad as to hold as an infringement every other possible process patent for producing the same product. No valid machine patent can be of such scope as to close the field to other machines for carrying out the same process. By "possible" is here meant theoretically possible, as it may occur, as in the telephone invention, that the method discovered and applied is the only one. This is a fundamental truth of patent law, notwithstanding that the existing mass of patents fails to support it.

Process inventions are in general the most fundamental ones. They *are* the "useful arts." The most valuable manufactures have been known and used for years, and as ways of manufacturing essentially old products are the prime problems of manufacturing industries, it is most important to have process inventions protected.

A process is a way of attaining a result; and any process that is new, useful, and based on an inventive conception, is patentable under the law, if it is applied to "science and the useful arts." It matters not whether or not it includes "chemical" reaction or "similar elemental action," or is carried out by an automatic machine. The only conditions precedent imposed by the law are that it shall be new, useful, and an invention; and those conditions apply equally to all classes of invention.

The much discussed and much applied phrases "function of a machine," "mere mechanical process," should be dropped from consideration in determining the patentability of a process. They have no bearing on the question of invention involved in them. Process inventions should be approached in the same way as machine or article inventions.

In settling whether a defined process is patentable it must, of course, be determined that it is within the field of permissible monopolies, and if it is, then it must be ascertained, (1) if it is new, (2) if it is useful, (3) if it is an invention—nothing else. The question of utility presents little difficulty and that of novelty, none, except research into the existing art. The serious question is that of invention. In settling this, most of the negative rules applicable to machine inventions are applicable to processes, and there is no more mystery connected with the treatment of process than with the treatment of machine inventions. If the process alleged is an "aggregation" of separate processes, if it involves over an old process the mere substitution of an equivalent step, it is not patentable.

The word "mystery" was frequently applied to processes in the early days of patent monopolies. It was used in the decision of Boulton & Watt vs. Bull, above, and is a word that aptly indicates the essential quality of a patentable process. To be patentable a process must be mysterious to one who has not been informed. No process that is not mysterious, that does not include hidden steps, no process that is apparent when the result of it, or the principle involved in its practice, is considered, is patentable. The process of making a car wheel that consists in forming a wheel body of paper, and applying a steel tire thereto, is the obvious way of making the desired product, which is a paper wheel having a steel tire. The conception of the wheel came first. There was no room for further invention in the process. Merely practicing manufacturing steps that are apparent in the article made is not invention,—it is mere following copy. Furthermore, a patent for such a process covers by its terms all possible ways of making the defined article and violates an axiom of the law of monopolies.

Chemical processes have been uniformly admitted patentable. What are the "similar elemental actions" that render process inventions patentable? Can any one conceive of any acts performed on matter, gaseous, liquid, or solid, that do not take advantage of some elemental law of nature? One hammers iron into a nail, taking advantage of the laws of cohesion and malleability. One sifts ashes aided by the law of gravity, one folds paper, taking advantage of the property of flexibility. But whether elemental action is involved or not is wholly immaterial—such action probably always is involved—the sole thing to be considered is whether there is a "mystery" which this process has unraveled.

Every machine and every instrument operates to practice some process in whole or in part. The fact that that process is ancient and common makes it none the less a process. The process of smoothing wood by planing, or shaping iron by hammering, is still a process under the patent laws, although an ancient one. A process that is carried out by an automatic machine may be no less an invention than one carried out by hand or by chemical reagents.

A pair of revoluble rolls may manufacture sheet iron, if hot iron billets be passed between them, make breakfast food of corn or wheat, squeeze water out of wet clothing, flatten bent plates, calender paper, roll plate glass, etc. The function of these rolls is not to make sheet iron, crack wheat, wring clothes, or calender paper. It would hardly be sensible to reject a process of preparing grain for food by passing it between metal rolls, on the ground that the process is the function of the machine, for it is no more the function of the rolls to crush wheat than to make sheet iron or wring clothes. In approaching a question of this sort, instead of concluding at once that the process is the mere function of the machine, it should be considered in accordance with the fundamental principles. First, the result is disintegrated wheat in flaky form, conclusively old as a conception. The process of producing it by applying pressure sufficient to break down its resistance and flatten the grain, is disclaimed and conceded to the public. The rolls as a piece of mechanism are disclaimed. Their capability of applying pressure must be conceded as known. Was there then any invention in using a known pressure applying instrument, for carrying out a presumptively known process of flaking wheat by applying pressure?

Such a question is always one of invention. Some things cannot be done by hand. Gases cannot be confined without instrumentalities, and metals cannot be shaped by the fingers. Instruments are usually necessary to the practice of processes. A claim for a process practiced by a particular instrument as a rule does not define the real invention; but it is conceivable that the use of a particular instrumentality for practicing a process may be of the essence of the invention, or that a new process may be devised for operating an old machine. Denial of validity of process inventions by allegations that they are the mere functions of a machine would better give place to treatment by considering the novelty and utility in the abstract process or series of steps as a mental conception divested from any instrumentalities, and then, presuming the abstract process to be disclaimed, considering whether there was any invention in selecting the stated instruments to aid in practicing it.

* * *

"Scissors, Five Cents" in a store show window called our attention to a collection of chilled cast-iron contrivances that by courtesy may be called scissors—but only by courtesy. Cheapness is a relative term. Compared with the price of really good scissors, the price five cents, is cheap, but when the quality is considered, they are dear at any price. One who values his time and material at anything could hardly afford to use such tools. The competition that leads to the production of goods so cheap and poor as these is destructive and dangerous.

* * *

Emery wheels are beginning to be used in Sheffield, England, for grinding cutlery. Up to the present time grindstones have been exclusively employed

MACHINE-TOOL DESIGN

By W. D. FORBES †

The condition of a concern that has been in the machine building business for some years, and that of one about to embark in such a business, must, of course, be considered from two very different standpoints. Few, if any, established concerns will throw patterns, tools, or fixtures to the wind, take a clean sheet, and let the "dead past bury its dead." It is generally too much of a temptation not to use the 2 9/16-inch sixteen-thread tap which is on hand, although the new design calls for 2¾-inch, twelve threads; and it is difficult to remember that the 2 9/16-inch sixteen-thread tap was made nine years ago and is really "no size at all." The newly-born concern, again, can take a clean sheet, is not hampered by traditions, and can start and make its tap to the required size without feeling bad about it.

If machine-tool designing is engineering, it is safe to say there is less mathematical calculation of the design than in any other branches of the profession; here, tradition holds the field. The lead-screw of a lathe is made a certain diameter and pitch, mainly because other lead-screws are found to be of such and such dimensions, and not because there is any calculation made showing that the heaviest cut on the hardest machinable metal will result in certain maximum strains which should be provided for. The lathe bed is made so wide because one of the best lathes in the market has such a width, and, in fact, the calculations of machine tool stresses are far from concise, and the general assumption of designers is that if the part is made too strong nobody will find it out, while weakness will show and trouble result.

The developing of a new design is usually due to the fact that some rival concern has brought out a design which meets the demands of the market, and something must be done to make good the falling off of orders. Of course, somebody has to have originality. But it is not reasonable to suppose that a "going" concern, having all it can do to fill orders, will voluntarily undertake to design something which will, in a large measure, antiquate its own production. There are concerns which are wise enough to know that while to-day they lead the procession, they will fall behind if they do not "step lively" in the matter of improved construction and design. This means, of course, a large outlay of money, a great deal of work for all hands, close attention, and a certain amount of risk, because we all make mistakes in judgment, and at times designs that seem most admirable do not sell. For example, some years ago the writer saw a bolt cutter which cut bolts on centers. Its product was admirable, yet the first ten or a dozen machines did not sell, and a large proportion were carried in stock and finally broken up as uncommercial tools. On the other hand, a little mechanical hacksaw came on the market; it looked so light in design that there seemed to be danger that it would blow out of the window if open; yet the writer never bought a tool of any kind which gave such splendid money returns and was so useful as this little power hacksaw.

It should not be understood that the "cheapness" of a machine tool makes it an easy seller or a good commercial article; a really cheap machine is one which accomplishes what it is built to do at the minimum cost of operation and up-keep and which, when sold, not only stays sold, but sells others. It is, of course, out of the question to buy certain special tools, or what we call "single operation tools," when an establishment is run on a comparatively small scale, but this class of tools is being more and more thought about, and an entirely new system of machine-shop equipment can be conceived which would consist of a complete equipment of single-operation tools whose product would be far more satisfactory, both in quality and cheapness, than that of the present multi-operation tools, and which would cost about the same as the usual equipment. Certain standard tools cannot, of course, be dispensed with for the tool-room and for jobbing shops, but the writer thoroughly believes that a few years will see machine-tool builders equipping shops on a system of single-operation tools.

Tradition in machine-tool design is a very powerful factor, and one often wonders why certain things are continued, as, for instance, the form of the lathe lead-screw. In general, it is square threaded, but its function is to traverse the carriage 95 per cent of the time toward the headstock. It is rare to see the work being done from the head- to the tailstock. In cutting a left-hand thread, of course, the carriage would travel toward the right and against the dead center. In the running back in right-hand screw cutting, the lead-screw has to carry only the carriage, and many times it is

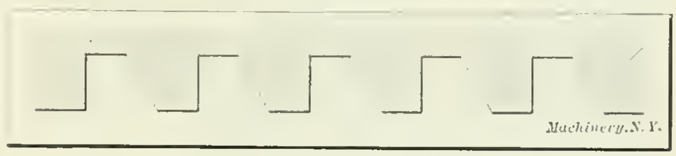

Fig. 1. Proposed Ratchet Thread for Lathe Lead-screws

run back by hand by the operator. It is, therefore, difficult to see why the ratchet form of thread, as shown in Fig. 1, is not used; this form of thread is successfully used in a vise.

Most lathes have an apron, back of which are the gears, clutches, worms, and wheels, all out of sight and out of reach. You have to lie down on your back to inspect them, and then you drip candle grease into your mouth, and can see very little. From oil holes in the apron, small tubes lead to the various bearings. A squirt-can is introduced into these holes by the machinist, who presses the spring bottom of the can with his soul filled with satisfaction, as he feels he has performed his whole duty as to oiling the apron by this action, and to all intent and purposes the bearings are oiled according to usual ideas. Now, we all know that they are not oiled by this operation. Why not put all the gears, etc., on the outside of the apron where they can be seen and cared for? Or, if the people object to dirt, why not put a piece of plate glass in front of these gears? And, again, why not have a central reservoir for oil, which can be neglected every six months instead of oftener, as are the various independent oil holes now in use?

The mere fact of a departure from recognized practice should not be considered unless it accomplishes something better, offers greater accuracy, speed of production, less cost, or greater wearing qualities. To-day there are many who believe that gearing will not permit of as fine work as a belt drive, yet the writer never saw a planer that was not driven by gear, except one—and that had a chain. One recalls no objection to gearing in this class of machine tool, and often wonders why. If gears are bad in a lathe, why are they not bad in a planer? The spiral gear drive used in some planers is also a form of gear.

For years we have been content to have a single speed supplied for all planer work, yet a lathe with but one speed would never sell at all. It is clear that the planer does not demand the variety of speed that the lathe does, but there is no question that its output is less than it should be because of the lack of possible speed variation. There are available speed riggings now on the market which are said to be excellent, but they are totally separate from the planer, are expensive, and somewhat bulky. What is required is a speed variation mechanism built into the planer. In shapers, which are nothing more nor less than a form of planer, variable speeds have always been provided, and in this particular class of tool the last few years have seen some most convenient modifications and vast improvements in design.

When Mushet steel first came into the market it met the foe of all new things—that is, prejudice. Its value was not

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grasped and could not be taken advantage of, as most machine tools were built light and would not pull the cut which could be taken with even the original carbon steel. To-day high-speed tool steels can be used to full advantage, but to the writer's mind it is not the ability to cut large quantities of stock which is its greatest value, but its wonderful lasting qualities. It is, of course, difficult to say to what extent high-speed steel has added to the value of a certain class of machine tools, but it is a very important factor in screw machine work, for instance, where form tools are used. The possibilities of turning out large quantities of work without regrinding the tools may augment the output many times.

In making any new design it must be remembered that too much novelty is expensive to introduce, and this extra expense must be counted on in selling; yet, a real novel feature assists in selling, as most people want to buy what is "up to date." It is safe to say that any new tool must have marked improvements over what has been made in the past

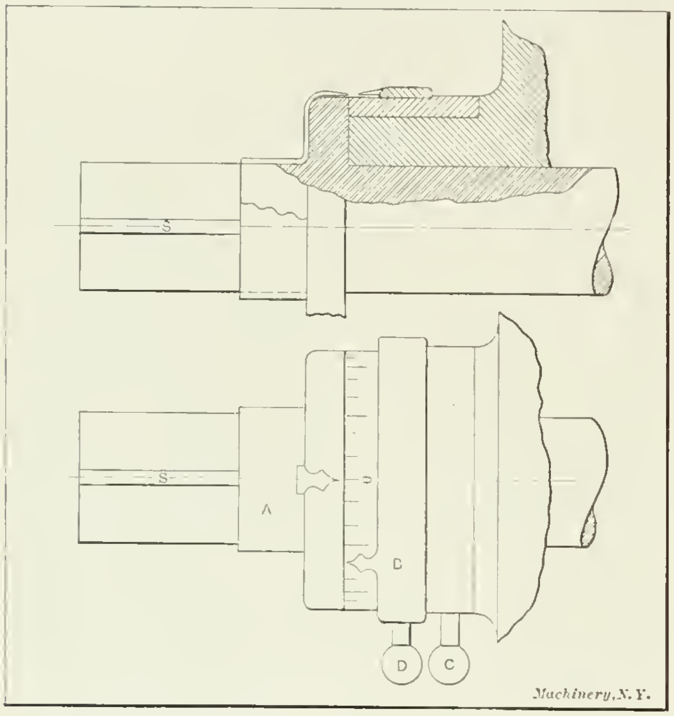


Fig. 2. Improved Micrometer Dial and Indicator for Feed-screws

few years, or its selling qualities will not be great. It must be capable of rapidity of production, ease in changing tools, power, and accuracy. Ease of handling is of great importance, as some very productive tools have been disappointing, in that they were "men killers." They were too heavy in operation, which made it difficult to find men to run them; and on this class of tool it is pretty well admitted that, instead of a very low grade of labor, a high rate of intelligence in the operator has proved more economical in production.

The operator's mental requirements must be considered by the designer, but he must remember that somewhere there must be skill in obtaining a product from any machine. All tools lose their cutting edge and when again ground require adjustment. The mere fact of bringing an edge to a stop is not sufficient for fine work, as a slight difference in keenness will vary the size of the article produced, and even a slight change of cutting angle may affect the results. The writer would call "bringing the tool to a stop" a rough adjustment, and the exact size and adjustment must be obtained by trial for accuracy.

Of late years a micrometer plate is quite often provided for the adjusting screws in various machine tools, and it is a very great advantage, as the machinist can use a micrometer and see to what extent he varies from the desired measurement, and this difference can be then adjusted almost exactly by the micrometer plate. The writer, however, finds fault with the divisions of the micrometer plates and has often wondered why they were not very popular among machinists. The reason is that errors are often made on lathes through the operator forgetting that if the work is one-thousandth inch large, he must only set his tool one-half a thousandth, or he will be removing two-thousandths inch of stock instead of one-thousandth. In other words, the micrometer plates on lathes should be graduated differently from those used, say, on a boring mill; but in both cases the little indicator, illustrated in Fig. 2, would prevent error. It is very much easier to adjust differences when the plate can be turned to zero and then the amount of movement made, but if the little indicator shown is simply turned back or forward the number of divisions required, and then the screw carrying the plate turned and the indicator brought to zero, fewer errors are made.

To explain more clearly: *A* is a pointer held by friction to the screw *S*; this pointer can, however, be turned to any position without turning the screw. We will suppose the arrangement is fitted to a horizontal boring mill, and that we want to shift the platen over four divisions. For convenience in reading, bring the pointer *A* uppermost; then by the handle *C* bring the 0-division of the plate to the pointer *A*, and by the handle *D* move the pointer *B* to the fourth mark. All that has to be done now is to turn the screw *S* with its pointer *A* until the pointers *A* and *B* coincide, and the platen will have been advanced four divisions.

It can, of course, be said that the pointer *B* is superfluous, as after the pointer *A* is made to coincide with the 0-mark, the division plate can be advanced four divisions and the screw then turned until the pointer *A* is again at 0; but this is somewhat confusing to do, as the divisions have to be counted to the left of the 0-mark, while the screw for its adjustment has to turn to the right.

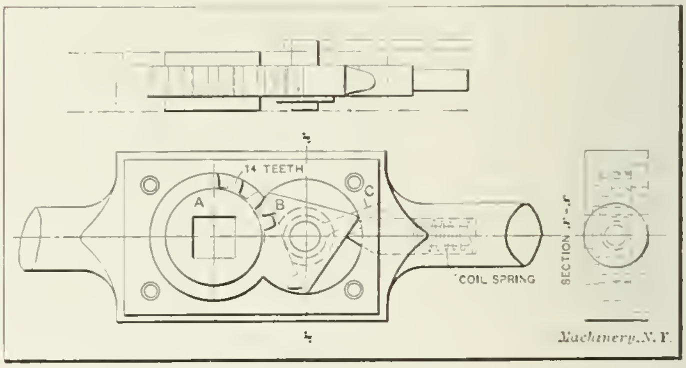
In practice, the machinist sometimes chalks the divisions, with more or less clearness, or resorts to scratching the division plate, or even using a prick punch. This pointer *B* is an error preventer.

In this article, of course, it has been impossible to any more than suggest to designers certain ideas; but, after all, is not a suggestion better than concrete information, as the latter would probably only be adapted to one case, while a suggestion can be general. In concluding, attention should be drawn to one more thing, and that is that builders of machine tools could, at very little cost, stamp on the name-plate the range of the tool.

* * *

RATCHET TAPPING WRENCH

A short illustrated article describing a ratchet tapping wrench used by the Société Anonyme des Ateliers de Construction H. Bollinckx appeared in the June number. The accompanying illustration, supplied by the company, shows



Bollinckx Ratchet Tapping Wrench

the construction. The socket *A* for the tap square is made like a gear pinion with square hole, having fourteen teeth of characteristic gear-tooth forms. A two-toothed pawl *B* engages these teeth, being thrown by the workman in either direction as desired, by the lever *C*, shown in dotted lines.

The advantage of the rachet tapping wrench, as set forth in the previous article, is that it prevents the workman turning the tap backwards when tapping a hole. The backward movement rapidly dulls the cutting edges and breaks the teeth. When the hole has been tapped, the workman can reverse the ratchet and remove the tap the same as with an ordinary tapping wrench.

MILLING AND DRILLING OPERATIONS ON THE ELLIS ADDING TYPEWRITER

By RALPH E. FLANDERS*

In last month's number of MACHINERY the Ellis adding typewriter was described in some detail. Some idea was also given of the systematic procedure by which it was invented and developed. This same orderliness is also apparent in the manufacturing operations, as will be seen in this and subsequent articles dealing with shop practice at the Ellis Adding Typewriter Co.'s factory in Newark, N. J.

As an illustration of the methods pursued in the milling and drilling operations, the machining of the side frames is here illustrated and described. Rough and finished examples of these frames are shown in Figs. 1 and 15. They are flat, ribbed castings, on which a number of milling cuts are taken, and in which a great number of holes are to be drilled, reamed, counterbored, countersunk, tapped, etc., requiring a great variety of operations. The right- and left-hand frames are somewhat different in design, although the character of the work to be done is the same on each.

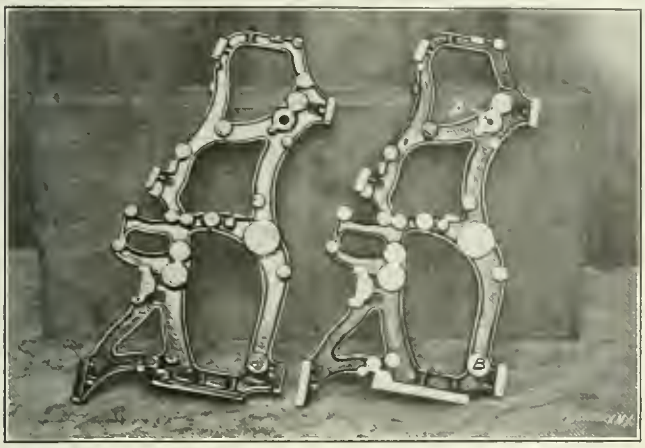


Fig. 1. The Japanned Side Frames before and after Surfacing on the P. & W. Vertical Grinder, showing Center Spot for Locating First Drill Hole

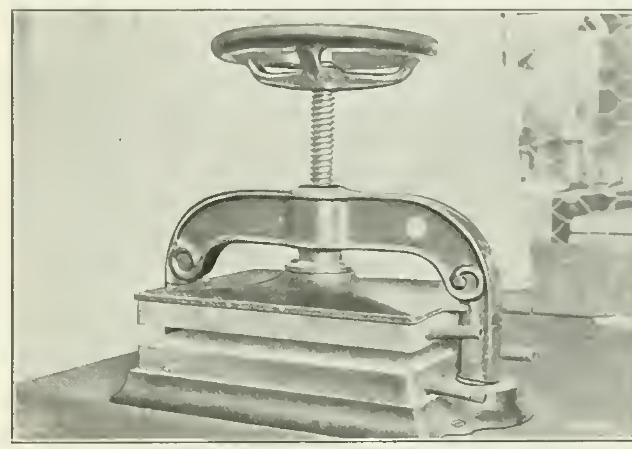


Fig. 2. Letter Press fitted with Water-cooled Platens for Straightening Side Frames preparatory to Grinding

The first machining operation to be performed is the finishing of the sides. In the original design the bosses and feet were of different thicknesses for different parts of the frame, and these surfaces were face milled on the profiling machine. This operation did not prove entirely satisfactory, however. It was too slow, for one thing. Besides this the cutting action was localized and the work was, in consequence, unevenly heated, causing it to spring so that it was difficult to keep it of an even thickness over the whole length of the piece. It was decided, therefore, to reduce the finished thickness to the same dimensions all over, and to finish these surfaces by the operation of face grinding, which would cover the whole extent of the piece at one sweep, thus diffusing the heat generated and doing away with the distortion.

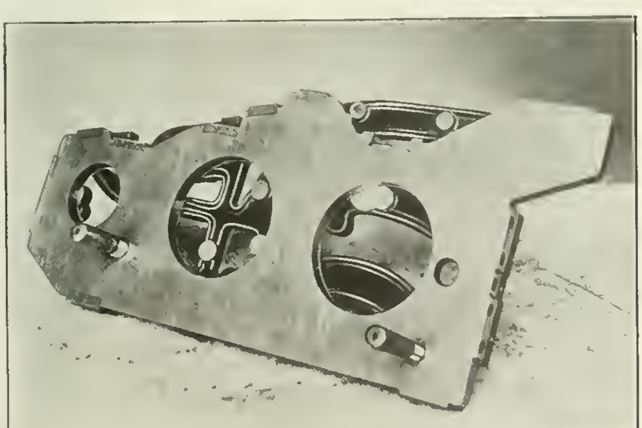


Fig. 3. Templet used for Setting Cutters and Testing Finished Surfaces for all Milling Cuts on Both Right- and Left-hand Side Frames

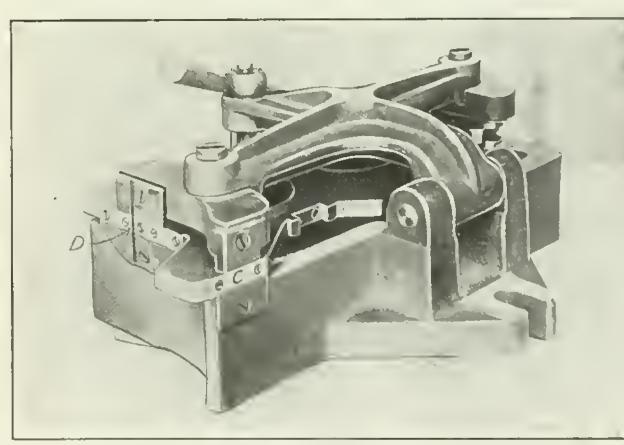


Fig. 4 The First Milling Jig with Templet in Place for Setting Cutters

Straightening the Frames

In order to get the greatest economy from the grinding operation, the stock left to finish was reduced to the least possible amount, so only 1/64 inch on each side, or 1/32 inch in thickness overall, was left on the rough casting. With so slight an allowance it often happens, of course, that the castings come warped slightly, so that they will not machine out. It thus became necessary to devise some means of straightening the frames. This straightening was done in the letter press shown in Fig. 2.

This letter press, as may be seen, is provided with upper and lower water-jacketed platens, through which a constant circulation is maintained. Those frames which are too crooked to finish out are heated in an ordinary gas furnace to a "cherry red," and laid in the press, which is then tightened down on them. They cool to the temperature of the circulating water almost immediately, and when so cooled are found to be straight enough for all practical purposes, though a surface plate is provided for testing them, and a second heating given if necessary. This straightening operation, which is a matter of a very few seconds, results in a great saving of time over what would be necessary if enough finish were left on to avoid this press job. Straightening is, in this case, much quicker than grinding or any other form of machining.

An interesting difficulty was encountered in this straightening apparatus and had to be remedied. The men on the drill presses claimed that certain of the frames appeared to have a chilled surface on one edge which raised havoc with the cutting edges of the drills, in breaking through the skin. A little detective work showed that this chilled surface was found only in frames which had been straightened in the manner we have just described. Still further investigation showed that the workman who did the straightening was accustomed to place the work in the press the same side first each time, and the only part that was chilled was that close to the inlet pipe of the water-jacket platens. It was, therefore, concluded that the cooling of the iron from cherry red down to nearly the temperature of the water was sufficient to chill the metal.

This difficulty was overcome simply by throttling the inlet water until it moved so slowly that it attained practically the boiling temperature near the inlet. The drop in temperature from the cherry red to about 212 degrees appeared to be enough

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to straighten the casting, but not enough to chill or harden the metal.

The frame (after being thus straightened, if necessary) is japanned. One side is then roughly faced on a Gardner vertical-spindle disk grinder, to give a smooth surface for the magnetic chuck to take hold of. The work is next taken to the Pratt & Whitney vertical spindle surface grinder, where it is laid on the magnetic chuck and each face has about 1/64 inch removed from it, surfacing the sides up to exactly the required thickness. Only a few passes of the wheel are required for each surface. This method of finishing has proved to be the best and the cheapest yet tried for the work.

Drilling the Gage Holes

Every operation on these frames is located from two of the holes which are common to both the right- and left-hand frame, or from one of the holes and a milled edge located from them. These holes are drilled with reference to the rough casting, and thus locate all the other holes and the milled surfaces with reference to the rough casting. Under these conditions, when the casting does not finish out, it is considered to be defective and is discarded.

The first of the two gage holes is drilled without using a jig

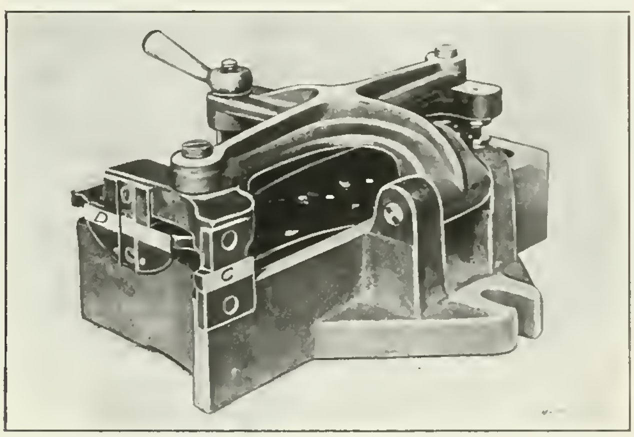

Fig. 5. First Milling Fixture with Work in Place

or fixture of any kind. In Fig. 1 it will be seen that one of the bosses, *A*, at the upper end of the frame, has a center hole cast in it. This is more plainly seen at the right, where the japan with which it is filled shows dark against the ground and finished surface of the boss. This locates the first hole. The work is simply taken to the table of the drill press, is drilled through and reamed. The cast center hole or countersink locates the hole with reference to the casting, which is what is required at this point. Everything else is brought to agreement with this.

The second gage hole is drilled in a simple jig (not here illustrated) which locates the work on a stud entering the first gage hole, and against a suitably chosen contact point on the casting. This hole is drilled in the boss shown at *B*. The castings, with their gage points thus located, are now ready for the regular jig and fixture operations.

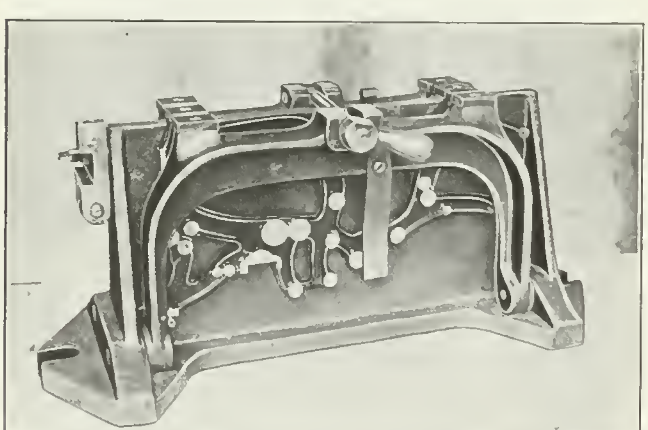

Fig. 6. Double Knee Fixture for Milling the Foot Surfaces of Two Side Frames simultaneously

The Edge Milling Operations

The milling cuts on the edges of the frames are the first to be taken. For setting the cutters in taking these, and for testing the work as well, a gage or templet is provided, shown at Fig. 3. This is made of cast iron, of the same thickness as the side frame (5/16 inch), and is provided with several inserted hardened steel plates or gages. These are of the exact dimensions, and in the exact positions with relation to the gage holes, to agree with the various milling cuts. Some of the gage surfaces, as may be seen, apply to the frame

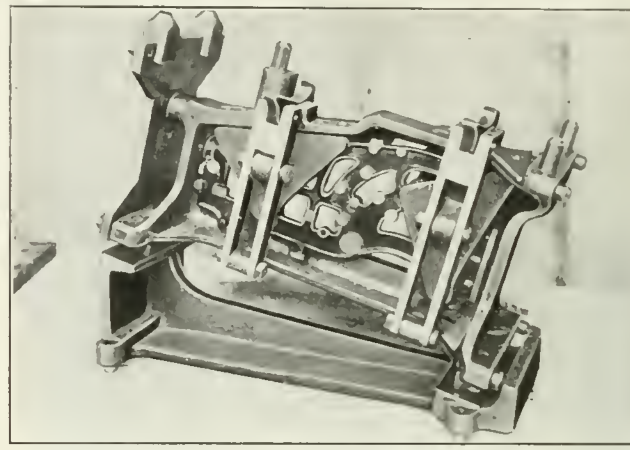

Fig. 7. Jig for Drilling Edge Holes in the Side Frame, Provided with Angle Knee as shown for Drilling Inclined Holes

shown laid against the gage, while others do not. Two plugs are shown in place, passing through the gage and the gage holes in the work, locating them properly with respect to each other.

The fixture for the first milling operation is shown in Fig. 4. This is a gang milling operation, which finishes the flat surface at *C* and the tongued surface at *D* simultaneously. The templet is shown in place. The fixture is mounted on the table of the milling machine, and the gang of cutters is set on the arbor so as to accurately match the hardened surfaces of the gage. When so set, the gage is removed and the

Fig. 8. Master Plate for All the Holes in Both Right- and Left-hand Side Frames—Holes Common to Both Frames are bored through

work is inserted in the same position and held in the same way, as shown in Fig. 5. The same studs in the fixture which locate the gage locate the work. The fixture holds the work down at four points. A swinging clamp arrangement is used, controlled by a single lever nut and swinging bolt, as shown. This holds the work firmly, and gives the solid foundation necessary for accurate cutting with a reasonable rate of speed. The table is fed vertically in this case. The fixture might have been set up horizontally, so that the longitudinal feed could have been used, but owing to the length of the work, this would have required setting the cut at a considerable height above the table, inviting chatter and inaccuracies of various kinds.

The next and last milling operation is performed in the fixture shown in Fig. 6. This is of the knee type, but is so arranged as to hold a piece of work on each side, so that two pieces are finished at one cut. The two swinging clamps

are tightened down against the work and the knee by a single swinging bolt and handle nut, as shown.

At E is shown a gage, which was provided for setting the table to the proper height in this jig before the templet shown in Fig. 3 was devised. This gage has a hardened upper surface, set at exactly the height of the cut to be made in the work. The milling machine table was brought up until the cutter would just bite a piece of tissue paper held between it and the top of this gage. After thus setting the cutter the gage was swung down out of the way, it being pivoted as shown. It is just as convenient, however, to use the templet shown in Fig. 3, mounting it on the gage pins in place of the work.

The templet is used for testing the various milling cuts. It is located against the face of the work with plugs, as shown in Fig. 3, and then a square is laid against it to determine whether the edges of the gage and of the work are flush. A little experimenting with a piece of thin tissue paper serves

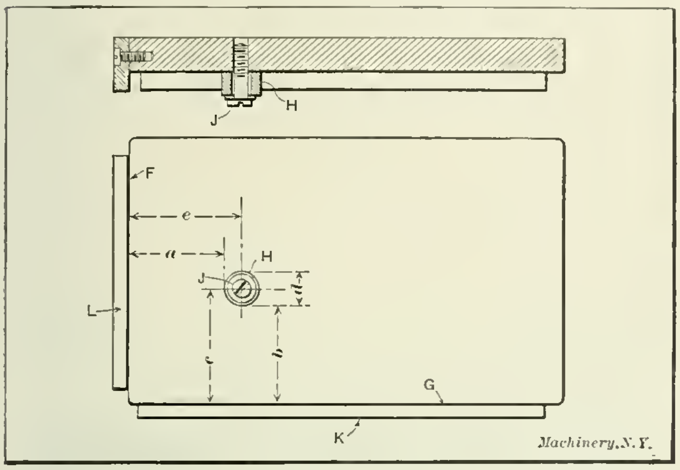

Fig. 9 Locating Holes in Master Plate with Gage Strips and Buttons

to show where and how much the surfaces are out of line with each other.

Drilling the Holes in the Edges

The first drilling operation takes care of all the holes in the edges of the frame, all the way around. The jig shown in Fig. 7 is used for this work. This is of the cast-frame type, as shown, and is provided with four legs on each of the four faces about its periphery, all of these faces being used. Suitable hardened bushings are provided for each hole. The work is held in place by two swinging clamps, each provided with a three-footed equalizing clamping pad. The work is

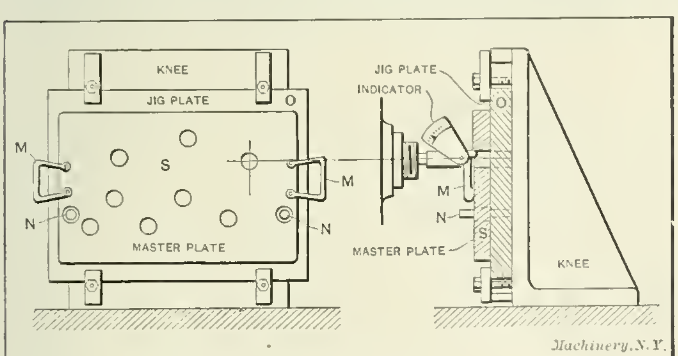

Fig. 10. Transferring Holes to Jig from Master Plate

thus held in place by pressure applied at six points. It is located, of course, by studs fitted to the same gage holes as in the preceding operation.

The holes in the bottom and ends are vertical and horizontal, at right angles to each other. There are, however, a number of holes in the inclined top edge which are drilled at an angle, and provision has to be made for this. This provision consists, as may be seen, of a simple angle fixture into which the jig is set, bringing work and jig to the proper position for drilling these inclined holes.

The work is now ready for drilling the multitude of holes in the sides. Some of these holes are common to both right- and left-hand frames, being supports for shafts, rods, etc., passing through the whole width of the machine. Others are used on one frame only. Some of the holes are simply drilled, some are drilled and reamed; others are counterbored, countersunk, tapped, etc. An immense number of operations is required on these holes for each piece.

The Making of a Master Plate

All of these holes, for both side frames, are located from a master plate which is shown in Fig. 8. Such of these holes

Fig. 11. Master Jig for Right-hand Side Frame. The Holes in this Jig were located by the Master Plate shown in Fig. 8

as are common to both frames are bored through. Holes intended for the right-hand frame are only bored half way through from the right side, while the left-hand holes are similarly bored half way through from the left side.

The method of laying out and boring the accurately located holes in this plate will be understood from Fig. 9. The first thing to do was to obtain a plate of soft, close-grained and well-seasoned cast iron, 7/8 inch thick, machining it on both sides, and being particularly careful to have edges F and G

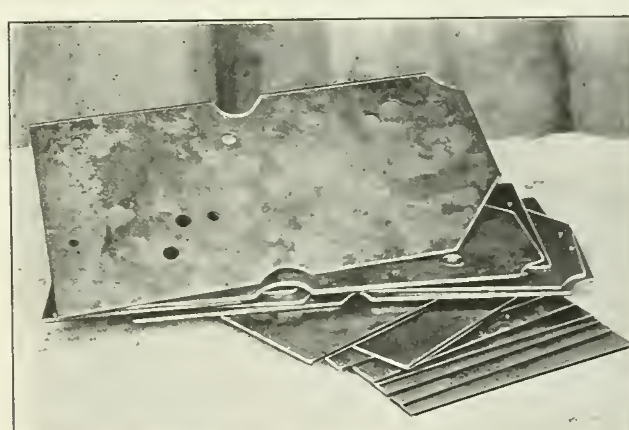

Fig. 12. Set of Mask Plates used for Locating the Holes to be drilled in Each Operation on the Side Frame

at right-angles to each other and square with the faces. Getting these edges square with each other and with the faces of the plate is a vital point in the usefulness of this device, as will be seen.

The various holes are located by jig buttons, one of which is shown at H in Fig. 9. This method, of course, is the common procedure for such work. The button is of any convenient diameter, accurately lapped, and with faces ground square with the axis. It is located approximately in the place desired for the hole, by a screw J passing through it and tapped into the face of the plate. The button or bushing is loose enough on this screw so that it may be adjusted slightly to bring it to the exact position required.

To bring it to this exact position required, strips K and L were screwed to the accurately finished edges of the master plate. Measurements e and c were given by the lay-out furnished to the toolmaker. From each of these dimensions was subtracted $\frac{1}{2}d$, giving measurements a and b. These measurements were then taken with an inside gage between the

sides of the button and the inner edges of the gage strips. The button was clamped by these measurements in exactly the required position. The plate was then mounted on a precision knee on the milling machine, and the bottom was located exactly concentric with the axis of revolution of the spindle. A test indicator mounted in the taper hole of the spindle was used for this. While in this position a hole was then drilled and bored to any suitabl: diameter. Care was taken, of course, that the work was done on a milling machine having accurately fitted boxes and sliding surfaces, so that no change in position could take place when drilling and boring.

Each subsequent hole in the master plate was located from the draftsman's lay-out in the same way by screwing a b·tton on the plate at the approximate position, and locating i accurately by a vernier height gage from strips K and L. These strips were wide enough to extend beyond the plate on each side, so that the blind holes on each side were properly located with reference to each other and to the through holes.

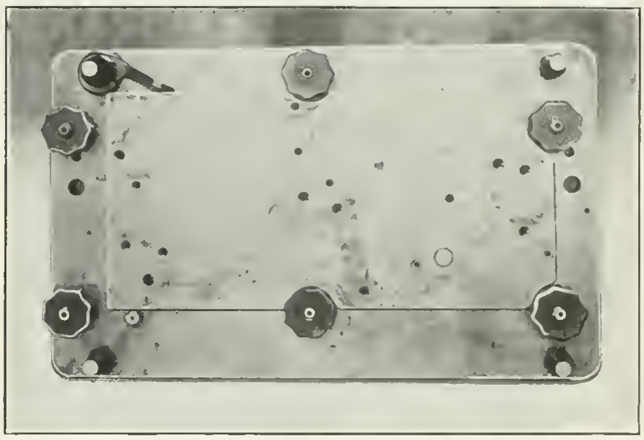

Fig. 13. The Jig shown in Fig. 9 with a Mask Plate mounted on it ready for the Multiple-spindle Drill

Making a Jig from the Master Plate

One of the jigs, for the making of which this master plate was used, is shown in Fig. 11. This contains, it will be seen, a great number of holes of various sizes, bushed with hardened steel. These holes were all laid out from the master plate in the manner illustrated in Fig. 10. The plate is here provided with handles M and with gage pins N, as shown in Figs. 8 and 10. The cast-iron plate O has had drilled and reamed in it holes to receive gage pins N. These holes, as well as those in S which receive pins N, were drilled with a supplementary jig, so that a good fit of the pins in O is assured.

This jig plate O is clamped to the knee of the milling machine in position to have the different holes drilled and bored. The first thing to do is to fit the master plate onto the jig plate, where it is accurately located by gage pins N. The cross and vertical adjustments are then set so that the hole in the master plate which it is desired to transfer to the jig plate is exactly concentric with the axis of revolution of the milling machine spindle, as shown by a test indicator mounted in the spindle. When this adjustment has been accurately made, the gage plate is taken off from the jig plate, and the desired hole is drilled and bored in the latter. The master plate S is then replaced on O and the next hole is centered with the spindle in the same way, and drilled and bored in the jig plate.

Any holes in the master plate may thus be transferred to the jig plate with definite assurance that they will all be the proper distance from each other; and this assurance is obtained without the necessity of making any measurements whatever, or of employing any operation that might result in a mistake of any kind. When the master plate is once made right, and is inspected and found right, it may be used in this way to transfer any number of holes to any number of jigs in a way which gives the greatest accuracy with the least work and worry.

The completed jig, shown in Fig. 11 and again in Figs. 13 and 14, is provided with feet T on both sides, and with gage pins U and V, which also extend through both sides. The larger pin U, enters one of the gage holes of the work, while the finished edge rests against the smaller pin V. Hook clamp screws Q are reversible, as is cam R, which forces the work down against pin V. It will be seen from this that the work may be held on either side of the jig. This is required, because it has been found good practice to drill each hole through from the side on which the hole has to be matched up with other parts. This obviates even such slight errors as might occur from the creeping of the drill or reamer in passing through the 5/16-inch thickness of metal in the frame.

Various Methods of Drilling in Manufacturing Works

Now there are several ways of using such a jig as this, depending on the number of pieces per year for which it is to be used. The work, for instance, might be clamped in place and all the holes drilled at a single setting, changing the tools constantly as required for the different sizes of holes, and for the different taps, reamers, counterbores, etc. This method of working, however, would only be fit for making one or two or a half dozen pieces at a time. For quantity production and continuous use, it might be better to provide elaborate multiple-spindle drilling heads, drilling all the holes simultaneously if possible; or, if some of the holes are too close together, drilling them in two operations to avoid interference. Or, finally, one of the highly specialized automatic machines for this work might be used, in which the work is carried from one multiple-spindle head to another, for performing the whole series of operations at one setting.

The method used in this shop at present is a compromise between the two possible extremes. It was decided on as being the most satisfactory procedure for beginning manufacturing, where the lots are comparatively small, and the rate of production not up to the amount expected when the factory gets into full swing. The compromise is a highly interesting one, and does great credit to the ingenuity of the shop management. The principle of it is illustrated in Figs. 12 and 13. A sixteen-spindle drill is used, of the type shown in Fig. 14.

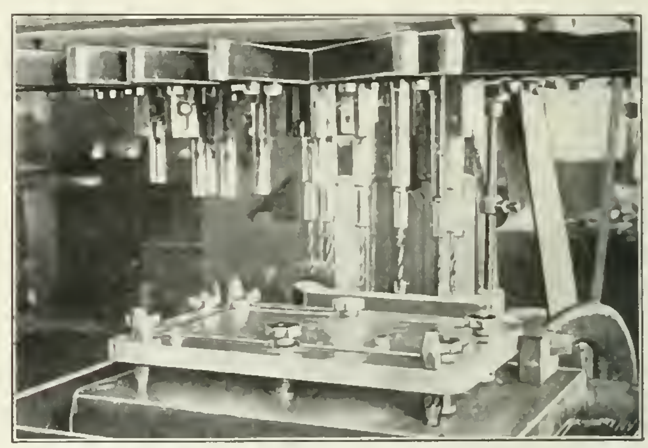

Fig. 14. Jig with Mask Plate in Place on the Table of the Multiple-spindle Drill. Note the Gage at the Back for Locating the Jig

The Use of Mask Plates for Multiple Drilling

The tool designer goes carefully over the drawings of the work, and segregates the holes and operations into groups of not more than 16, taking great pains to see that the holes in each group are of approximately the same diameter, and are not too close together for the minimum center distance of the spindles. Mask plates, of which a number are shown in Fig. 12, and of which one is shown in place on the jig in Fig. 13, are then made, one for each of these selected groups of operations. These plates cover up everything except the holes to be drilled in each of these operations. The holes are roughly laid out and roughly drilled, the masks not being used in any way, of course, to guide the drill itself. The plates are thus very cheaply made from 1/16-inch sheet steel. Each hole is stamped with the name, size, etc., of the drills, reamers, etc., required, so that a mistake is inexcusable.

If the work should be desired in larger lots, requiring more jigs to permit several operations to be done simultaneously, these new jigs would be made from the master plate in the way shown in Fig. 10, very much more cheaply than would be possible if they had to be measured up from the beginning. For the present, however, this set of mask plates with four jigs

(two for each side frame) gives enough of a supply to meet the requirements of production. It is probable that in the future, as production increases, drills having special multiple-spindle heads will be provided, each carrying 25 or 30 drills, counterbores and other tools. When that is done, the masks will be made to correspond, or new special jigs will be made for each operation.

The Use of the Metric System

It may be a matter of interest to state that the metric system is used in this shop. It has been found to have advantages in some respects, and disadvantages in others. It has required a somewhat increased expenditure in the matter of standard small tools in some cases; this has not been as great as might be expected, however, since practically everything in the way of reamers, taps, counterbores, etc., has to be special in any case. It is on the tool work that the greatest difference in the use of the metric system is noticed, rather than in the manufacturing, as the tendency is to provide special gages and measuring tools for all manufacturing operations. Since the machine tools were not bought with metric lead-screws, the index dials on the milling machines, etc., of course, are useless, requiring a slight increase in the length of time needed in setting up the machines.

There has been one point of advantage in the use of the system which is purely psychological. Apparently the workmen, after a little training, find it as easy to work to hundredths of a millimeter as to work to thousandths of an inch.

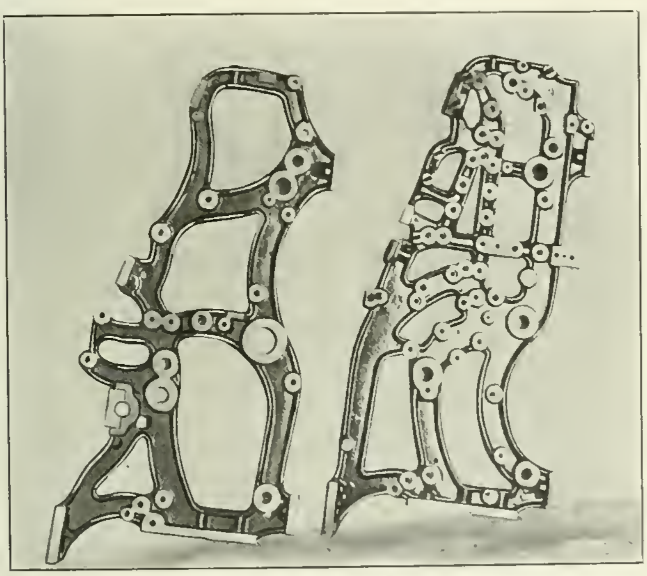

Fig. 15. The Completed Side Frame—Right- and Left-hand Sides

In each case it is merely the question of working to certain graduations on a micrometer or vernier. Since the metric subdivision is less than one-half that of the English measurement, it has been found that the same workmen, when the metric system is used, tend to do rather more accurate work than before, without realizing it.

The points of particular interest described in this article which are worthy of the attention of mechanics as being of wide application, are these: The practice of straightening soft iron castings before grinding, thus saving the time that would otherwise be necessary to remove an excess of material; the use of countersunk holes, cast into the work, for locating the first drilling operation with relation to the rough casting; the use of a templet, interchangeable with the work in the jigs and fixtures, for setting cutters and for testing the work; the use of a master plate for duplicating jigs; the use of mask plates with a master jig, so laid out as to group together holes of nearly the same diameter, permitting multiple drilling to be done to the best advantage.

This is, it will be agreed, a very creditable list of items of improved practice for a job as simple, comparatively, as the work on these side frames. It is, however, only one evidence of the attention to detail which Mr. Ellis, the inventor of the machine, Mr. MacFarland, the superintendent, and Mr. Perkins, the tool designer, have given to the whole process of manufacture.

ECONOMICAL TOOL DRESSING AND GRINDING*

By JOHN BRANDLE†

John Brandle‡

In the majority of shops tool dressing and grinding has become an exact science. The tools are dressed and forged by means of formers so that the exact shape desired is obtained, in order that in grinding no more stock is removed than necessary. The tools are ground on tool grinders with the least expenditure of time and material, and with the view of getting the proper cutting angles for the work to be performed.

This article is not written for those shops which are efficiently equipped, but is intended to help correct the waste and loss which occurs in most engineering and railroad shops, particularly in those districts where the tool grinder is considered a waste of money and space. In these shops you hear the expression, "We could not use anything like that because no two machinists grind their tools alike." What they really mean is that no two machinists grind them right, being allowed to grind them their own way by the foreman, who should know better, and generally does know better, but is careless. This carelessness on his part increases the cost of tool dressing, decreases the efficiency of the tool and causes a waste of material that is surprising.

As an example of this take the common round-nosed tool 5/8 inch by 1¼ inch by 8 inches long shown in Fig. 1. When received from the forge shop the mechanic grinds the tool to the desired shape, and after it is dull retains the proper shape by grinding it on the top as shown in Fig. 2, thereby following the line of least resistance, as he knows it to be or has been taught. Now let us see what occurs by pursuing this method. After the tool is ground down about half way it becomes too weak to stand up under a heavy cut and must be re-dressed. In order to dress this tool the material shown at the right of the dotted line, Fig. 2, must be cut off, and is a total waste. On a tool eight inches long, the usefulness of which is five inches of its entire length, this method would only allow the tool to be dressed from six to eight times. On a tool of this size the writer kept an exact record with the following results:

6 dressings of the tool at 40 cents each	$2.40
Weight of metal cut off, 1/4 pound high-speed steel, at 75 cents per pound. Total cost of wasted steel	1.125
Total cost of dressing the tool	3.525

This was an average cost and some careless workmen ran it up still higher. On larger tools for both planer and boring mill work the cost increased in proportion to size, the increase in cost depending on the amount of metal cut off. We tried to utilize some of this waste stock by forging it into small square bars to be used in toolholders; but it proved unsatisfactory as the steel buckled in drawing out and broke off easily, and

* The up-keep practice for lathe and planer tools as recommended by Mr. Brandle differs radically in one respect from that recommended by Mr. F. W. Taylor in his paper "On the Art of Cutting Metals," read before the American Society of Mechanical Engineers, December, 1906 (see MACHINERY, January to August, 1907, inclusive), in respect to forging. Mr. Taylor laid stress on the proper forging of lathe roughing tools to save grinding and steel. He recommended that the end of the tool be bent and turned up, and carefully shaped to a templet, and gave elaborate directions with illustrations for carrying out his method. With proper forging and grinding practice, the amount of steel wasted with Mr. Taylor's system is not as much as with Mr. Brandle's plan. However, the latter has the merit of being simple and easily administered, and is economical as compared with the wasteful practice all too common in many shops. No doubt it would work well in many comparatively small shops resulting in a substantial saving of tool dressing labor and steel, and increased efficiency of cutting action.

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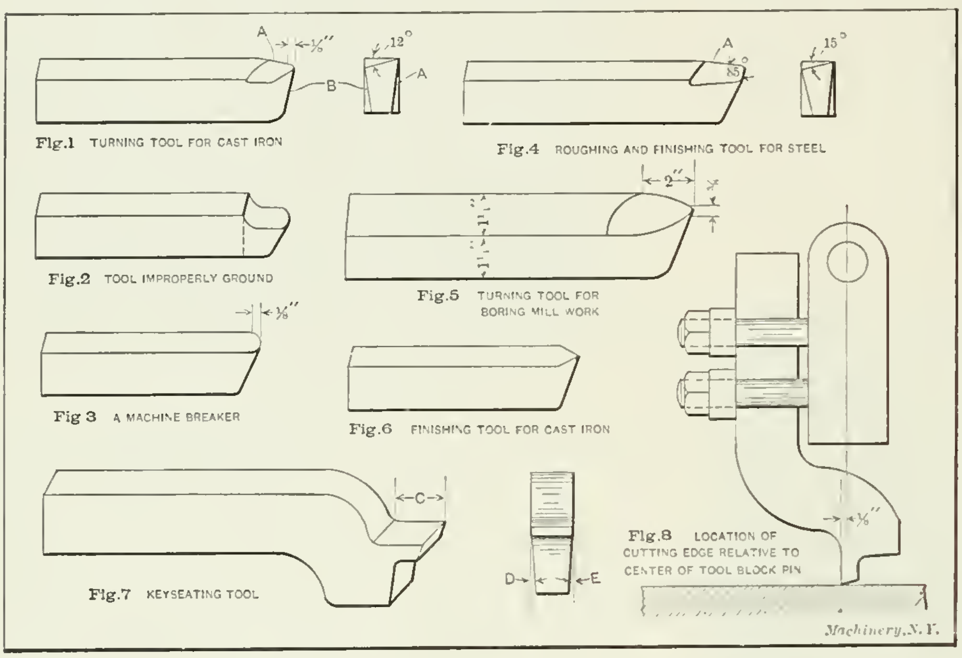
the cost of working it up in this shape was greater than the price of the bar steel.

The unnecessary cost of forging was reduced by having apprentices grind the tool, which extended the life of each tool over one year. This was done without the aid of the tool grinder by merely grinding the tools in the usual way on an emery wheel. In the first place, the proper cutting angles were selected for the class of work to be done, and then the tools ground to their proper shape. After that the boys were taught to grind them only on the front faces as shown at *A* and *B*, Fig. 1, for all round-nosed tools, both straight and bent. This method was continued as long as the tool lasted requiring no more dressing, the 40 cents expended being charged to hardening the tool as it wore back. Round-nosed tools were ground so as to present the least cutting surface to the work. Figs. 1 and 3 will readily explain the reason for this. In order to take a cut 1/8 inch deep with a tool 3/4 inch wide ground



Figs. 1 to 8. Correct Methods of Grinding Cutting Tools

as shown in Fig. 3, the tool would present at least 1/2 inch cutting surface which on a small machine would cause an enormous strain being put upon the feeding mechanism when the tool became dull. It is a fact that the majority of ruptures and breakages of machine parts, can generally be traced to the tool being ground as shown in Fig. 3. In Fig. 1 it will be noticed that in order for the tool to take a 1/8 inch depth of cut, there is less than 3/16 inch cutting surface. The point of the tool should be ground wider than the width of feed in order to leave a smooth surface for a finishing cut. The reason is therefore obvious why manufacturers fail to obtain the results promised for high-speed steel tools, because when the tools are not ground properly the machine will not pull even an ordinary cut.

By standardizing the tools it was found unnecessary to carry a large variety of bar steel in stock. This was accomplished in the following way: For lathes between 16- and 20-inch swing inclusive, 5/8 by 1 1/4 inch tool steel was selected; for lathes from 24- to 30-inch swing, 3/4 by 1½ inch tool steel was used. Then the toolpost rings were cut down or made thicker, so that when the tool was set on a horizontal line, the top face of the tool was 1/8 inch below the lathe center. This was done in order that facing, cutting off and threading tools when elevated to their proper height, *i. e.*, to the center of the lathe, would have just enough top rake to make them cut easily.

The boys were also told to see that the bottom of the tools were straight. This was accomplished by grinding them on the side face of an ordinary emery wheel. If this is not done and the tool used as it comes from the forge shop, it will sometimes be found to rest only upon one or two points, so that it will require but little force to move the tool; and the men will tighten the toolpost screw to the breaking point or else will take a light cut, blaming it on the machine. After numerous experiments the writer found the proper cutting angle for the top face to be 12 degrees for cast iron (see Fig. 1), and the side and front clearance was found to be from 5 to 20 degrees depending on the diameter of the work. A very cheap gage was made from 1/16-inch sheet steel and supplied to each boy, as cast iron was used in the construction of the machines more than any other material.

Tools for turning steel were ground as in Fig. 4, and given a top clearance of 15 degrees, and the side *A* ground straight presenting no more cutting surface than the depth of the cut. This tool saves the time required for changing the tools and for squaring the shoulder with a facing tool. The corner is rounded to prevent it from wearing; this also enables it to be used for both roughing and finishing cuts. These tools when dull were ground similarly to the round-nosed tools for cast iron and made to hold their shape by grinding on the faces, requiring no more dressing, but merely hardening them again when necessary.

Ordinary planer tools were made from 3/4 inch by 1 1/2 inch, and 3/4 inch by 1 3/4 inch stock. For heavy planers or lathes the tools were made from 3/4 by 2 inch stock. The tools 1 1/2 inch square which we had previously used were discarded, because they were found to be practically no stronger than the 3/4 by 1 3/4 inch tools, and at the same time contained about 71 per cent more material. The top clearance was ground the same as the lathe tools, and the side and front clearance just a little more than was necessary for these parts to clear the work, thereby leaving the section at the cutting edge as strong as possible.

Tools for boring mill work were made from 1 1/4-inch square stock and forged as shown in Fig. 5. The dimensions shown here give the best results. If the point is drawn out more, the cutting edge will stand too far from the body of the tool causing it to spring and producing chattering. The same system of grinding was applied to these tools also, and when the tools became blunt it was necessary only to draw them out again to their proper shape, no stock being wasted. The writer has seen a tool of this kind ground down as shown in Fig. 2, and when sent to the forge shop in order to dress it, the weight of stock cut off was a fraction over 3/4 of a pound. Our blacksmith foreman showed me the cuttings of tools for a period of six months which were dressed under the old system, and the weight totaled over 100 pounds. This was mostly high-speed steel, Novo, Midvale, and Allen's, which cost 75 cents per pound.

For facing cast iron the straight pointed tool shown in Fig. 6 gave the best results, as it finished the surface truer than the ordinary facing tool and also required no forging.

Another tool standardized was the key-seating tool shown in Fig. 7. This tool was used exclusively for keyseating crankshafts, set-shafts for saw mills, saw mill mandrels, etc. It was forged so that its cutting face was 1/8 inch ahead of the center of the tool block pin (see Fig. 8). It was found that if it was set back further than this, it would not lift out of the cut, when cutting between the ends of the shaft, and if not given enough set it is liable to spring into the cut. The length of the portion *C* was made from 1 to 2 inches long depending on the width of the keyseat, and was ground straight the same size as the keyseat to be cut. It will be found that most machinists grind tools of this type with a little clearance, fearing that they will tear. Then when the tool is ground two or three times it is too small, necessitating taking two cuts or re-dressing the tool. If the tool is given five degrees clearance on each side as shown at *D* and *E*, Fig. 7, sloping toward the back end, the front cutting edge can be kept keen by occasionally whetting it with a good oil stone which

makes a smoother job, and the tool will also last longer than by just grinding the front cutting edge. This rule will apply also to cutting-off tools. The writer has seen a tool as above described which cut keyseats in set-shafts totaling 215 feet long by 1/2 inch wide and 7/32 deep, without necessitating removing it from the tool block for grinding. This tool holds its size 2/3 of the length of the portion *C* before it is necessary to have it re-dressed.

The methods given resulted in a saving for the first year both in steel and dressing that was simply astonishing. It was accomplished by sticking to the following principles, which seem almost too simple to write about, and yet they are being neglected daily:

1. Selecting the proper shape of tool for the work.
2. Keeping the proper shape throughout its entire length without re-dressing, if possible.
3. By teaching apprentices (who really took hold better than the older mechanics) to grind the tools correctly by one who knew how and encouraged them to do so, also making them adhere to the rules by close watching. This latter is the most important of all. No system no matter how complete and perfect is worth anything if the human equation is left out of the question. It was also found possible to grind the tools after forging without drawing the temper. This was accomplished by grinding on a small emery wheel, having close at hand a small tank for holding a sufficient quantity of water.

The writer has just taken up the ordinary tools which are mostly used in machine shops, and endeavored to explain them in clear and everyday language without technical phrasing, so that it may be understood by all. This method has been installed without any confusion and with the appliances usually found in large and small shops. "It should be very simple" you will say. It is, after it is installed and in good working condition, because it is the best and easiest, but for one year you will find it will take the closest attention and patience to bring it about. But after that period is over the men would not change back to the old system. The increase in output and decrease in the cost of tool steel used, the reduction in wear and tear of belt and breakage of machinery resulting from this, will make you feel that it is worth while.

* * *

THE PROBLEM OF AUTOMATIC STABILITY OF AEROPLANES

It is claimed that the problem of automatic stability of aeroplanes has been solved by Lieutenant J. W. Dunne, of Farnborough, England. At the trials the machine rose to a height of about 60 feet and then flew for a distance of about two miles without the touching of a lever or wheel, the machine during the whole time being in absolute equilibrium. The machine is a biplane, the most remarkable feature being the absence of a tail and steering surfaces or rudders of any kind, with a single exception of a couple of small steering flaps hinged to the rear extremities of the upper surface for tne purpose of altering the course of the machine during the flights. The carrying planes are provided with a double curvature which, it is claimed, produces the automatic stability.

* * *

COLLECTIVE OR SELECTIVE CATALOGUES

Collective catalogues are made up of separate sheets, fastened together with ordinary wire staples or by other means tnat are selected according to the demands of the prospective customer or to what the manufacturer or dealer thinks would interest the recipient. Very often, however, the idea, good as it is, of saviug printing and postage and not bothering the recipient with things that would not interest him, is partially vitiated by a very slight mistake on the sender's part, of tastening the sheets together by their upper edges, instead of along the left-hand edge. As a rule, bound catalogues which open vertically from the reader, are inconvenient to handle, and still more so to file; and when the collective catalogues are fastened together at the upper edges they are given both these most undesirable features. Fasten them at the left-hand edge; and where feasible perforate them so that the recipient will have no trouble in putting them in a folder or other binder.

R. G.

INTERNAL CUTTING TOOLS*—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The conditions met with on the Brown & Sharpe automatic screw machines are such that for general work the simpler the design of the tool used, the more efficient will be the results obtained. Of course, in some cases it is necessary where difficult shapes are to be formed to make the tools somewhat complicated, but even then the simplest design possible should be adopted. It is obvious that in internal cutting there is more chance of the tool's sticking and breaking, due to the clogging of chips and improper lubrication, than on external work. It is therefore necessary to make all cutting tools for internal work with as much chip space as possible, and also to provide means for proper lubrication. The periphery clearance given to the tools also has an important bearing on their efficiency. Where there is too much cutting surface in contact with the work, the tendency is to produce rough work and also to break the tool, as heating is developed at the point of contact, thus causing the tool and work to seize.

In making complicated tools for internal work the excessive use of springs, especially when flat, is objectionable, for if the spring fails to work, the cutting tool is generally broken. If a spring is necessary, a coil spring should be

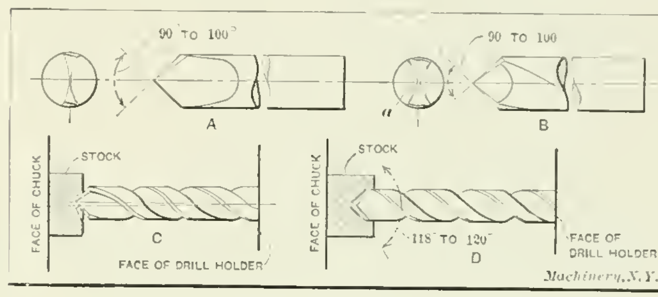


Fig. 1. Centering Tools—Starting the Drill Concentric

used and provision made to have it long enough so that it will retain, as much as possible, its initial tension. Springs for internal cutting tools, as well as other tools of a similar character, should always be tempered in oil, as this increases their life. The design of an internal cutting tool is largely governed by the material which it is to cut and the amount of material it is required to remove.

The tools used for internal cutting are numerous, but as one type of tool is generally better adapted for certain classes of work than another, the specific uses of the various tools and holders illustrated herewith will be briefly reviewed by the writer.

Centering and Centering Tools

When drilling holes which are less than 3/16 inch in diameter it is always advisable, especially when the hole passes through the work, to use a starting or centering tool. At *A* in Fig. 1 is shown a centering tool which is used for brass work, and at *B* is shown a centering tool which is used for steel and soft iron. This latter tool is made similar to the ordinary twist drill except that the flutes are shorter. A worn-out twist drill is sometimes used for this purpose and the point ground thin, as shown at *a*, which reduces the pressure and allows the drill to start easier. It also makes a better center than would a drill with a thicker point. The included angle of the cutting edges on a centering tool should be less than the drill which is to follow. If this is not the case the point of the drill will start to cut before the body of the drill is properly supported; consequently, an imperfect center will be formed. If an imperfect center has been formed, the drill will run out, as is shown clearly at *C* in Fig. 1. It can be seen that it is practically impossible for a drill to start concentric with the center of the work when a small

* For additional information on Brown & Sharpe automatic screw machine practice see "Designing Screw Machine Tools and Cams," MACHINERY, August, 1910, and other articles there referred to.
† Associate Editor of MACHINERY.

teat, as shown, has been left by the centering tool. Using a centering tool with a more acute angle obviates this trouble, as the body of the drill is well supported before the point of the drill starts to cut. This is also clearly shown at *D* in Fig. 1. The included point angle, which has been found most suitable for centering tools, varies from 90 to 100 degrees. 90 degrees should be used, preferably, for brass and 100 degrees for steel. The included point angle on the drill varies from 118 to 120 degrees, 118 degrees being generally used for the drill, as it has been found to give the best results.

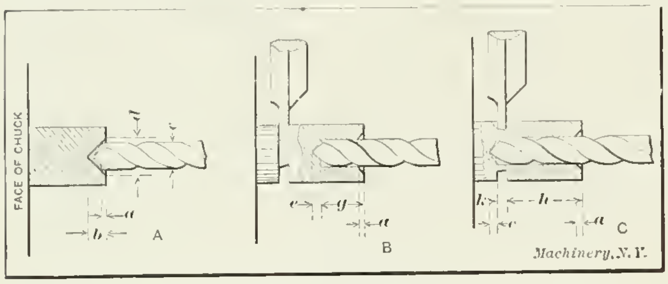


Fig. 2. Diagrams illustrating Method of Finding Cam Rise for Drilling and Centering

In Table I is given the length of the point for centering tools and twist drills, having included angles of 90 and 118 degrees, respectively. The formulas for finding the length of point for the various angles are as follows:

For 90 degrees $b = 0.5\ d$.
For 100 degrees $b = 0.43\ d$.
For 118 degrees $e = 0.3\ c$.
For 120 degrees $e = 0.29\ c$.
where b = depth of centered hole,
e = length of drill point,
d = diameter of centered hole,
c = diameter of drill.
(See Fig. 2.)

Cam Rise for Centering

When the length of the point on the centering tool is known, it is then an easy matter to find the rise on the cam required for centering. There are four different conditions governing the amount of rise required for centering, which are as follows:

First: When the drill does not pass through the work and a stop to gage the stock to length is used.

Second: When the drill passes through the work and a stop to gage the stock to length is used.

Third: When the drill does not pass through the work and a stop for gaging the stock to length is not used.

Fourth: When the drill passes through the work and a stop to gage the stock to length is not used.

The rises on the cam for centering as governed by the previous conditions are as follows:

First: $R = b + 0.010$ inch
Second: $R = b - e + 0.010$ inch
(See Fig. 2.)
where R = rise on cam for centering,
b = depth of centered hole,
e = length of point on drill.

It will be noted by using the second method that on starting a new rod the rise on the cam would not be sufficient to allow the centering tool to travel the full distance; or, in other words, would not be equal to the length of the point of the centering tool used. But the correct way to start a new bar is to throw over the operating lever, thus stopping the operating of the machine; open the chuck by hand and feed the stock out just past the cutting-off tool, enough to allow it to face off from 1/16 to 1/8 inch from the end of the bar. Then the stock is fed out by hand and the centering tool also operated by hand, after which the machine can be started.

Third: The rise for the various machines is as follows:
For the No. 00 $R = b + 0.020$ inch.
For the No. 0 $R = b + 0.028$ inch.
For the No. 2 $R = b + 0.035$ inch.

The values as given, which are added to b, are for facing, and the feeds should be decreased for this. A dwell should also be allowed on the cam varying from 2 to 5 revolutions, the number of revolutions necessary being governed by the material to be cut. More revolutions for dwelling are required for steel than for brass stock. The feed for facing brass should be from 0.0015 to 0.002 inch per revolution, and for steel the feed should vary from 0.001 to 0.0012 inch per revolution.

Fourth: The rise for the various machines is as follows:
For the No. 00 $R = b - e + 0.020$ inch.
For the No. 0 $R = b - e + 0.028$ inch.
For the No. 2 $R = b - e + 0.035$ inch.

As was previously mentioned, the feed should be decreased for facing, and from 2 to 5 revolutions for dwell left on the cam. The suggestions previously given should also be followed for starting a new bar. When short pieces are being made it is generally advisable to make the rise on the cam as given, as this sometimes saves from 5 to 10 minutes on each bar. This, as can be seen, will soon mount up when a large number of pieces are required. The time for starting a new bar in the manner given is practically negligible, as the machine always has to be stopped when a new bar is being inserted, or trouble will result.

TABLE I. LENGTH OF POINT ON TWIST DRILLS AND CENTERING TOOLS

Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°	Size of Drill or Diameter of Center	Decimal Equivalent	Length of Point when Included Angle = 90°	Length of Point when Included Angle = 118°
60	0.0400	0.020	0.012	41	0.0960	0.048	0.029	22	0.1570	0.079	0.047	3	0.2130	0.107	0.064	31/64	0.4841	0.242	0.145
59	0.0410	0.021	0.012	40	0.0980	0.049	0.029	21	0.1590	0.080	0.048	2	0.2210	0.111	0.067	1/2	0.5000	0.250	0.150
58	0.0420	0.021	0.013	39	0.0995	0.050	0.030	20	0.1610	0.081	0.048	1	0.2280	0.114	0.068	33/64	0.5156	0.258	0.155
57	0.0430	0.022	0.013	38	0.1015	0.051	0.030	19	0.1660	0.083	0.050	15/64	0.2344	0.117	0.070	17/32	0.5313	0.266	0.159
56	0.0465	0.023	0.014	37	0.1040	0.052	0.031	18	0.1695	0.085	0.051	1/4	0.2500	0.125	0.075	35/64	0.5469	0.273	0.164
55	0.0520	0.026	0.016	36	0.1065	0.054	0.032	17	0.1730	0.087	0.052	17/64	0.2656	0.133	0.080	9/16	0.5625	0.281	0.169
54	0.0550	0.028	0.017	35	0.1100	0.055	0.033	16	0.1770	0.089	0.053	9/32	0.2813	0.141	0.084	37/64	0.5781	0.289	0.173
53	0.0595	0.030	0.018	34	0.1110	0.056	0.033	15	0.1800	0.090	0.054	19/64	0.2969	0.148	0.089	19/32	0.5938	0.297	0.178
52	0.0635	0.032	0.019	33	0.1130	0.057	0.034	14	0.1820	0.091	0.055	5/16	0.3125	0.156	0.094	39/64	0.6094	0.305	0.183
51	0.0670	0.034	0.020	32	0.1160	0.058	0.035	13	0.1850	0.093	0.056	21/64	0.3281	0.161	0.098	5/8	0.6250	0.313	0.188
50	0.0700	0.035	0.021	31	0.1200	0.060	0.036	12	0.1890	0.095	0.057	11/32	0.3438	0.171	0.103	41/64	0.6406	0.320	0.192
49	0.0730	0.037	0.022	30	0.1285	0.065	0.039	11	0.1910	0.096	0.057	23/64	0.3594	0.180	0.108	21/32	0.6563	0.328	0.197
48	0.0760	0.038	0.023	29	0.1360	0.068	0.041	10	0.1935	0.097	0.058	3/8	0.3750	0.188	0.113	43/64	0.6719	0.336	0.202
47	0.0785	0.040	0.024	28	0.1405	0.070	0.042	9	0.1960	0.098	0.059	25/64	0.3906	0.195	0.117	11/16	0.6875	0.344	0.206
46	0.0810	0.041	0.024	27	0.1440	0.072	0.043	8	0.1990	0.100	0.060	13/32	0.4063	0.203	0.122	23/32	0.7188	0.359	0.216
45	0.0820	0.041	0.025	26	0.1470	0.074	0.044	7	0.2010	0.101	0.060	27/64	0.4219	0.211	0.127	3/4	0.7500	0.375	0.225
44	0.0860	0.043	0.026	25	0.1495	0.075	0.045	6	0.2040	0.102	0.061	7/16	0.4375	0.219	0.131	25/32	0.7813	0.391	0.234
43	0.0890	0.045	0.027	24	0.1520	0.076	0.046	5	0.2055	0.103	0.062	29/64	0.4531	0.227	0.136	13/16	0.8125	0.406	0.244
42	0.0935	0.047	0.028	23	0.1540	0.077	0.046	4	0.2090	0.105	0.063	15/32	0.4688	0.234	0.141	27/32	0.8438	0.422	0.253

Speeds and Feeds for Centering

The surface speeds for centering tools should be the same as for drills; the latter will be given under another heading. The feed for centering tools (as they are generally large enough to stand a heavy feed) is the same in most cases.

Table II gives the feeds for centering tools having diameters as specified:

TABLE II. FEEDS FOR CENTERING TOOLS

Diameter in Inches	Feed in Inches per Revolution Brass Rod	Machine Steel	Tool Steel
1/4	0.004	0.003	0.002
5/16	0.004	0.004	0.003
3/8	0.005	0.0045	0.004
1/2	0.0055	0.005	0.0045
3/4	0.006	0.005	0.005
1	0.0065	0.005	0.0055

The feeds as given are not extremely heavy, but it is obvious that if an imperfect center has been formed, disastrous results may occur. These feeds have been found satisfactory for general work.

Centering Tool Holders

The manner in which a centering tool is held when being applied to the work governs to a considerable extent the results obtained. The tool should be held rigidly and concentric with the center of the work if an imperfect center, as shown at *C* in Fig. 1 is to be avoided. At *A* in Fig. 3 is shown a common form of centering tool holder. This holder has been found very successful for general conditions when the work has been gaged to length by a stop, thus obviating the necessity of using a facing tool. It is supplied with a split bushing *a*, as shown in the end view, or is made without the bushing, the hole for the centering tool passing through the body and the shank, being the same diameter as the centering tool. In most cases the holder with the split bushing is preferable, as the tool is more easily set concentric with the center of the work. At *B* in Fig. 3 is shown a combination centering and facing tool holder. This holder is used when the stop for gaging the work to length has been dispensed with, the tool *b* being used for facing the work to the required length. This is found to be a very suitable holder where the work does not project more than 2½ times

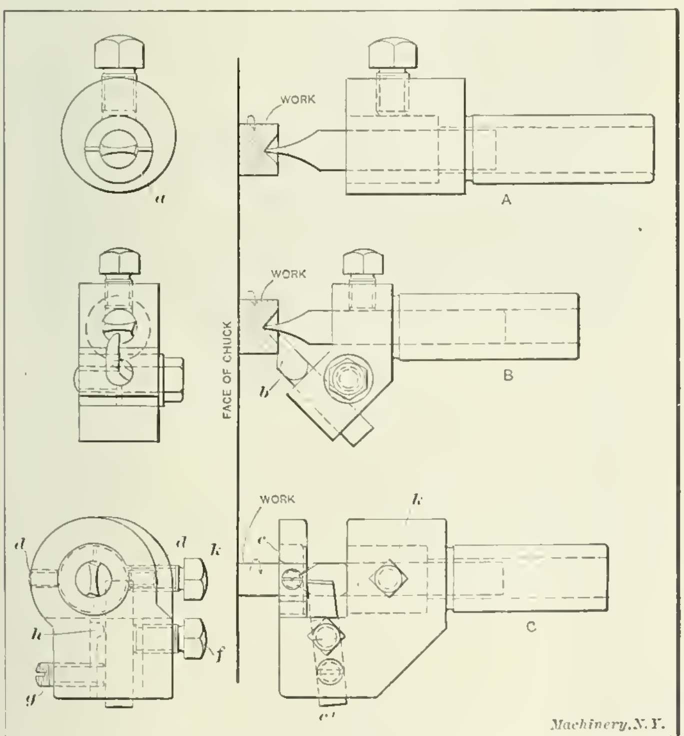


Fig. 3. Various Types of Centering Tool Holders

its diameter from the face of the chuck. At *C* in Fig. 3 is shown a combination centering and facing tool holder with a supporting bushing *c*, which is held in the body of the tool by two headless screws *d*, shown in the end view. The centering tool is held in a split bushing similar to that shown at *a* by set-screw *k*. The turning or facing tool *e* is adjusted to cut the required diameter by set-screw *f* and headless screw *g*, the block *h* acting as a fulcrum. This holder is used when the work has been turned before centering, and it is also found convenient for centering long and slender work. A B. & S. floating holder is sometimes used for holding the centering tool when the turret and spindle are not concentric.

Drills and Drilling

For general work commercial drills of the two-fluted type are used exclusively on the B. & S. automatic screw machines for drilling cylindrical holes. The spiral fluted drill is used for drilling machine steel, Norway iron, etc., and also for shallow holes in brass; but when deep holes are to be drilled in brass a straight fluted drill should be used in preference to a spiral drill, as it breaks up the chips, allowing them to be removed with greater ease. The grinding of the lips on the cutting edge of the drill, has a considerable bearing on the shape of the chips produced and also on the amount of power required to force the drill into the work. If the angle as previously given is used, and if the point of the twist drill is ground thin, it will produce a long, curling chip, and will not require much power for drilling. When drilling,

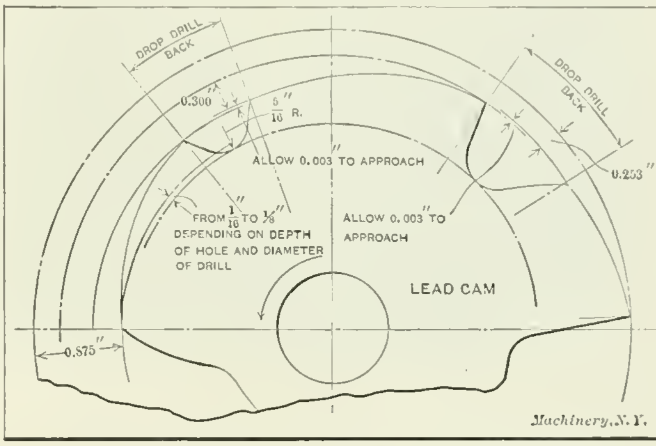


Fig. 4. Method of Laying out Cams for Deep-hole Drilling

if the edges of the drill burn, it is an indication that the surface speed is too high; if the drill chips, the feed is too great, and if the drill splits at the point it is an indication that the proper clearance has not been given at the cutting edges. The correct method of grinding twist drills was given in the June, 1909, number of MACHINERY. If the centering tool and drill have been ground to the correct included point angle there is no reason why the drill should not produce a straight and cylindrical hole; that is, if the feed is not increased too much.

Cam Rise for Drilling

There are three general conditions which govern the amount of rise required for drilling. They are as follows:

First: When the drill does not pass through the work and a centering tool is not used.

Second: When the drill does not pass through the work and a centering tool is used.

Third: When the drill passes through the work and a centering tool is used.

There is also another condition, *viz.*, when the drill passes through the work and a centering tool is not used; but as this is not a commendable method, the rise on the cam when drilling in this manner will not be given.

The rises on the cam for drilling as governed by the previous conditions are as follows:

First: $R = g + e + 0.010$ inch (see *B* in Fig. 2).

Second: $R = g - a + 0.010$ inch (see *B* in Fig. 2).

Third: $R = h + k - a + 0.010$ inch (see *C* in Fig. 2).

where R = rise on cam for drilling,

g = depth of hole to be drilled,

e = length of point on the drill (see Table I),

h = overall length of the work,

k = thickness of the cut-off tool,

a = distance that the drill projects in from the face of the work in the centered hole before starting to cut (see *A* in Fig. 2).

The values of a for centering tools having 90- and 100-degree point angles are as follows:

For 90 degrees, $a = d - c \times 0.5$ inch.

For 100 degrees, $a = d - c \times 0.43$ inch.

where d = diameter of centered hole,

c = diameter of drill.

It will be noted that k is the thickness of the cut-off tool.

Therefore, when tapping a hole which passes through the work the thickness of the tool should be greater than for ordinary work. This was explained in a previous article dealing with circular form and cut-off tools which appeared in the March, 1910, number of MACHINERY.

Deep Hole Drilling

The automatic screw machine lends itself to the production of straight holes, but when producing deep holes there are a number of difficulties to overcome, three of which are the following: In the first place, the drill is not at the will of the operator, and cannot be withdrawn from the work when it begins to seize or plug up with chips; in the second place, keeping the point of the drill cool and removing the objectionable chips is a difficult proposition, and, in the third place, the feed of the drill is governed automatically. It is, therefore, necessary to take extra precautions to have the drill well lubricated and the feed not greater than it will stand.

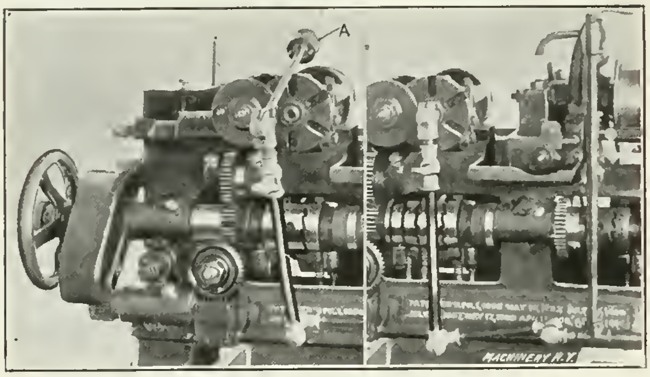


Fig. 5. No. 00 Brown & Sharpe Automatic Screw Machine equipped with Oil-pumping Attachment for Turret Tools

More desirable results are obtained by giving a rotary motion to the work and a feeding motion to the drill for shallow holes, but when drilling deep holes the drill and the work should both be given a rotary motion. This helps to clear the chips from the holes and also allows oil to penetrate to the cutting point of the drill.

When drilling deep holes the drill should not penetrate into the work more than two and one-half times the diameter of the drill before being withdrawn from the work. For drilling deep holes in tool and machine steel, the spiral fluted drill is generally used with good results, but for drilling deep holes in brass the straight fluted drill gives better satisfaction, as it does not produce a long, curling chip, which is generally objectionable. Further information on the subject of deep-hole drilling can be obtained from MACHINERY'S Reference Series Pamphlet No. 25.

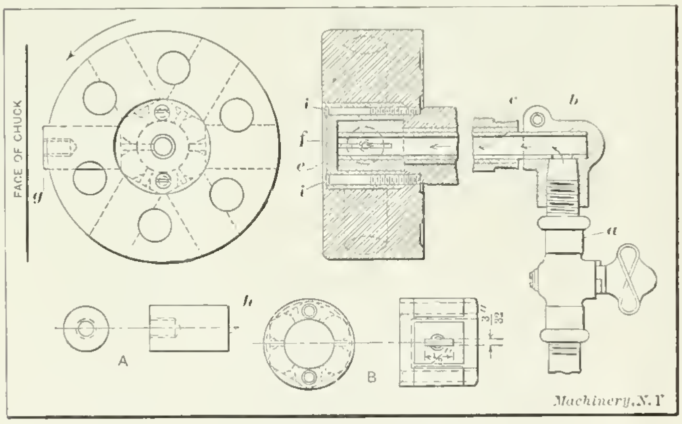


Fig. 6 Sectional View showing Construction of Oil-pumping Attachment for Turret Tools

Designing Cams for Deep-hole Drilling

As was previously mentioned, the drill should be dropped back clear of the drilled hole, so that the chips can be removed from the flutes and the drill cooled and lubricated. To accomplish this the lead cam is laid out as shown in Fig. 4. To explain the method of laying out a cam for deep-hole drilling we will take a practical example: Assume that a hole 1/8 inch in diameter and 7/8 inch long is to be drilled in a piece of brass rod. Now, it can be seen that this will require three distinct lobes on the cam, as it will be necessary to drop the drill back twice in producing the hole. The rises for the various lobes can be found with the aid of the following formulas:

Rise on first lobe $= 2\frac{3}{4} \times D + 0.005$ inch.
Rise on second lobe $= 2\frac{3}{8} \times D + 0.003$ inch.
Rise on third lobe $= 2 \times D + 0.003$ inch.
where $D =$ diameter of drill in inches.

The amount for each successive rise should be decreased in about the same proportion, and the feed on the drill should also be decreased slightly for each additional lobe when cutting machine and tool steel; but when cutting brass the feed can generally be uniform for each lobe. The rise on the various lobes would then be as follows:

Rise on first lobe $= 2\frac{3}{4} \times \frac{1}{8} + 0.005 = 0.349$ inch.
Rise on second lobe $= 2\frac{3}{8} \times \frac{1}{8} + 0.003 = 0.300$ inch.
Rise on third lobe $= 2 \times \frac{1}{8} + 0.003 = 0.253$ inch.

The depth to which the drill can be fed into the work before withdrawing can sometimes be increased, especially when a turret drilling attachment is used and the drill is greater than 1/8-inch in diameter.

The space on the cam surface necessary for dropping the drill back is generally equal to the space necessary for revolving the turret. It is, therefore, advisable to use more than one drill when there are sufficient empty holes in the turret, as it will not be necessary to resharpen the drill so frequently, and it will also be kept cooler.

Oil-pump Attachment for Turret Tools

When drilling and cutting deep holes, where a good supply of oil to the cutting edge of the tool is necessary, the attachment *A* shown in Fig. 5 is used. To the right of the engraving the attachment is shown inserted in the turret, and to the left it is shown removed. To explain clearly how this attachment works we will refer to the line engraving, Fig. 6. The oil is brought through the pipe *a*, as shown, up into the tube *c*, which is held in the split elbow *b*. The pipe *c* passes through the bronze bearing in the turret spindle to the oiling attachment *e*. This pipe has a slot *f* 3/4 inch long by 3/32 inch wide cut in the end facing the chuck. It is, therefore, obvious that oil can flow from this pipe only through the tools which are facing the chuck and in operation on the work. If any of the holes in the turret are not in use, a plug is inserted as shown at *g*. A clearer view of this plug is shown at *A*. The small teat *h* is not necessary, but keeps the oil well within the attachment. The oiling attachment *e* is fastened to the turret by two small screws *i*. Thus the attachment rotates with the turret, bringing each hole successively into line with slot *f*, where the oil can flow through. The outer shell of this oiling attachment is shown at *B*. Slots 1/2 inch long by 3/32 inch wide are cut in the hexagonal surfaces as shown, allowing the oil to pass through. The idea of having these slots elongated is to provide oil to the tools where it is impossible to have the oil pass through the hole in the center of the tool. A hole can be drilled close to the outside of the shank, and passing through the body,

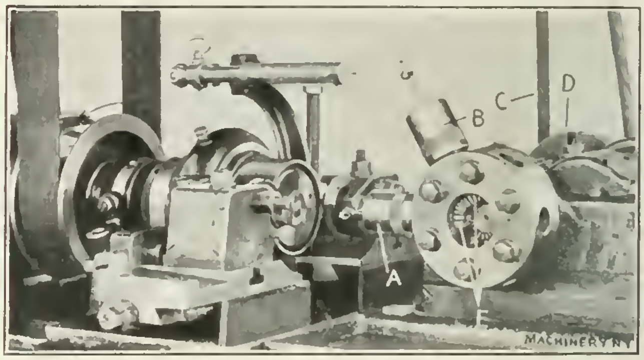


Fig. 7. No. 2 Brown & Sharpe Automatic Screw Machine equipped with Drilling Attachment

thus allowing the oil to penetrate to the cutting point of the tool.

Turret Drilling Attachment

In Fig. 7 is shown a No. 2 Brown & Sharpe automatic equipped with a turret-drilling attachment, two drill holders *A* and *B* being shown in position in the turret. This attachment is driven from the overhead works by the ½-inch twisted belt *C*, the shaft passing through the turret connecting the pulley *D* with the bevel gears *E*. The manner in which this attachment is located and held in the turret is clearly shown in the sectional view Fig. 8. The pulley *D* is keyed to the

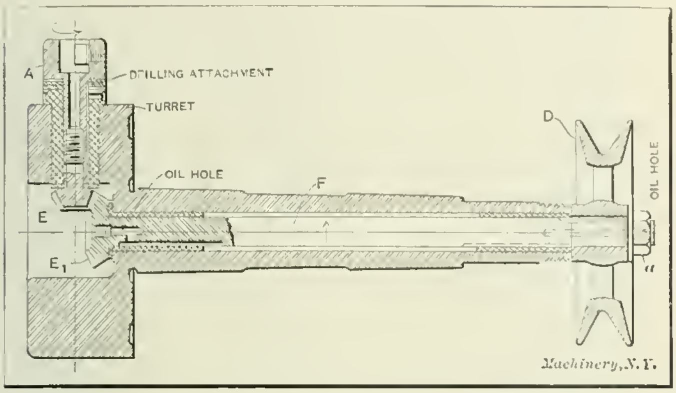


Fig. 8. Sectional View showing Construction of Drilling Attachment

shaft *F* and is also held in position with the nut *a*. Shaft *F* and bevel gear E_1 are made in one piece. The spindle of the drill holder is made of steel, hardened and ground, and runs in phosphor-bronze bearings.

The grooved pulley on the countershaft can be changed to increase or decrease the speed of the drill, as may be desired. The drill is revolved in the opposite direction to that in which the spindle and work are rotating, thus increasing the speed of the drill relative to the speed of the other tools. It is, therefore, obvious that the lobe on the cam for the drilling operation cannot be calculated from the speed of the spindle alone, but must also take into consideration the speed of the drilling attachment. To illustrate clearly the method of finding the number of revolutions required for drilling we will take a practical example. Before proceeding with the calcu-

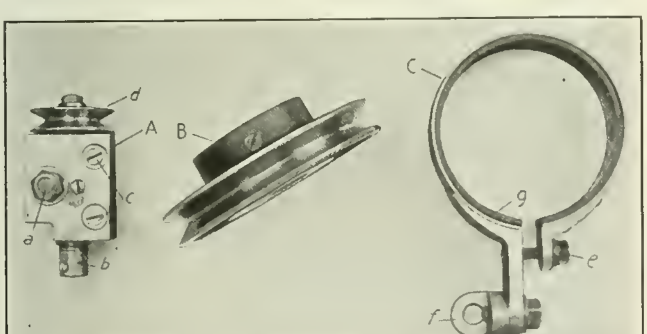


Fig. 9. Brown & Sharpe Cross-slide Drilling Attachment

lation we will assume the following values for speeds, depth of hole, time, etc.:

Let speed of spindle = 1200 R.P.M.,
speed of drilling attachment = 900 R.P.M.,
number of seconds to make one piece = 20,
total number of revolutions to complete one piece = 400,
depth of hole = ⅜ inch,
diameter of drill = ¼ inch,
feed on drill = 0.0032 inch per revolution.

Then the total revolutions required for drilling, if the drilling attachment is not used, would be $= \frac{0.375}{0.0032} = 117$ revolutions.

Then, the actual number of revolutions required for drilling when using the drilling attachment $= \frac{1200}{1200 + 900} \times 117 =$ 66.85, or, approximately, 67 revolutions.

The following are three of the many advantages gained by using this attachment: First, the drill and the work are both given a rotary motion, which tends to produce a straighter hole than if the work alone were rotated; second, rotating the drill facilitates the removal of the chips from the hole and also allows the lubricant to penetrate to the cutting point; third, a suitable surface speed for the drill can be obtained without increasing the speed of the other tools in the turret.

It may also be mentioned that a spiral fluted drill gives satisfactory results for drilling machine steel and brass when using this attachment; but for drilling brass where a long, curling chip is objectionable, the lips of the twist drill can be ground in, making them similar to a flat drill.

Cross-slide Drilling Attachment

It is sometimes found necessary to drill holes in a piece of work, at right angles to the center line, or, in other words, across the piece. For this kind of work the cross-slide drilling attachment shown at *A* in Fig. 9 is found very serviceable. To apply this attachment to the cross-slide, the toolpost which carries the circular tool is removed and the attachment located in its place. The attachment is then held to the cross-slide by means of screw and nut *a*. The drill is held in a bushing in the spindle *b* by means of the headless screw shown. The two screws *c* are provided for taking up the wear in the bronze bearing. The small grooved pulley *d* is keyed to the spindle *b* and held by the nut and washer

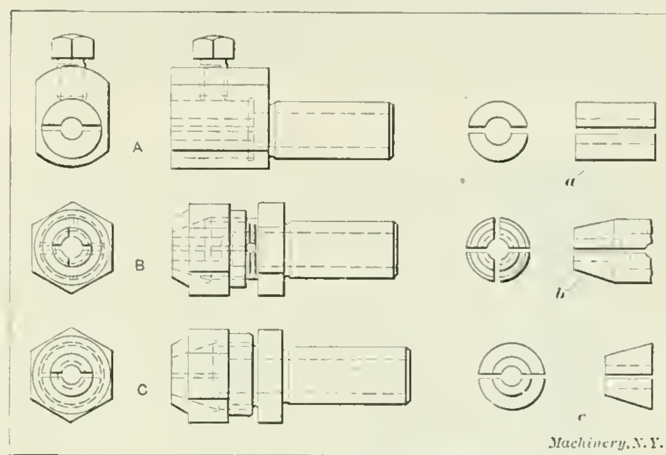


Fig. 10. Various Types of Drill Holders

shown. The large grooved pulley *B* is located on the countershaft and drives the cross-slide drilling attachment through the medium of a ⅜- or ½-inch round twisted belt, the size of the belt depending on the machine to which the attachment is to be fitted. In cross drilling it is necessary to stop the spindle and also hold it rigidly before the drill can operate. A brake shown at *C* for holding the spindle when drilling is used for this purpose. The brake proper is made from soft iron and has a strip of leather *g* attached to its inner surface, which grips the spindle firmly, preventing it from slipping. The cap-screw *e* is used for tightening the clamp on the pulley. The lug *f* is located on the pin which acts as a stop for the cross-slide tools. It is obvious that threading operations cannot be performed without the aid of a die and tap revolving attachment, as the spindle can rotate in one direction only. When using a revolving attachment in connection with the cross-drilling attachment, the threading attachment rotates the tap in the proper direction to release it from the work when the spindle is stopped, so that the tap is operated at one-half the spindle speed for running on the work and at the same speed for releasing from the work. For example, if a right-hand thread is being cut, the tap is rotated left-hand, advancing in the work when the spindle is running and retreating when the spindle is stopped. An opening die-holder is also sometimes used for cutting external threads when a cross-drilling attachment is used. The method of fitting up this attachment is as follows:

The belt is removed from the pulley nearest the collet, and the band *C* expanded over the pulley. It is then fastened to the pin which acts as a stop for the cross-slide, and clamped to the pulley by cap-screw *e*. The dogs on the

drum are then set to throw the clutch onto the pulley, which is clamped just before the drilling attachment advances toward the work. After the drilling operation has been completed and the drill retreats from the work, the clutch is thrown out and onto the other pulley and the other operations continued. The spindle is reversed practically instantaneously in both directions, but it is advisable to allow about five revolutions before and after the drilling operation for clearance. The drill should be ground with a more acute point angle than for ordinary work, and should also be ground thin at the point to facilitate its starting into the work. The rise on the cam is similar to the rise for ordinary drilling, but the feed should be less. In most cases, for cross-drilling operations it is an advantage to carry a guide bushing in the turret for locating the drill. Under this condition it is obvious that the work is drilled as if it were held in a jig, as the bushing is held in a floating holder that can be adjusted to produce the desired relation between the cross-hole and the outside diameter of the work.

Drill Holders

There are various types of drill holders used in the automatic screw machine, some of them being more complicated and expensive than is really necessary. The alignment of the turret holes with the spindle is nearly always perfect, and it is not necessary to have floating holders for holding a drill. At *A* in Fig. 10 is shown a common form of drill holder. This drill holder is serviceable and cheaply made. As can be seen, it is slabbed down on the sides to take up as little space as possible when working in conjunction with the cross-slide tools. The hole for the bushing is laid off eccentric to the main body of the holder, which allows enough stock on the upper portion to hold the set-screw. A plain bushing as shown at *a* is used. This bushing holds a drill very effectively. At *B* is shown a more expensive holder which is sometimes used for holding reamers and counterbores for operating on a piece which has previously been drilled concentric. This holder is made solid and then slotted as shown. The bushing part of the holder is shown at *b*. At *C* is shown a holder somewhat similar to that shown at *B*, but instead of the shank and drill holder being in one piece, a bushing is used. This holder is easier to set concentric with the work, but the extra cost prohibits its use to a great extent. The bushing as used in this holder is shown at *c*. For ordinary work the holder shown at *A* is advisable.

Drilling Speeds and Feeds

When drilling in the Brown & Sharpe automatics the best results are generally obtained by giving the drills light feeds and high peripheral velocities. The reason for this is that the conditions as obtained on the automatics are nearly ideal as regards lubrication and uniformity of feed. High-speed drills are commendable for drilling Norway iron, machine steel, tool steel, etc., but the ordinary carbon drills are suitable for brass and similar materials where the surface speed does not exceed that given in the following. The surface speeds here given for carbon and high-speed drills have been found satisfactory for the materials specified:

Speeds for Ordinary Carbon Drills

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	160—180
Gun screw iron	60— 70
Norway iron and machine steel	50— 60
Drill rod and tool steel	30— 40

Speeds for High-speed Drills

Material	Surface Speed in Feet per Minute
Gun screw iron	100—125
Norway iron and machine steel	80—100
Drill rod and tool steel	50— 60

Feeds for high-speed and ordinary carbon twist drills are given in Table III. The feeds given are for general work, but when the surface speed is not high the feed on the drill can be increased somewhat. It is found to be more satisfactory in general practice to keep the feed down, as a straighter hole can be produced than if the drill is forced.

Drills from 1/8 inch to 3/16 inch are capable of standing the heaviest feeds in proportion to their diameter, and where a hole does not pass through the work a 1/8-inch drill has been found to stand a feed of 0.016 inch per revolution when drilling brass. Feeds as heavy as this are not recommended, because concentric holes cannot be produced when the drill is forced to such an extent.

TABLE III. FEEDS FOR HIGH-SPEED AND CARBON TWIST-DRILLS

Diameter of Drill, Drill Gage or Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Diameter of Drill, Drill Gage or Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
70	0.00070	0.00060	0.00050	9/32	0.0058	0.0052	0.0042
65	0.00075	0.00065	0.00055	5/16	0.0059	0.0055	0.0043
60	0.00080	0.00070	0.00060	11/32	0.0060	0.0058	0.0045
56	0.00120	0.00100	0.00080	3/8	0.0062	0.0060	0.0048
1/16	0.00180	0.00150	0.00100	13/32	0.0065	0.0062	0.0050
5/64	0.00250	0.00200	0.00120	7/16	0.0068	0.0065	0.0052
3/32	0.00250	0.00230	0.00150	15/32	0.0070	0.0068	0.0055
7/64	0.00300	0.00250	0.00180	1/2	0.0070	0.0070	0.0058
1/8	0.00320	0.00280	0.00200	17/32	0.0072	0.0072	0.0059
9/64	0.00350	0.00300	0.00230	9/16	0.0075	0.0075	0.0060
5/32	0.00380	0.00320	0.00250	19/32	0.0078	0.0078	0.0062
11/64	0.00400	0.00350	0.00280	5/8	0.0080	0.0079	0.0063
3/16	0.00420	0.00400	0.00300	21/32	0.0082	0.0080	0.0064
13/64	0.00450	0.00420	0.00320	11/16	0.0085	0.0082	0.0065
7/32	0.00480	0.00450	0.00350	3/4	0.0090	0.0083	0.0068
15/64	0.00500	0.00480	0.00380	13/16	0.0095	0.0085	0.0069
1/4	0.00550	0.00500	0.00400	7/8	0.0100	0.0088	0.0070

* * *

The British firm of Vickers Sons & Maxim, Ltd., Barrow, England, has erected an interesting apparatus for testing propellers for aeroplanes and airships. The apparatus consists of a horizontal cantilever 165 feet long, mounted on a cast-iron pedestal. At the end of the cantilever is placed a 100 H. P. electric motor connected by gearing to a propeller shaft, which runs at velocities varying from 500 to 1000 revolutions per minute. Directly above the pedestal, a place is provided for taking the observations. The cantilever rests on a ball-bearing at the upper end of the pedestal. A velocity of 70 miles per hour can be obtained at the outside periphery of the cantilever. On account of the long radius of the circle in which the propeller is moving, the circular arc at every point coincides nearly with a straight line, so that the experiments made give practically the same results as if the propeller were used directly in an aeroplane or airship. Owing to the circular motion, the effect of the wind is neutralized, and a very accurate comparison between different kinds of propellers can thus be made.

* * *

An ingenious process of finishing high-speed gears has been proposed, its theory being that low spots in mating gears will be built up as the gears are run together. The method proposed is to electroplate the teeth with copper while running them in a suitable plating tank. The process is the direct opposite of the wearing-down process which, as every gear expert knows, is not conducive to the best results.

SOME FIXTURES USED IN MILLING PARTS OF LANDIS GRINDERS

By W. G. NEVIN*

In manufacturing parts of the Landis grinders to the extreme degree of accuracy required, many interesting fixtures are used to insure a high standard of workmanship and also to assist in rapid production. A few of the many fixtures used in producing parts of these machines are shown in the accompanying illustrations.

In Fig. 1 a milling fixture is shown that is used for holding the headstock base while the surface upon which the cover is secured is being finished. As the engraving shows, duplicate jigs are used, the operator filling one jig, while the other piece is being milled, thereby accomplishing what might be called continuous milling, with the exception of the time lost in moving the cutter from one piece to the other. In finishing the shoulder, the table is fed by hand against a positive stop, the power cross-feed being used in cutting. The work is mounted on a No. 4 Cincinnati high-power vertical machine. The cutter used is 6 inches in diameter and is preferable to one of a larger size, as there is less torsion. The way the work is held in this fixture and its construction is so plainly shown that a description is unnecessary.

In Fig. 2 another fixture or vertical milling operation is shown, the work being in this case a thin cover or spindle guard. As a raised pad around the edge of this cover had to be finished, it was necessary to design the fixture so that the work would be held rigidly, but without interfering with the movement of the cutter. The clamping is effected by set-

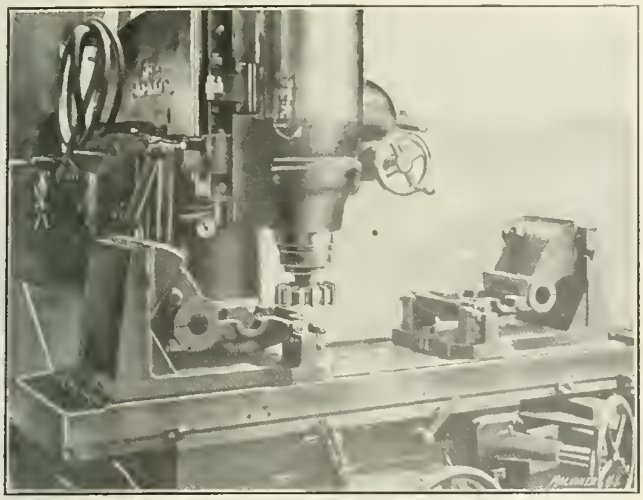


Fig. 1. Milling Fixture for Headstock Base

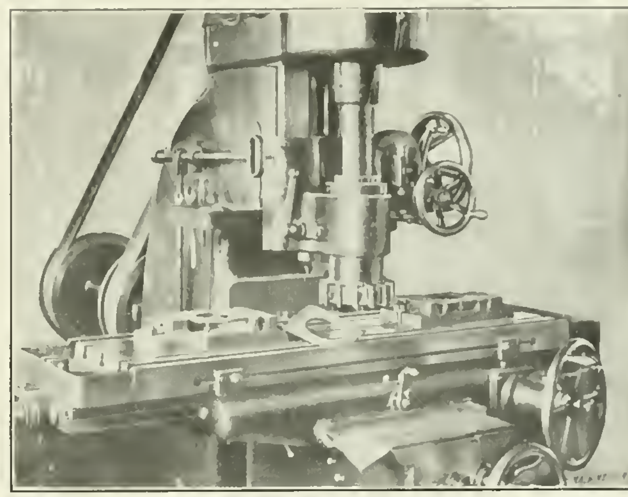


Fig. 2. Milling Fixture for Spindle Guard

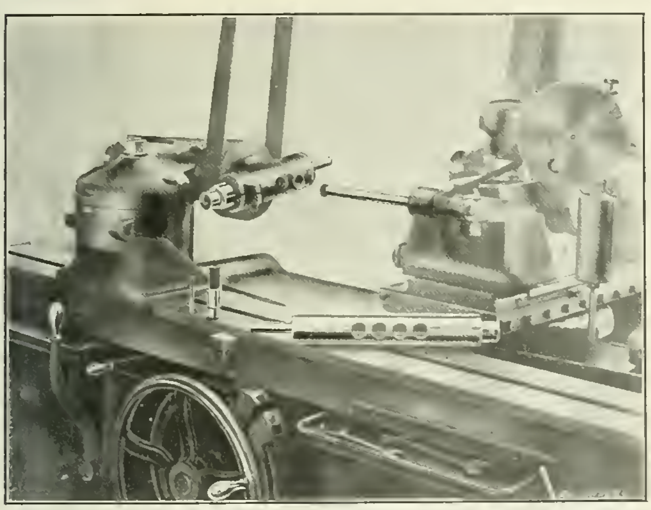


Fig 3. Fixture for Grinding Clutch-pin Holes in Speed-change Shafts

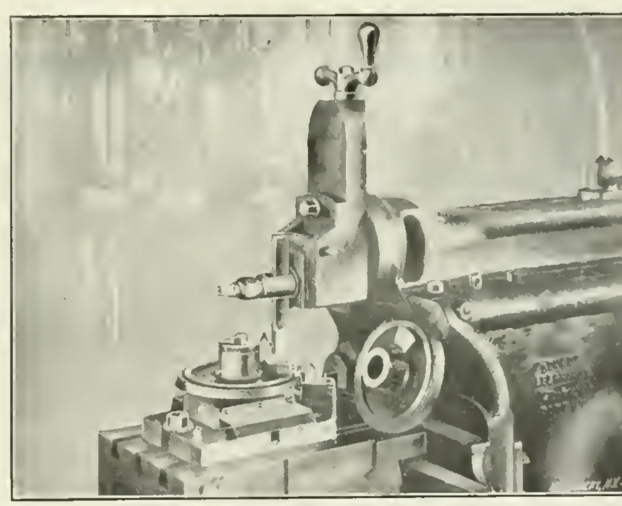


Fig. 4. Shaper Fixture

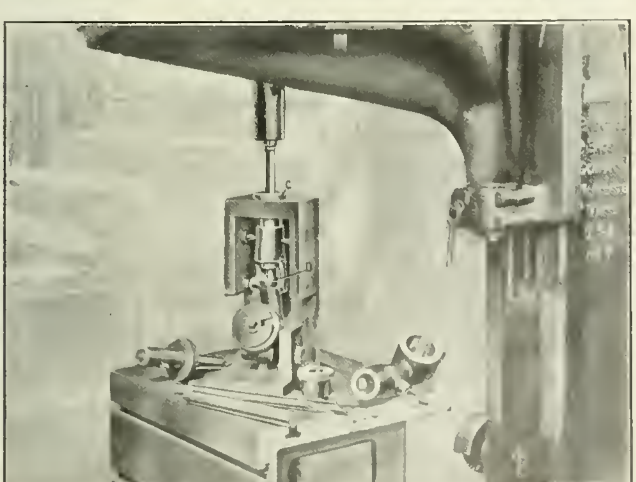


Fig. 5. Drilling and Boring Jig

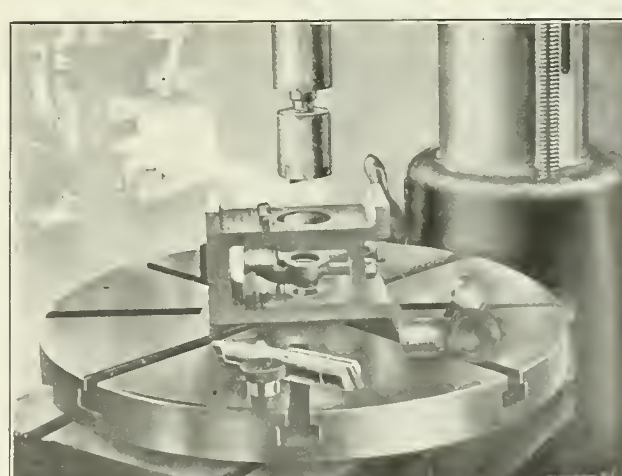


Fig. 6. Boring, Tapping and Facing Jig

* Address: 7 West North St., Waynesboro, Pa.

screws that force serrated jaws against the side cover, which is additionally supported against downward thrust by adjustable screws and the body of the fixture. The work is shown mounted on a No. 2 Brown & Sharpe vertical milling machine.

In Fig. 3 is shown an interesting fixture for grinding the holes for the clutch pins in the speed-change shafts for the headstocks. The fixture consists of a cast-iron head, having a spindle which runs in bearings of the universal headstock, with a pulley for driving and a sleeve for carrying the shaft to be ground, all being cast in one piece. After the first hole is ground, the shaft is loosened and shifted until the finished hole coincides with a hole in the sleeve in which a close-fitting plug is inserted, which insures the proper spacing of the holes.

The fixture shown in Fig. 4 is for shaping the sides of lugs on the backs of bevel gears. This fixture has a base *B*, on which is mounted a sub-plate *C*, that has a tongue piece which fits a cross-slot in the base. On each side of the sub-plate *C* there are pins which are spaced to allow the plate a cross movement equal to the width of the tool's cutting edge. When the fixture is first set up, the table is adjusted until the center of the gear is in line with the travel of one side or the other of the tool, depending on the position of the sub-plate. A square-nosed tool, ½ inch wide, is used and the sub-plate is first set so that the side *A* of the tool is in line with the center of the gear, that is with the plate moved against the

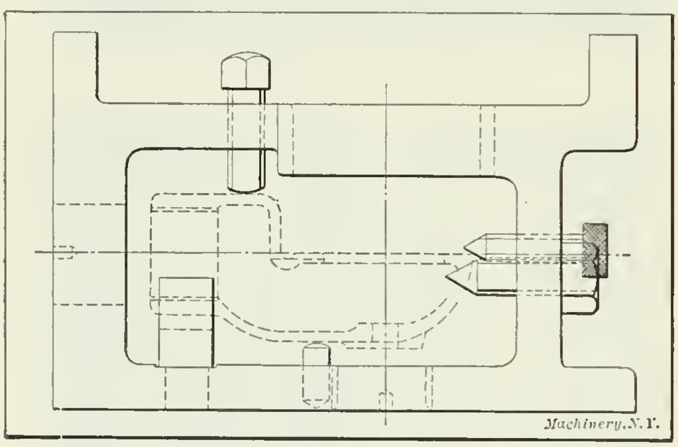


Fig. 7. Elevation of Jig shown in Fig. 6

stop pin on the farthest side, as viewed in the illustration. One side of the lug is then machined, after which the gear is loosened and the plate shifted against the opposite pin, the movement of the sub-plate equaling the width of the tool. The gear is turned until the planed face of the lug comes against the stop *D*, the other side of the tool being used for finishing the remaining side of the lug.

In Fig. 5 a drilling and boring jig is shown that is used for machining bevel pinion supports. After the hole *A* is bored and faced in a lathe, the remaining work is done in a jig. Hole *B* is first bored and reamed. Bushing *C* is then inserted in this hole and also through a line bushing in the jig with which it fits. The bar runs in bushing *C* while boring hole *D* and, as it is supported close to the hole, perfect alignment is assured. The remaining holes are then drilled, after which the job is complete.

In Fig. 6 is shown a boring, tapping and facing jig for pipe swivels. The work is supported and located at one end by a V-shaped block, and at the other by two conical-pointed screws as shown. In addition, there is a small pin beneath the center of the swivel and a set-screw at the top for clamping. A central knurled screw, which also has a conical point is brought into contact with the work, as illustrated in Fig. 7, during the boring and tapping operations, after which it is backed out so as not to interfere with the facing cutter, which is shown inserted in the spindle. All machine work is done without removing the piece and the facing bars run in steel-lined bushings which are hardened and ground. This method of using guiding bushings gives far better results than piloting the bars in a drilled or reamed hole in work being machined.

PRODUCTION OF "HEAT-BLACK" FINISH ON BRASS, BRONZE AND COPPER

The so-called "heat-black" finish on brass, copper, or bronze is one of the new methods of coloring metals that has recently appeared and is one of the most durable. It is adapted for a large variety of work and is even replacing nickel-plated work for some kinds of articles. Desk telephone sets are now being finished in the "heat-black," and in many parts of the United States have supplanted the nickel-plated article previously used.

The adaptability of the "heat-black" finish is wide, and the reader will undoubtedly find many new uses for it. The color is an absolute dead black, and as it is not difficult to apply, the future will undoubtedly find it extensively employed. It can be applied to brass, bronze or copper. It does not work evenly on steel or iron.

The article to be treated should be free from grease, although a slight tarnish does no harm. It is usually customary to sand blast the surface, although very good results may be produced without it. A sand-blasted surface takes an excellent finish, but those who do not possess the apparatus for producing it need not have any hesitation in using the finish without it, as about the only difference between the results is that the sand-blasted surface is a little more dead.

The Solutions

Two stock solutions are first made up. One is a solution of nitrate of copper in water, and the other is a solution of nitrate of silver in water. The proportions need not be exact, although it is preferable to keep them fairly close. They are made up as follows:

Nitrate of Copper Solution

Water	1 oz.
Nitrate of copper	1 oz.

This gives a practically saturated solution of nitrate of copper in water and is used for a "stock" solution. If desired, the nitrate of copper may easily be made by taking 1 ounce of strong nitric acid and dissolving in it all the copper wire it will take up. A thick, blue solution is left which is used for the "stock" solution. As few platers have nitrate of copper in stock, it can easily be made from the copper wire.

Nitrate of Silver Solution

Water	1 oz.
Nitrate of silver	1 oz.

This solution can also be made by dissolving pure silver in nitric acid until no more will dissolve, but dilute acid (1 part acid and 1 part of water) should be used as silver does not dissolve readily in strong nitric acid. It is preferable, however, to purchase the nitrate of silver as it is easily obtained. The nitrate of silver solution is practically a saturated solution and is used as the "stock" solution.

Mixed Solution for Applying

The mixed solution for applying to the metal is made as follows:

Water	3 parts
Nitrate of copper solution	2 parts
Nitrate of silver solution	1 part

The solution is kept in a glass or stone-ware vessel for use.

Applying to Brass or Other Metals

The brass, bronze or copper article to be treated is heated on a hot iron plate or in an oven to a temperature of about 250 degrees F. and the solution applied with a brush or cotton swab so as to cover the surface uniformly. The brush should be a rather soft one in order to allow the coating to be made in the best manner. The so-called "rubber-set" brushes are the best for the purpose, as there is no metal on them to be attacked by the solution.

One or two coatings of the solution on the surface of the article is usually enough; it dries almost immediately leaving a green froth. The temperature is not sufficiently high to draw the temper of hard brass, but it will usually melt soft solder.

When the entire surface has changed to a uniform black color, allow the article to cool and then brush off the fluffy

material on the surface of the metal with a stiff-bristled brush. The color will now change to a brownish-black that is quite pleasing for many purposes and which is very tenacious. When the fluffy material is completely brushed off, it is surprising how even and uniform the coating is and how tenaciously it adheres. If the brown-black finish is desired, the surface may now be waxed or lacquered, but it is usually customary to give the article an additional treatment in a liver of sulphur solution in order to change the brown-black coating to one that is absolutely dead black.

Final Treatment

When the smut has been brushed off from the surface of the article, it is immersed in a cold liver of sulphur solution for 5 minutes. This solution is made by dissolving 2 ounces of liver of sulphur in 1 gallon of water. The article is immersed in it, allowed to remain about 5 minutes and then, without rinsing, is again heated until the surface is uniformly black.

The surface is now brushed again with the bristle brush when it will be found that the color is a dead black and quite uniform. It should be borne in mind that the article is not rinsed at all after it is removed from the liver of sulphur solution, but is simply drained off and then heated.

The article may now be lacquered with a flat lacquer or waxed as may be desired. The final appearance of the surface will be found quite satisfactory and contrary to what one would naturally expect. The coating of the solution that is first applied need not be very even as long as a sufficient quantity is put on.

The process as arranged by steps may be summed up as follows:

1. Applying the solution to the metal.
2. Heating on a hot plate or oven until the solution has dried and the residue left by evaporation has turned black.
3. Brushing off the smut.
4. Immersion for about 5 minutes in a liver of sulphur solution.
5. Drying without rinsing and heating on the plate or in the oven again.
6. Lacquering or waxing.

If the surface is not satisfactory, or an old article is to be refinished, the wax or lacquer may be burned off and the process repeated.

It is believed that this is one of the most satisfactory black finishes known, as it is dead black, is readily applied and is very durable. It is calculated to resist considerable handling, such as a desk telephone would receive. There are many articles that can well be treated by it.—*Brass World.*

* * *

INCREASING PROFITS BY REDUCING COSTS VS. INCREASING PRICES

"There are two ways only of increasing profits," said Mr. H. L. Gantt to the National Association of Cotton Manufacturers at its annual meeting in April; "one by increasing the selling price, the other by reducing the cost of production. The successful salesman, or the operator who has succeeded in persuading his competitors to join with him in upholding or advancing prices, has, on account of the increased profits resulting from his efforts, been considered a very important man, and been compensated accordingly. The recognition of ability and the compensation for success in this field have been so great that capable workers from all directions have swarmed into it, and the industry of making prices has prospered amazingly. With increase of prices comes higher cost of living; with higher cost of living comes demand for higher wages; with higher wages comes higher cost of production. Then, to maintain the same profit under the new conditions, we must again increase our selling price, and the cycle repeats itself. This process has been going on for years, and as the producers have gradually been attracted from the field of making products to the more lucrative one of making prices, to-day we have a surplus of prices and a shortage of products. The field has been overworked."

* * *

An alloy of 95 per cent of copper and 5 per cent of aluminum is the nearest imitation of pure gold of any of the known alloys.

CARE OF MACHINERY

By H. M. WOOD

The majority of machine tool users—including even the large shops—fail to realize how absolutely essential are all details in the care of their machinery if their work calls for any degree of accuracy.

The foundation is a very important adjunct to any machine. Money spent to secure a firm and unyielding base is true economy. A machine should always be leveled up when first installed, and care should be taken that the wedging material used to bring it level will not warp or shrink. A carpenter's level will not do for setting machinery; this work requires a sensitive level of known accuracy.

Occasionally we receive a complaint: "Lathe just received will not turn true; send operator." In such cases we almost invariably find the difficulty results from a shaky foundation from the lathe being out of level. As soon as the machine is leveled up so that the bed lies perfectly horizontal, the alignment is just as perfect as when the machine was shipped. Many managers don't see how a heavy casting can spring out of true by being a bit out of level. But it is an established fact that no matter how massive the bed, or what the style of the machine, it must be level to do its best work. A planer has an extremely massive bed—in fact, the bed constitutes the bulk of the machine—and it is truly surprising how "warped" planer work will be if the bed is out of level.

No matter how good the foundation, a machine cannot be leveled "once for all." Our product requires the most accurate machine work. Therefore, we have a shop rule that on the first Saturday afternoon of each month every foreman must stay (the plant closes at noon on Saturday) and personally see that each machine in his department is absolutely level.

Cleanliness is another essential; manufacturers more generally recognize that this is so—as applied to the other man's factory. The accuracy of the work turned out by any machine tool depends upon the alignment of the different parts and the regularity of their relative movements. If chips cover the ways of a lathe and work in under the carriage bearings, the quality of the work will rapidly depreciate and the machine itself will soon need to be overhauled. A little grit will play havoc with the spindle bearings. A dirty chuck plate will soon spoil the threads of the spindle nose. Yet in many plants expensive machines, capable of accurate work when properly cared for, are subjected to these abuses.

We expect each operator to care for his own machine to the extent of keeping all bearing surfaces free from dirt and chips. Laborers empty the chip pans beneath the machines as frequently as necessary. In addition to this, there is a general clean-up once a week. Each department has one or two men who thoroughly clean all machines every Saturday afternoon and wipe up the bearing surfaces with oily rags.

With the heavy duty put upon machines by present-day high-speed cutting tools, ample lubrication is more necessary now than it ever was. Not only are the speeds higher to-day, but there are also greatly increased pressures on the bearings, due to deeper cuts. The oiling of the line-shafting and countershafts can well be left in charge of one man in every department, but each operator must be largely depended upon to oil his own machine as frequently as necessary.

We find that sight-feed oil cups, each holding a day's supply of oil, are a great advantage on the main bearings. In the first place, they insure positive lubrication of the journals and allow the supply of oil to be exactly regulated to suit individual conditions. Another valuable feature of the sight-feed oil cup is that the glass shows at a glance whether the cup is full or empty. The superintendent in passing through his shop can instantly tell whether or not the oiling has been attended to. A full oil cup proves that that particular bearing has been recently oiled, and is also a pretty good indication that the operator did not forget to oil the other bearings when he had his oil can in hand.

Careful attention to the leveling, cleaning and oiling will increase the life of the machine and a better grade of work will be turned out. Many costly delays will also be prevented, because the machine is not out of commission for repairs.

* Address: Care of Lodge & Shipley Machine Tool Co., Cincinnati.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Ethan Viall,
Douglas T. Hamilton,
Associate Editors

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

SEPTEMBER, 1910

PAID CIRCULATION FOR AUGUST, 1910, 25,847 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

The sixteenth yearly volume of MACHINERY was completed with the August number. The index for the Engineering Shop and Railway editions is ready for distribution, and will be sent to any address on receipt of request. A new form of index has been compiled in which the page numbers for all three editions appear in parallel columns, thus really combining three indexes into one. The advantage of the new form is that all the matter published in the three editions is shown in one index. The total number of reading pages in the Engineering and Railway editions, exclusive of forty-eight data sheets and thirty-six shop operation sheets, is 1042.

* * *

BAD PRACTICE IN THE USE OF UNIVERSAL JOINTS

A fundamental principle is so often violated in the erection of the common universal or Hooke joint that it seems worth while to call general attention to the bad practice which results in irregular action and reflects on the intelligence of the mechanics in charge.

When two universal joints are used to connect shafts at a right angle or less, the knuckles should be so located that the pins in the knuckles of the middle shaft are parallel. Very often they are placed in some other relation, often in planes at a right angle.

The reason for requiring the parallel positions of the pins or axes is, of course, to preserve uniformity of angular motion throughout a revolution. The variation of angular velocity is as $\cos a$ to $\frac{1}{\cos a}$ in one joint, but if two joints are connected with their knuckle pin axes parallel, the irregular action of one joint is offset by that of the other, thus making the motion transmitted to the driven shaft practically uniform.

Machine designers should thoroughly appreciate the necessity of preserving uniformity of angular motion wherever possible, especially in rapidly turning shafts. Mysterious breakdowns have been traced to improperly placed universal joints. When so placed that the knuckle axes are at an angle, the variable action of one joint is superimposed upon that of the other, resulting in irregularity of action in the ratio $\cos^2 a$ to $\frac{1}{\cos^2 a}$ when the pins are at right angles. To show the difference in action take the case of a shaft connected to another at an angle of 60 degrees through an intermediate shaft and two universal joints, each working through an angle of 30 degrees. When properly connected, the driven shaft rotates uniformly with the driver, the intermediate shaft varying in the ratio first given. If the driver runs at 100 revolutions per minute, the intermediate shaft action varies at the rate of 86.6 to 115.4 turns per minute. Now if the knuckle-joint pins are at right angles the irregularity of action of the intermediate shaft is transmitted to the driven shaft in increased ratio, being, in the case given, in the ratio of 75 to 133.3 turns per minute. Imagine the severe torsional stresses imposed on the shafts and joints when running at high speed and driving wheels or gears of considerable weight.

* * *

THE MODERN CONCEPTION OF BUSINESS

The old saying, "business is business," with its implication that success in trade and commerce is founded merely on shrewd business dealings and one-sided bargains is happily being replaced by the broader conception of business relations defined by the expression "service for service." It is coming to be more and more universally understood that the bargain must be mutually advantageons in order to be really beneficial to either party. The truth of this has made itself more keenly felt in some industries than in others, and the machine building industry in general was one of the first to recognize its economic value. The machine builder cannot be satisfied with a mere *sale;* to him it is of the greatest importance that his machine makes good for the particular purpose for which it is sold. The salesman who sacrifices all other considerations to the one of merely making a sale will not long be a useful factor in the success of his firm. For permanent success it would be better sometimes to make no sale at all, than to sell a machine not suited to the buyer's requirements. The most successful firms are those which thoroughly inquire into the needs of the purchaser and then carefully select the machine most suitable. In such a case both buyer and seller are benefited by the transaction. Future trade relations are likely to be on a basis of mutual confidence; and firms which handle their customers with this in mind will acquire a reputation for reliability. It is a case of service for service. The seller receives a fair price and makes a reasonable profit, and the buyer obtains a machine by means of which he is able to perform the work in his shop or factory to better advantage.

The same principle of service for service makes the relationship between employer and employe one of mutual confidence instead of one of misunderstanding and strife. The employer who requires good service also expects to pay a fair price for it, and the employe who expects fair compensation for his services should give a full day's work in return; but whenever either tries to secure a price or service out of real proportion to value given or received, then the "service for service" idea has been lost sight of, and the door is opened for suspicion, misunderstanding and antagonism which ultimately work a loss to both parties. The "service for service" idea is the modern principle of business, and while its full application is, perhaps, not possible without thorough-going social reforms in many directions, it is the ideal toward which every permanently successful business must strive.

* * *

"The micrometer," says a well-known instructor in machine shop practice, to his classes, "is essentially a measuring instrument of precision, but in order to be an instrument of precision in the hands of the unaccustomed, it must be used with extreme care. Especially is it an instrument that must be used carefully and slowly by the beginner: First, to obtain accurate adjustment and second, to read the measurement correctly. With careless adjustment or incorrect reading, or both, the micrometer is anything but an instrument of precision; on the contrary its use may cause more mistakes than the use of ordinary calipers."

THE COST OF ACCIDENTS IN THE INDUSTRIES

We have already discussed in MACHINERY the basis and justification for employers' liability laws, and have given some figures* relating to the cost to employers of their enforcement. Laws of this character have been adopted by all industrial countries except the United States,† and are intended to make the industry in which an accident occurs bear the financial responsibility for it. The objection most commonly made to employers' liability laws is that the heavy expense would have to be met by the employer, and that in many competitive enterprises the margin of profit is so narrow that there is nothing with which to finance an expense burden of this kind if enforced by a rigid liability law. In connection with the statistical information given in the December, 1907, number of MACHINERY, some information published by the *Engineer*, London, in reviewing the recent workings of the liability laws of Great Britain, may be of interest.

According to the figures published in that journal, the average annual compensation per injury per employe at work in the metal trades is $1.52; or at the rate of hardly more than one-half cent per working day. Of course, this figure would be somewhat higher in the United States, owing to the generally higher level of prices and the consequent higher rate of compensation required; but on the same basis as the British liability laws one cent a day per employe should cover the employer's expense for this insurance, the casualty companies assuming the burden of paying compensation in cases of proved liability, up to the amounts of the policies issued by them. The experience of England seems to indicate that insurance against disability due to accidents in the industries would by no means involve a serious burden on the employer.

A very important result of the workings of the new liability law in England is that instead of going into court with their differences, as was formerly nearly always customary, these are now usually adjusted and the compensation settled directly between the parties concerned, according to the law, and without the expense of litigation.

* * *

THE UTILITY OF THE ENGINEERING PROFESSOR

By JULIAN C. SMALLWOOD‡

There are two charges that may be brought against the engineering professor. First, he is not, in the economic sense, a direct producer; second, he does not satisfy the special need which is supposed to justify his existence. To amplify, the old-fashioned idea about the school teacher is that he is a man worthy of some respect as knowing more than his fellows. This respect, however, is tempered with a certain amount of condescension because he cannot or does not apply his learning in the practical world. He can only impart knowledge; he cannot use it. He can develop others so that they may make money, but he cannot make it himself. Now, this idea about teachers in general still prevails, and it still clings to the technical teacher. It may be that it is more marked in his case than in others. Engineering, of all professions, is most directly concerned with economics—in the last analysis with the dollar. Therefore, it is natural that the popular eye should be attracted to the discrepancy between the engineering professor's vocation and profession. It is reasonable, too, to conclude that if he cannot apply his knowledge to engineering production he cannot adequately teach others to do so. These two shortcomings, whether wholly or partly true in the individual case, are attributed to a quality of mind too abstract, too theoretic, too narrowly academic. The scientific professor is pictured by those who hold these views as a man whose nose is immersed in a book and whose vision is limited by the margin of the printed page, a man whose wisdom comes from texts and not from the life and work-a-day world around him.

It is well that the practical engineer of to-day, the manufacturer, and the father of embryonic engineers should ascertain the worth and limitations of the engineering teacher. In a large sense all those who are concerned with engineering enterprise are directly concerned with the utility of the technical professor. It is he who prepares and shapes the brains of future organizations and, in a measure, with his university, guarantees their fitness. We may therefore ask: "Is he a practical engineer to the extent that he could make a living in his profession or not, and can he in either case teach engineering?" It is the purpose of this article to answer the two divisions of this question.

There are two classes of engineering professsors those who practice their profession and teach it and those who do not practice it. The former class has an unquestioned utility in engineering production, the latter may or may not have it, and members from either class may or may not be able to teach. It is thought that if a man knows his business thoroughly and has made a success of it he can impart to others his wisdom and ability. This idea is clearly a superficial one; nevertheless, there are universities which accede to it to the extent of employing men as teacners whose reputations as successful business men are big with no other apparent reason than that their names look well in the catalogue. It is a bowing to popular clamor, and in this commercial and competitive age, when universities sprout—mushroom-like—over night, many such bows must needs be made. So these gentlemen adorn the catalogue and undoubtedly draw customers. "Professor Blank," reasons the manufacturer who is about to send his son to college, "knows all about power-plant practice and now he is going to teach it at Dash University. That is the place for my son. It employs practical men." Professor Blank, however, may be a fool in the class- or lecture-room or in any room outside the power house.

Whether or not the professor is directly engaged in engineering production aside from his teaching, his utility in the latter may be judged almost infallibly by what he has or has not written. A good teacher can hardly refrain from writing a book, and if any teacher is the author of a textbook which fulfills its purpose well and thoroughly, it is an almost certain inference that he is capable in the class-room. It is not an absolutely certain inference, for a man may be able to write clearly and yet be unable to formulate his thoughts quickly enough for clear speech. The important qualification, however, is that he be able to *think* clearly; if he writes so, it is certain that this is the case, and therefore likely that he can transmit his thoughts orally, as well.

This brings me to a consideration decidedly favorable to the engineering professor who is engaged only in academic work. The standard textbooks, and, in fact, the greater and more valuable part of technical literature, are contributed by him. This affords a chance for education through his agency not only to those who come into personal contact with him, but to many others who have neither the time nor the money for a college course. Such works are used not only by students, but by practical men who find it necessary to add some theory to their knowledge. Furthermore, the particular kind of technical literature that the academic man produces probably would not be created at all but for his efforts. The work written by the so-called "practical engineer" is vastly different from professorial contributions. The latter may be thought too theoretical, but, on the other hand, it should be noted that this very excess of theory is what the practical man needs to round out his education and usefulness. His daily experience teaches him practicality; it does not teach him the theory of practice.

In the field of research and invention the technical teacher has been unquestionably useful. Little research for the general good is accomplished by others. Almost the only others engaged in such work are certain business organizations which do so only for the furtherance or their own ends and generally do not publish their results. In invention, of course, the professor does not preempt the field; nevertheless, it is remarkable how much of this sort of production is attributable to him. Consult almost any reference or textbook and you will find many devices invented by academic men tor tne furtherance of scientific measurement and in-

* See MACHINERY, November and December, 1907, engineering edition, "Liability of Employers."

† A new liability law was enacted by the last New York State Legislature, going into effect September 1, which provides for compulsory compensation to employes for accidents sustained in dangerous work, no matter who is at fault. The new law marks a great step in advance in the relation of employers and employes, and undoubtedly will result in greatly reducing accidents in hazardous occupations.

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vestigation, as well as practical machinery and constructions. In this way and in research they have furnished the guide posts by whose aid much of our rapid advance along the road of engineering science has been accomplished.

In the foregoing I have pointed out unquestionable services performed by the men who make it their business to teach. Undoubtedly there are many of them who do not share in these services; who are satisfied to remain in the rut made by timeworn lectures and repetitions of class-room grinds. But surely the accomplishments of the former, even though they are in the minority, are sufficient to remove the stigma of incapability in practical work attached to them as a class.

In regard to the usefulness of the professor in the class- or lecture-room, it has been previously mentioned in this article that, no matter what his practical attainments are, it does not follow that he is an efficient educator. If he is a practicing engineer he is better equipped to teach his profession, and there can be no doubt that there are many such who do so. Aside from this, if his individuality is strong and he possesses what is called "personal magnetism," his influence in education may be tremendous simply through the force of his personality. He excites the admiration of his students who seek to emulate him. His words are eagerly listened to and his slightest statement may be remembered for years. It may be that he is not a profound scholar nor imparts words of wisdom to be obtained nowhere else, but that what he says is convincing and sinks in. Probably every college graduate has been under one such man whom he well remembers and still admires as a "big" man, and equally probably there was only one.

Lecture courses given by such a teacher are of vast value not only in the training in engineering, but in character. Lecture courses given by any other than this sort of man are futile. They shift the work of learning from the student to the instructor, and they do it ineffectually if the latter has not the personality to rivet the interest of those whom he addresses. The process is like pouring water into vessels; some will be leaky and others will retain it all, but even such will never give out more than was poured in. The true function of education is to increase capacity; surely capacity is not increased by making students mere recorders of facts. In this part of the average professor's work I have no hesitation in saying that he does not adequately accomplish his purpose. Fortunately, however, it is not the only part. Education is imparted through recitations and laboratory work, the chief virtue of which is the mental training of the student involved in answering questions put to him by his instructor—questions not involving memory, but reason. The process of lecturing is like sowing seeds; the class-room work, like gathering the harvest. True, the seeds must be sown, but if the student does this himself and tills his own soil he will be better able to harvest. It is then the instructor's duty to see that the proper seeds are selected and to train their growth.

The question of whether a non-practitioner in engineering can teach his profession adequately is a serious one, for it is such that do most of the teaching in our technical schools. In this connection it may be remarked that a point overlooked by many critics of academic methods is that teaching is as distinct a profession as is engineering. To teach well requires study toward that particular object and practice in doing it. The ability to teach well is a gift of nature not easily to be acquired. Combine this gift with scientific attainments and a practical mentality in one man and you have the ideal engineering professor. Naturally, we may expect to find few such men, but this does not mean that the rest do not fulfill a useful function. The ideal opera singer is one who not only can sing, but can also act, and who combines these abilities with an admirable face and figure; yet those who are not in this way ideal are to be appreciated. They may lack the other qualities so long as they can sing, and in the same way the professor may lack the other qualities so long as he can teach. If he does lack them, at the worst he performs his functions in a mechanical way and grinds out a product year by year that has some, if not superior, merit. The result of his work, then, compares with what he might have produced, as machine-made art compares with handicraft. But I do not hesitate to say that the non-practitioner can do vastly better than this; that he can give engineering training of a high order to his students in the same way that astronomers can enlighten us upon the composition of the stars without ever having been on them.

It must be admitted, however, that the non-practitioner lives under narrowing influences which can be nothing if not detrimental to his university work. As a rule, he is interested in but one division of one branch of engineering and ignores the rest. He fails to take the broad view of the correlations of subjects, accentuates the trivial, and magnifies the theoretical. His theory departs too far from practice. He forgets that there is a line beyond which it is waste of time to carry theory. The result is that he does not teach adequately and may teach badly.

We may conclude, then, that the engineering professor's chief limitation is his estrangement from the practical world. To remedy this, those who are practical workers may in their own interest very materially assist. The business man and the scientist should recognize when each may supplement the other's knowledge and in doing so exchange benefits. In the laboratories of our technical schools there are splendid equipments for the determination of data for the need of which many a manufacturer is floundering helplessly. Such equipments are not maintained at their maximum usefulness when they are operated only in the performance of cut-and-dried experiments. Here we have the manufacturer developing a piece of machinery by unmethodically trying first one alteration and then another to ascertain the best combination, when at his elbow are the facilities for doing this work precisely and quickly and with advantage to those who undertake it for him. If the practical engineer makes his needs known to the technical educator and enlists his help, it will go a long way toward reducing the narrowing tendency of the latter's vocation and heightening his usefulness, as well. The technical schools should be open to and soliciting practical work, tests and research for the benefit of professors and students. There should be felt none of the old antagonism between theory and practice; where theory and practice do not agree it should be considered that it is not because the theory is false, but simply that it is incomplete.

On his part, the professor should seek to know the practical engineer, find out what he is doing, and, whenever possible, obtain work from him. He should remember that no amount of study of the practical side of his profession exactly fills the place of experience in it. The average teacher has plenty of time for such experience; he should seek it and aim to build up a practice for himself.

In concluding, I wish only to show as an example of ideal operation the methods of modern medical schools. Through their hospitals they furnish experience to their students and service to others. Their teachers are mostly men who practice their profession. Just so should the technical school be conducted—a service to those in need of scientific help, practical association for its students, and a training for its professors; in short, a hospital for the needs of engineering.

* * *

The following formula for determining the weight of flywheels for rolling mills is given in *Comptes Rendus Hebdomodaires*:

$$W = \frac{\text{H.P.} \times t \times C}{V^2}$$

in which W = the weight of the flywheel in tons of 2000 pounds,

H.P. = brake horsepower,

t = time in seconds between each pass,

V = the highest permissible velocity of flywheel rim in feet per second, and

C = a constant depending upon the permissible percentage of decrease in speed.

The constant C for a 5 per cent decrease in speed equals 185.3; for 10 per cent, 93.8; for 15 per cent, 65; for 20 per cent, 49.8; for 25 per cent, 41.3; and for 30 per cent, 35.3.

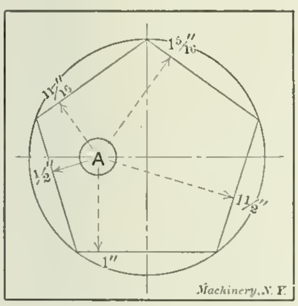
For cast iron, the velocity of the flywheel rim should not exceed 130 feet per second.

CLAMPS AND STRAPS FOR HOLDING WORK WHILE MACHINING*

By H. E. WOOD†

Among the tools used in the ordinary machine shop, the clamps and straps for holding work to the faceplate of lathes and the tables of drill presses, milling machines, planers, shapers, slotters, etc., play an important part. Not only is it necessary that the work is held down properly while the cut upon it is taken, but in any economically managed shop the required clamps and straps, clamping bolts, nuts, wrenches, etc., should be within easy reach of the machinist. It should not be necessary for him to search all over the shop in order to find suitable clamping appliances, but these should be kept in the tool-room or in some other convenient place where each man could easily find what he required for the particular job in hand. It is also well to adopt some standard designs of clamps, as this will often facilitate matters considerably.

In the Taylor system of shop management proper attention is given to the question of suitable clamping arrangements, as it has been found that often as much time is consumed in trying to find the required clamping bolts and straps as is necessary for the actual machining work. One of the principal objects of the Taylor system of shop management, as is well known, is to eliminate all useless waste of time and concentrate the workman's time and attention on the actual work in hand, this saving a large amount of time usually spent in preliminary preparations and unnecessary movements or operations. In the accompanying Data Sheet Supplement are shown a great variety of clamps and straps representing fundamental types. It is, of course, not necessary that a full set of all these types should be provided in the machine shop, but it is certain that it would be economical in the long run if each machine shop provided a set of sizes of the more common types for general use.



Laying out Pentagon for Adjustable Block Clamping Straps

Most of these clamps require little or no explanation. In Figs. 1 and 2 are shown clamps of the hair-pin type which are made either of square stock or of stock the width of which is two or three times the thickness. The latter clamp, of course, is used when a heavier stress will be put upon it. In Fig. 3 is shown a so-called "crotch-strap," which is used principally on drill presses. It is made in the same manner as the hairpin clamp in Fig. 1, except that the end is opened up so that it straddles the hole to be drilled. In Fig. 4 is shown a closed-end strap which is also made of square stock; it differs from the clamp shown in Fig. 1 only in that both ends are joined as indicated. Fig. 5 shows a yoke strap which is used almost exclusively on lathe faceplate work. It is made of square stock and closed at both ends as shown.

Fig. 6 shows a clamp made of flat stock. This is perhaps one of the most common and simplest forms of clamps or straps. Holes are drilled at certain intervals in which the clamping bolts can be inserted. A strap of this kind can either have a bolt in the center and clamp work on each side, or it may be provided with blocking, and clamp work on one end only. The work can also be placed in the center of the strap and a bolt applied at each end. Fig. 7 shows a clamp of flat stock which embodies some improvements over that in Fig. 6. It is provided with a slot for the bolt, and with V-grooves at one end to suit certain classes of work. In Fig. 8 is shown a very useful type of clamp which can be removed without unscrewing the clamping nuts. It is extensively used where studs are set into the body of a jig or fixture. It is a time-saving device and should be used wherever suitable. Fig. 9 is a so-called teat-clamp with a slot for the clamping bolt. The round end may be used in a groove or in a hole drilled in the end of the work. Fig. 10 is a clamp of the same type except that the pin is inserted in the body, making a simpler and cheaper construction.

Where the space is limited, so-called finger straps are often used. One strap of this type is shown in Fig. 11. In Fig. 12 is shown a clamp of the same type, but reinforced so that a heavy clamping pressure may be applied to it. This strap can be used in places where no other strap would be applicable. In many cases it is advantageous to have straps which bear only on three points in order to insure a perfect bearing and clamping action. In Fig. 13 is shown such a strap. It is sometimes drilled and tapped at the end opposite where the two clamping points are placed, so as to permit of inserting a screw to be used as blocking. This arrangement makes the clamp adjustable for work of different heights. Fig. 14 shows a foot strap. This type is simple and efficient and is very commonly used. In Fig. 15 is shown a strap of similar construction, except that it is made so as to provide for a three-point bearing. The projecting end is round so that it will bear in the center only, and two heels are provided at the front end, one on each side to bear on the work being clamped. In Fig. 16 is shown a clamp of the same type as that in Fig. 14, with the exception that it is provided with the adjustable "foot" as indicated.

In Fig. 17 is shown a clamp having a quick adjustable blocking providing for five sizes of blocks. The clamp proper is pivoted to a block of steel shaped like a regular pentagon. Assume, for example, that the diameter of the circumscribed circle is 2½ inches. Then the block can be laid out as shown in the accompanying engraving. The left portion of the horizontal line from the center of the circumscribed circle to the point where this line intersects the side of the pentagon is divided into two equal parts; the point of division *A* is the center of the rivet passing through the block and the clamp. From point *A* draw a line perpendicular to each side of the pentagon. By doing this we find that we have five heights of blocking of the following dimensions: 1/2, 11/16, 1, 1 5/16, and 1 1/2 inch. It will be readily seen that this simple clamping device is a handy tool to have around the planer, milling machine, or shaper. A number of different sizes of these clamps may be provided covering a range of from say 3/8 inch for the lowest blocking up to 3 or 4 inches by very small intervals. A clamp constructed on this principle was patented some years ago. Whether or not the construction shown in the illustration and in the Data Sheet Supplement is an infringement on this patent is a matter which would be difficult to decide.

Figs. 18, 19 and 20 show straps of the well-known goose-neck type. The one shown in Fig. 18 is a single goose-neck strap, and the one shown in Fig. 20 a double goose-neck strap, used principally when clamping work in gangs on the planer table. The strap shown in Fig. 19 is known as a goose-neck teat-strap, having a round pin inserted which enters into a hole or groove in the work.

Fig. 21 shows a curved end strap for round work. The appliance shown in Fig. 22 is termed a clamp-strap, and is used for clamping round work, as indicated. Two of these straps can be bolted together and used as a lathe dog. In Fig. 23 is shown a "hump-back" strap which is also especially intended for clamping round work. In Fig. 24 are shown two straps used together for clamping work to a jig or an angle plate. In many cases this simple method provides an excellent clamping arrangement.

Most mechanics, of course, are familiar with all or nearly all of the types illustrated, but nevertheless it is believed that the logical grouping of these straps in the manner shown in the accompanying Data Sheet Supplement will prove of value to many, as it indicates the fundamental and most common forms of straps used in the machine shop, and suggests the improvements that may be made in standardizing equipment of this kind and keeping it in the stock-room or other central place for the use of the machinist, instead of having all kinds of straps scattered around the machine shop which can never be found when required, and which have been made without any particular aim of universal application in view, and therefore seldom can be properly applied to more than the special jobs for which they have been made.

* With Data Sheet Supplement.

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THE AEROPLANE INDUSTRY IN FRANCE

By W. F. BRADLEY

Within twelve months the construction of aeroplanes has developed in France from an auxiliary of the automobile and other trades to the dignity of an independent industry. France has shown so much activity and has had so much faith in the future of the aeroplane that it is the first country to raise aeroplane construction to the rank of an industry. Contrary to general supposition, it was not the automobile trade that gave birth to the aeroplane business, for when such men as Voisin, Ferber, Bleriot, Santos-Dumont and Levavasseur were experimenting with flying machines, the automobile manufacturers were so wrapped up in the possibilities of their own Industry that they had not a thought for the insignificant rival which has forged ahead so rapidly. On account of this

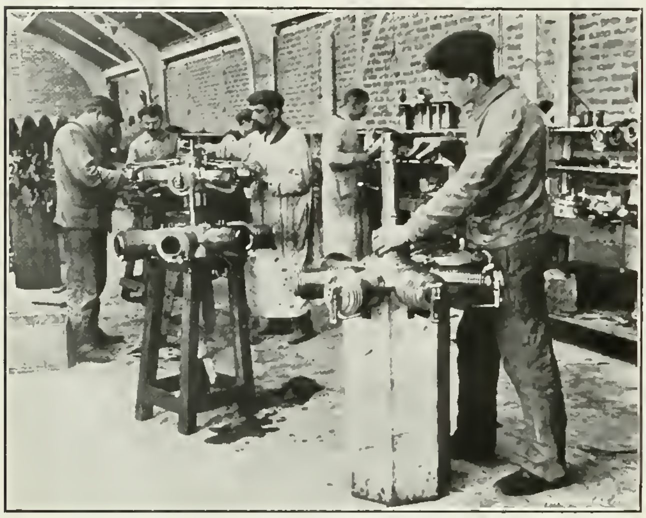

Fig. 1. Assembling Engines at the Gnome Factory

lack of interest on the part of established manufacturers, the experimenters had to build machines in private shops, appealing to the coach-builder and the metal-worker for such fittings as could be advantageously employed for flying machines. The automobile manufacturers were not even willing to study the problem of light-weight motors, and it was not until Levavasseur—who had never been a motor car constructor—had produced a special light-weight engine, that flights were made possible in France.

The Voisin Brothers, Billancourt, opened an experimental shop primarily for the benefit of Ernest Archdeacon; they were willing, however, to work under the directions of any would-be flier who came along, and at the same time were quietly developing what they thought would prove to be a successful flying machine. Bleriot was sufficiently wealthy to maintain a private workshop. Santos-Dumont also made his machine in a small private shop. Levavasseur, together with his associates, built experimental aeroplanes with very little hope of securing a quick financial return.

Although at the present time only one firm is producing a complete aeroplane, at least half a dozen concerns are making the entire flying machine with the exception of the motor and the propeller. The Antoinette company is entirely independent of outside help except for the canvas covering used for the wings. Levavasseur, the engineer of the company, experimented with aeroplanes until he could make no further progress for want of a light motor. Then for about two years he worked at motors only, and when a satisfactory one had been developed, returned to the construction of aeroplanes, with the advantage of being independent of external aid.

The Voisin Brothers have built a number of complete machines carrying their own motors, but their usual plan is to build the aeroplane only and fit it with a motor selected by the customer. It appears likely that for the next few years there will be two distinct industries, one occupied with aeroplane building and the other with the production of special aeroplane motors. It is in this way that most of the present aeroplanes are produced. Bleriot, Henry Farman, Sommer, Hanriot, and Voisin all have important establishments devoted exclusively to the building of aeroplanes in lots, the motors for which are supplied by different manufacturers. These firms employ altogether about 600 workmen, but this figure by no means represents the number of persons engaged in the aeroplane industry, for there are not less than a score of shops partly employed on aeroplane construction and a number of aeroplane builders who are really assemblers, wings, fuselages, chassis and motors being built in different shops and brought to them to be put together.

Throughout France there are at the present time probably not less than 3000 workmen directly employed in the construction of aeroplanes, aeroplane motors and fittings. Antoinette has 100 to 150 men building and testing aeroplanes and motors. The Gnome factory has not less than 200 men in the aeroplane motor section; the Anzani shop has 100 men building aeroplane motors exclusively; the E. N. V. and Dutheil-Chalmers have about fifty each, and the Esnault-Pelterie has about the same number occupied in experimental work of different sorts. Propeller makers, boat builders, coach builders, and woodworkers in general who supply various parts for aeroplanes number fully 800. At least half the leading automobile manufacturers have devoted some attention to light-weight motors, employing altogether about 600 men in such work.

As a rule, French automobile manufacturers have been content to supply motors only, the number including such leading firms as Panhard, Renault, Darracq, and Mors. In only one case has an automobile manufacturer added aeroplanes to his catalogue, the enterprising firm being the Clement-Bayard company, Maisons Laffitte, Paris, builders of the Santos-Dumont type of flyer. As the entire framework is of steel tubing, it is possible for this company to build everything in its own shops with the exception of the detachable portions of the

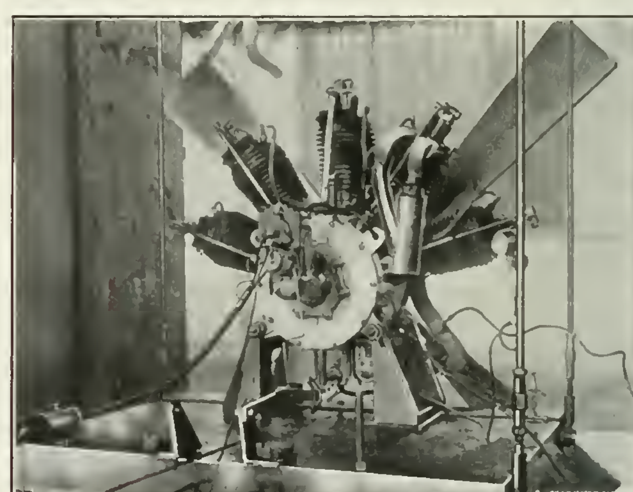

Fig. 2. Testing a Motor at the Esnault-Pelterie Shops

wings. As this is closely related to automobile body work, however, it is easy to foresee that as the demand for flying machines increases, the company will produce aeroplanes entirely under one roof, and in large lots, as is now done with motor cars. The Clement-Bayard company has also entered into the construction of dirigible balloons, obtaining the gas bags and cordage from specialists, but making the nacelle, or under framework, building and fitting the motors, and assembling and testing the whole.

The greatest success in light-weight motor construction has been made by comparatively small firms that previously built engines for special purposes. This is the case with the Gnome company, which formerly produced only heavy stationary motors, boat engines, and a few motors for car assemblers. Within twelve months the section of the factory devoted to the construction of light-weight revolving motors has become more important than the older branches and now employs 200 men who produce four or five aeroplane motors a day. Another example is the Anzani factory, which two years ago kept a score of men busy on motorcycle motors only; these have

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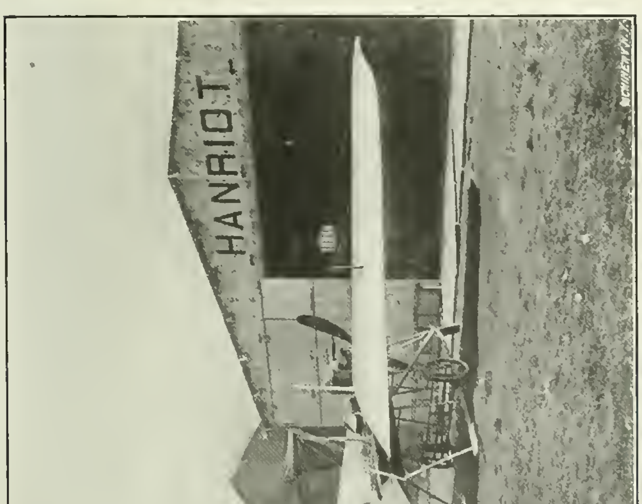


Fig. 3. Hanriot Testing Ground at Rheims

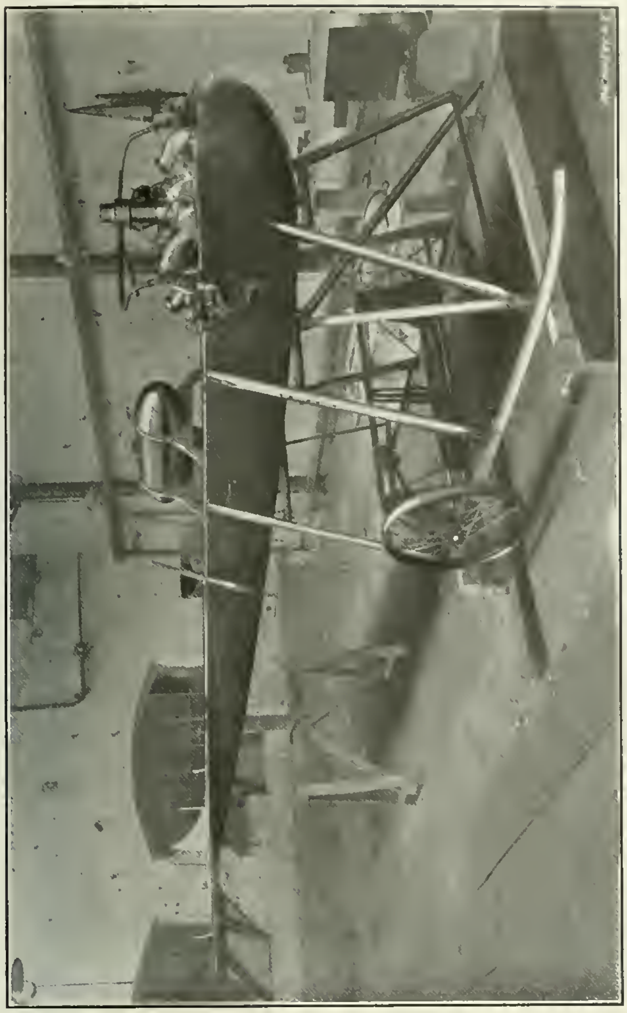


Fig. 4. Assembling an Aeroplane at the Hanriot Factory at Rheims

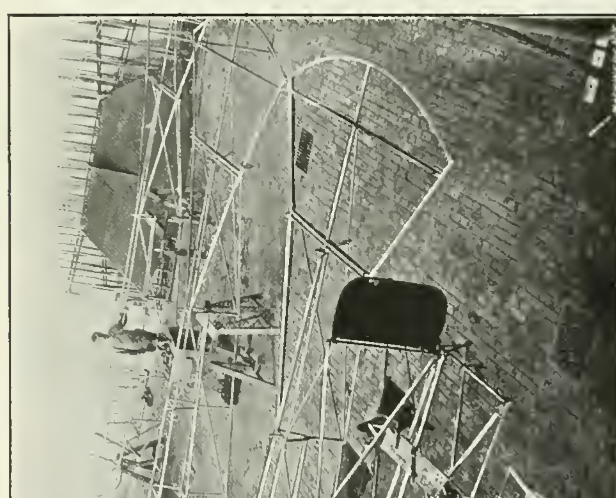


Fig. 5. Aeroplane Building at the Esnault-Pelterie Shops at Buc, France

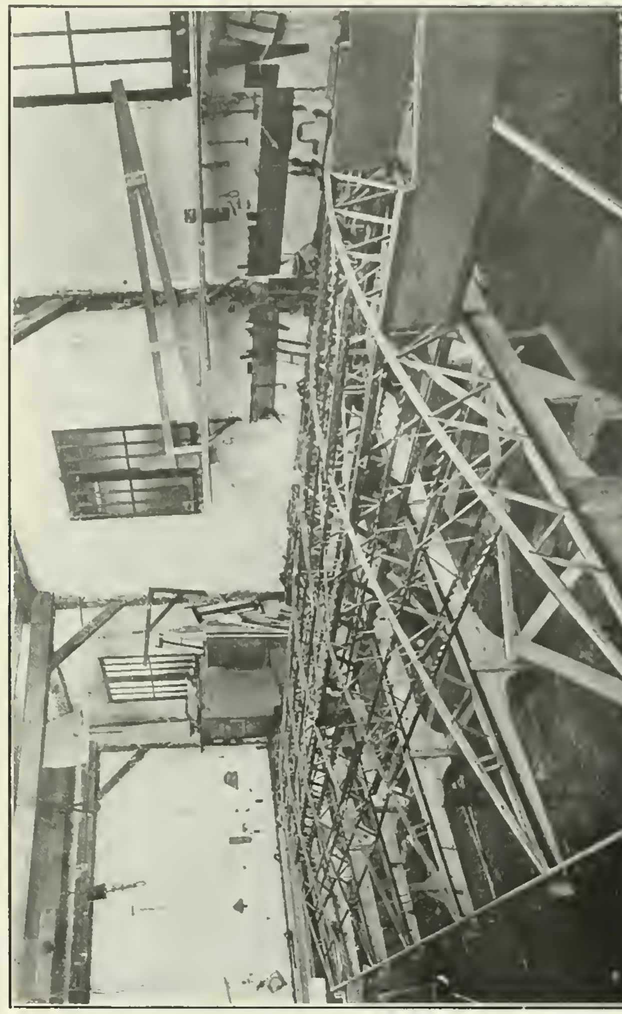


Fig. 6. Building Monoplanes—Societe Antoinette, 28 Rue des Bas-Rogers, Puteaux (Seine) France

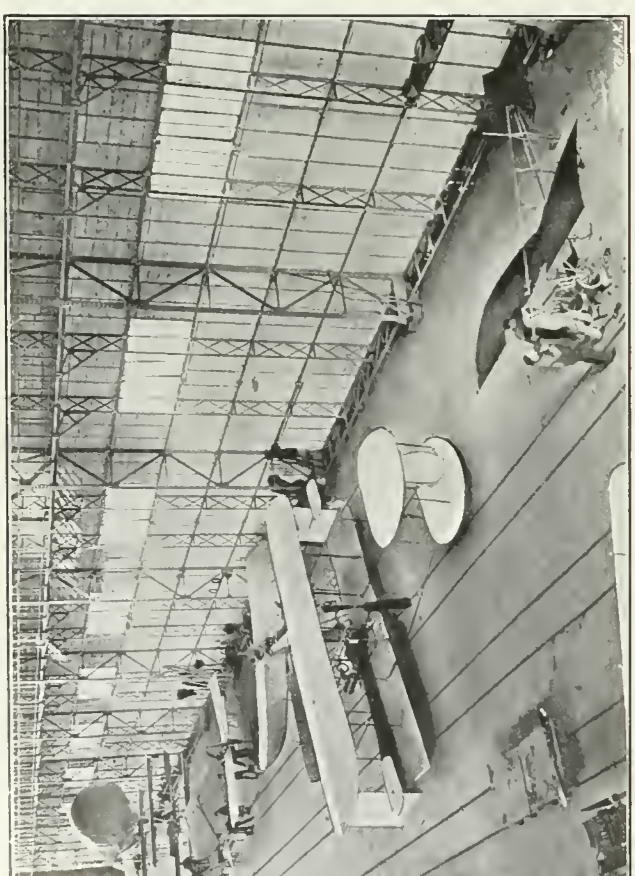


Fig. 7. View Inside the Clement-Bayard Balloon Co.'s Airship Garage at Issy les Moulineaux, Paris

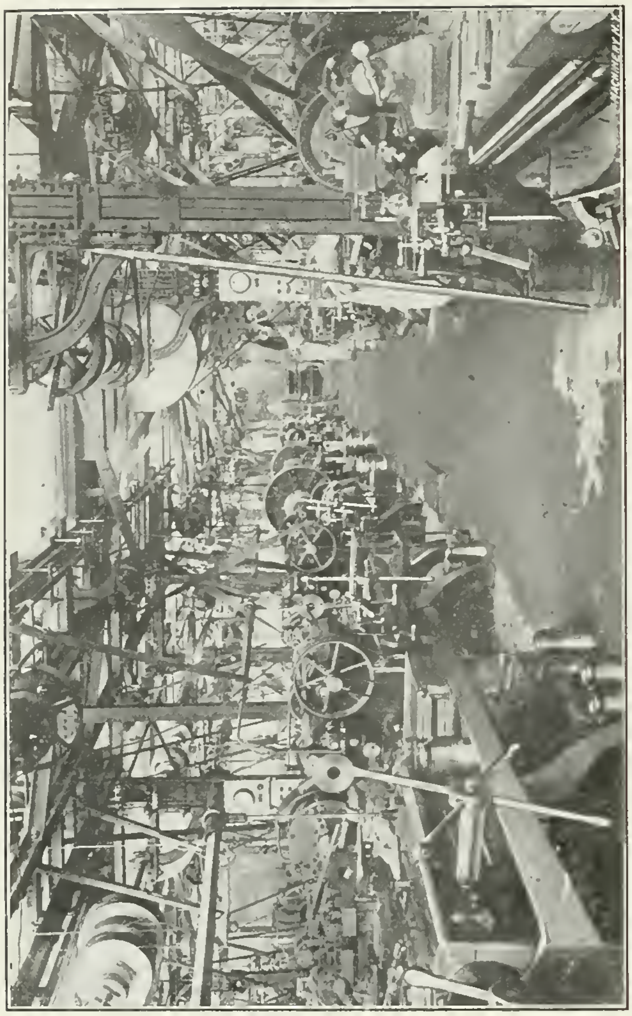


Fig. 8. Inside View of the Gnome Factory, 49 Rue Laffitte, Paris

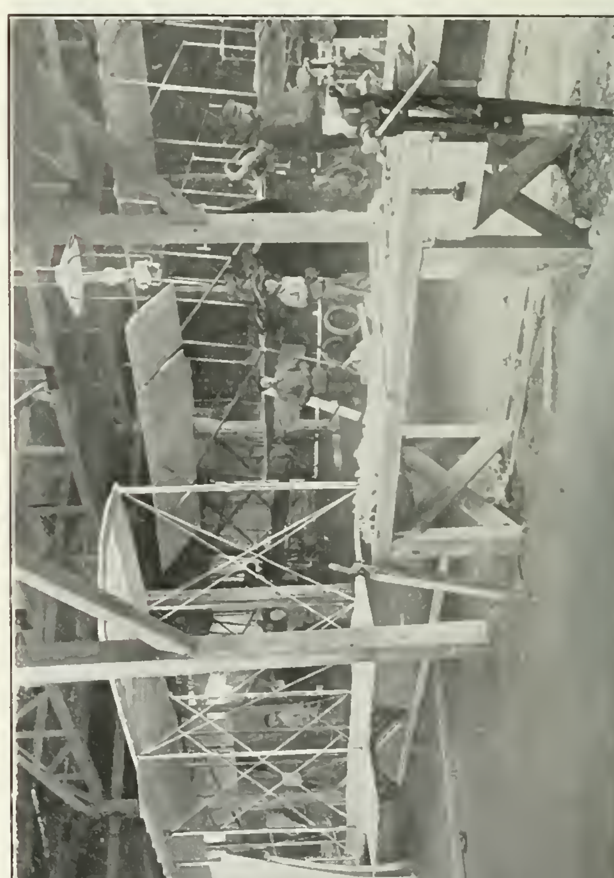


Fig. 9. View in the Henry Farman Shops at Mourmelon

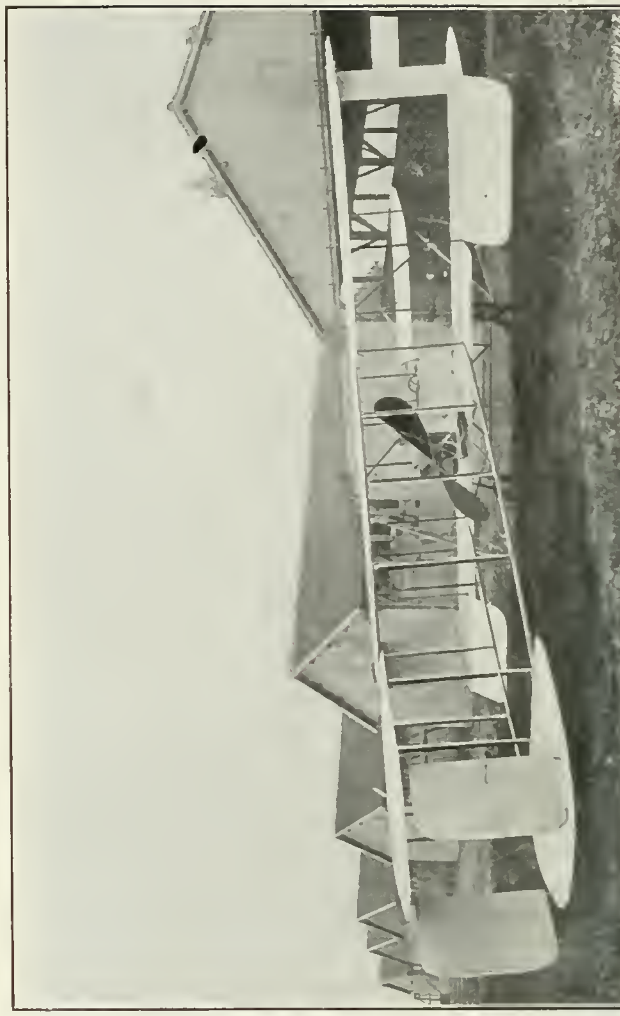


Fig. 10. Maurice Farman's School and Assembling Shops

now become auxiliary to the aeronautical section. The same conditions exist at the Dutheil-Chalmers factory, where aviation motors are built side by side with stationary gas engines and are beginning to exceed the latter in importance.

A certain number of men are also employed at the various aviation schools located in different parts of France. These include fitters, testers, repairmen and helpers, and although they are at present a rather small factor, the brisk sale of flying machines is a guarantee that their number will be considerably increased in the near future.

Until the aeroplane has become a more standardized article, and until a greater degree of efficiency has been attained in motors, it is likely that aeroplane building and the manufacture of special motors will remain separate industries. It is certain, however, that automobile constructors are only waiting for further developments to step into the aeroplane business, believing that it will be easier for them, with their engine experience, to copy a good type of aeroplane than it will be for the aviator to build special motors for his flying machines. This would be possible, however, only upon the supposition of some important discovery solving such a problem as automatic stability. If, on the other hand, the further development of the aeroplane is of the same slow and painful order as that of the past, it is likely that the present school of practical aviators will be able to keep the business in their own hands. The large motor car concerns will hesitate to invest their capital in aeroplanes until the period of groping has been brought to a close.

* * *

A GLOSSARY OF AERONAUTICAL TERMS

By L. R. W. ALLISON*

adjusting plane: A small surface for regulating lateral balance, usually located at the outermost end of a wing.

advancing edge: The front or leading edge of a supporting or balancing surface.

advancing surface: The anterior surface of a flying machine having more than one supporting plane.

aerocurve: A curved surface of a supporting plane; sometimes used to mean the amount of camber.

aerodrome: A mechanism similar to the aeroplane, and used in substitute; a course for flying machines. (Use is usually confined to latter term.)

aerodromics: The art of flying in the air with a heavier-than-air machine.

aerofoil: Used as a substitute for "aeroplane."

aeronate: A balloon that is fastened to the earth, *i. e.*, a captive balloon.

aeronaut: One who navigates the air.

aeronautics: The branch of aerostatics which treats of air navigation.

aeronef: Any type of heavier-than-air machine.

aeroplane: A dynamic machine. Name now given to any heavier-than-air machine with diversified form of supporting planes, but essentially applicable only to flat surfaces.

aerostat: A balloon free to move in air.

aerostation: The raising and supporting of balloons and flying-machines in air.

aileron: A small movable plane or wing tip usually hinged to the main planes and which can be operated independently. Used for maintaining lateral stability.

air shipping: Air craft of all kinds.

air speed: Rate of air flight.

airman: One who navigates the air; an aeronaut.

airmanship: Ability to navigate the air.

alighting gear: Controlling mechanism used in descending to stop the machine as it reaches the ground and diminish the jar.

angle of attitude: The angle formed by the main planes with the line of travel. Also called "angle of incidence"; "angle of inclination."

angle of entry: The angle formed by a tangent to the advancing edge and the line of motion in entrance to flight of aeroplane surfaces.

angle of trail: The angle formed by a tangent to the rear edge and the line of motion in entrance to flight of aeroplane surfaces.

apteroid: That form of wing which is short and broad.

arch: The downward curve or droop to the ends of supporting surfaces.

aspect: Plan view.

aspect ratio: The ratio of the length to the width of a wing surface.

aspiration: The suction of an air current against the edge of a curved aeroplane surface.

automatic stability: Stability that is maintained irrespective of any operating control—the self-action of the controlling surfaces in suiting themselves to flight.

aviation: Motion through the air by heavier-than-air machines.

aviator: The operator of a heavier-than-air machine.

balance: Maintaining equilibrium by proper movement of balancing surfaces.

balancing plane: Surfaces for establishing and maintaining equilibrium and to assist in turning, either automatically or self-controlled.

Baldwin's patent cloth: A rubberized silk fabric, light in texture, used for covering aeroplane surface and balloons.

balloon: A "lighter-than-air" vehicle, properly applicable to gas bags with passenger baskets. The air currents and the raising power of the gas are the sole means of ascension.

beat: The periodic recurrence of flapping-wing or rotating-blade motion.

biplane: An aeroplane with two main supporting surfaces, one above the other..

body: The portion of the machine which contains the power plant, fuel tank and aviator's seat.

box-kite: Also referred to as Hargrave (from inventor). Used with reference to a box-like form, consisting of two vertical and two horizontal planes for lateral and longitudinal stability.

brace: Usually a compression member in the framework.

camber: The depth of curvature.

caster-wheel: A pivoted wheel in the alighting gear; placed forward of its center of rotation, it suits itself to the course of the machine.

cellular: Cell-like; sometimes used instead of "box-kite."

cellular tail: The extreme rear planes of box-kite form.

center-of-pressure or "center-of-lift": An imaginary center line on the under side of an aeroplane surface on each side of which the pressure is equal.

center-of-resistance: The center at which the different forward pressures balance.

center-of-thrust: The axis along which the thrust of the propeller or propellers is in equilibrium.

chassis: Supporting truck used on the ground.

compound control: A controlling system whereby two separate operations are executed by a double movement of a single device.

compression-side: The side of a surface which faces the flow of air current.

continental rubber cloth: Cotton material upon which a gum preparation is used. Used for aeroplane surfaces.

control-for-elevation: Rudder planes placed in front or in the rear of main surfaces. Sometimes in both positions.

deck: A main supporting surface.

diagonal: A diagonal brace in a framework.

dihedral angle: The angle formed by two planes.

dirigible: A steerable balloon, controlled and propelled by mechanism.

double-decker: An aeroplane with two main planes; a biplane.

double monoplane: A monoplane with two supporting surfaces in the same plane, one in front of the other.

double rudder: A rudder having two surfaces acting simultaneously.

double surfaced: Covering both sides of aeroplane surfaces.

down wind: Moving with the wind.

elevator: A horizontal rudder for vertical steering.

entry: an aeroplane surface moving in air, embracing the entire form.

equilibrator: Horizontal tail.

even keel: Preserving balance and position.

feathering: Surfaces maneuvered in a manner to pass edgewise and flatwise in alternate directions while in motion.

fin: A fixed vertical plane.

fish-shape: A section resembling in shape the body of a fish; commonly used in struts.

fixed wheel: A wheel which cannot move from its rotating plane.

flapping flight: Flight by up and down movement of wing surfaces.

* Address: 1353 West 30th St., Los Angeles, Cal.

flexible propeller: Propeller consisting of cloth mounted on a frame, adjusting itself to flight.

flying angle (same as flying attitude): The variation in the angle of an aeroplane surface in flight and at rest.

following edge: The rear edge of an aeroplane surface.

following surface: A supporting surface behind another.

forced pressure: Increase in air pressure due to direct action upon it.

fore-and-aft: Longitudinally.

front control; front rudder: Framework and planes situated at the extreme front of the aeroplane, in advance of the operator.

fuselage: The framework of an aeroplane.

gap: The vertical distance between two planes.

glide: To travel rapidly by deflecting an aeroplane surface at an angle; when close to the earth a tip upward allows the machine to settle with slight jar. This is done without power.

glider: An aeroplane without mechanical power.

glider shape: A truss form of construction.

gliding angle: The angle of "glide."

ground incidence: The difference in the angle formed by the aeroplane surface when on the ground and when in flight:

guide planes: Planes placed between the rudder planes.

hangar: A structure for housing aeroplanes.

head area: The total head resistance offered by the entire framework of an aeroplane.

head resistance: The resistance a surface offers to movement through the air.

helicopeter: A heavier-than-air machine in which flight is secured by propellers rotating in horizontal planes.

horizontal rudder: A horizontal plane in front of main supporting surfaces for vertical steering.

in-lap: Toward the starting point.

keel: The under framing of an aeroplane, to stiffen it both laterally and vertically.

land speed: The rate of travel of an aeroplane on the ground before ascension.

landing area: A special allotment of ground on which a machine can land safely.

lateral: A strut for sidewise bracing in the framework of an aeroplane.

lateral stability: Lateral equilibrium in the side-to-side direction.

leeway: Lateral drift in the direction in which the air current is flowing.

lift: The supporting effect of an aeroplane surface.

longitudinal stability: Lengthwise stability.

main landing wheels: The wheels which take the greatest strain in landing.

main plane: The largest supporting wing; in a multiplane the lowest surface.

mast: A strut for fastening trussing wires to stiffen the wings.

monoplane: An aeroplane with one or more supporting surfaces, all in the same plane.

monorail: A rail used as a track in starting a certain type of machine.

montgolfier: A hot-air balloon.

multiplane: An aeroplane with three or more main supporting surfaces; a polyplane or a triplane.

nacelle: The framework of a dirigible, sometimes used for framework of an aeroplane.

negative incidence: The angle of attitude below the line of travel.

non-rigid dirigible: A dirigible having no rigid framework for the gas bag.

ornithopeter: A machine which attains flight by bird-like or flapping movement of the wings.

orthogonal: The vertical reaction of the air in affording equilibrium by means of wing motion.

out-lap: Away from the starting point.

panel partition: The vertical planes in a box-kite structure.

pendular movement: To-and-fro movement like that of a pendulum.

pitch: The forward movement that would be produced by a propeller in one turn if there were no slip.

plane: Literally a flat surface; in aeroplanes a flat or curved surface.

polyplane: A multiplane.

propeller reaction: The force developed by a propeller in driving an aeroplane.

pylon: The tower required by some types of aeroplanes to start.

rarefaction side: The side opposite the compression side; the far side from the air current.

reactive current: The compressed layer of free air flowing on the reverse side of an aeroplane surface.

rear control: Stabilizing tail surface.

rigid dirigible: A dirigible in which the framework for the gas bag is rigid.

rising angle: The greatest angle of ascension.

rudder: A horizontal or vertical plane placed either at front or rear of main planes, and used for steering.

rudder braces: Rods composing the rudder framework.

single-decker: A monoplane.

single-surfaced: Aeroplane surfaces covered only on one side.

skids: Runners underneath some types of machines, used for landing.

skin-friction: The friction of the air against aeroplane surfaces.

slip: Difference between pitch of a propeller and its actual longitudinal travel.

soaring flight: Upward flight without reciprocating wing motion.

spar: A strut, a brace, etc.

stabilize: To maintain equilibrium by means of surfaces and not by mechanism.

stabilizing plane: A surface for the maintenance of equilibrium; small horizontal planes hinged to the main planes at the rear edge, and suiting the angle of the wind.

starboard side: The right side.

starting frame: Chassis.

starting rail: Monorail.

starting thrust: The impelling force required for starting.

stay: A brace in an aeroplane framework.

steadying vane: Small vertical planes, usually placed in the front control.

straight pitch: In propellers, flat instead of a helical blade surface.

strainer: A turnbuckle.

supplementary surface: A small surface which acts in unison with a larger one for a specific purpose.

supporting surfaces: Sustaining surfaces; the main planes.

tail: The framework and planes in the rear of the main plane, collectively.

tail planes: Tail vanes; the rear planes supported by the tail framework.

tail surface: The supporting surface of the tail unit.

tail wheel: A small wheel under the tail to carry it on the ground.

tie: A tension member in a framework; used also with reference to wire trussing.

tractor screw: A propeller set in front of the supporting surface instead of in the rear.

transverse spars: Cross braces.

traveling speed: The rate of speed of an aeroplane in flight; sometimes gliding speed.

triplane: An aeroplane with three supporting surfaces.

up-wind: Moving against the wind.

vanes: Used with reference to the vertical planes in the rudder.

variable pitch: In propellers, a varying angle of blade width.

vertical strut: Upright in the framework.

wake: The track of air left by an aeroplane in flight.

warping: Also called "wing warping"; the act of tipping or twisting of movable planes for the maintenance of equilibrium.

wash: The sidewise currents of air sent out by a machine in flight.

wing arc: The arc described by a moving wing.

wing bar: A longitudinal strip placed to strengthen an aeroplane surface.

wing section: The longitudinal curvature with relation to the arc of travel.

wing skid: A runner placed under a wing tip.

wing tip: The outer end of a wing surface.

wing wheel: A wheel placed under a wing tip.

weight factor: Ratio of the supporting surface to the total weight of the machine.

wire trussing: A method of wire bracing.

Wright altimeter: An instrument invented by the Wright Bros. for measuring altitude. Used in place of an aneroid barometer.

yoke: In aeroplanes, a framework of tubing which fits about the aviator's shoulders and is used for insuring lateral stability.

REFERENCE SCREW GAGES*

By FRANCIS J. BOSTOCK†

The gages described and illustrated in the following are used solely for reference purposes. They are made in standard sizes, and from them the ordinary shop or working gages are made. Reference gages are generally provided with an external thread only, which is as near to the standard size as possible; it is very convenient, however, to have on the same gage the inside diameter of the corresponding ring gage or female thread gage. This inside diameter depends upon the size, shape and number of threads per inch.

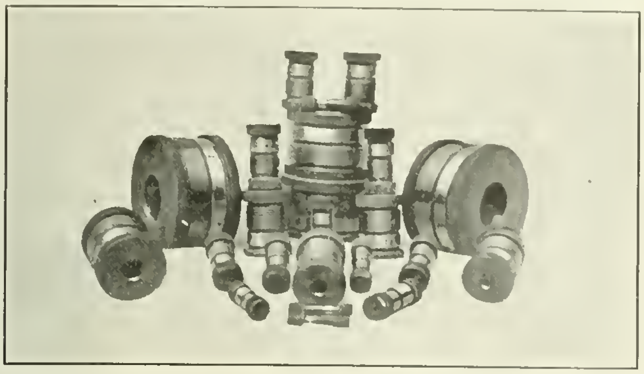
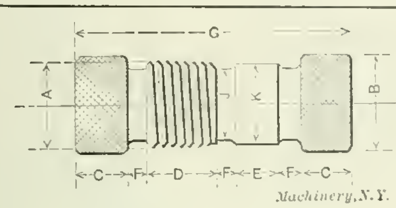


Fig. 1. A Set of Reference Screw Thread Gages

TABLE I. DIMENSIONS OF REFERENCE SCREW THREAD GAGES



English Sizes up to 1 1/2 inch
All Dimensions in Inches

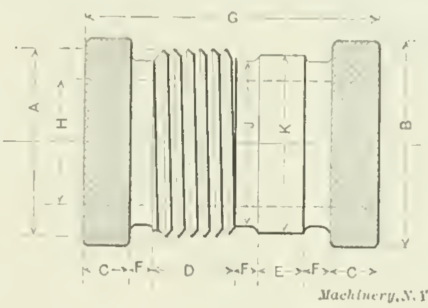
A	B	C	D	E	F	G
5/32	1/4	1/2	1/4	3/16	3/32	1 19/32
3/16	5/16	1/2	5/16	1/4	3/32	1 23/32
1/4	3/8	1/2	3/8	1/4	3/32	1 25/32
5/16	7/16	1/2	7/16	1/4	1/8	2 1/16
3/8	1/2	1/2	1/2	5/16	1/8	2 3/16
7/16	9/16	1/2	1/2	5/16	1/8	2 5/16
1/2	5/8	1/2	9/16	3/8	3/16	2 1/2
9/16	11/16	1/2	9/16	3/8	3/16	2 1/2
5/8	3/4	1/2	9/16	3/8	3/16	2 1/2
3/4	7/8	1/2	5/8	7/16	3/16	2 5/8
7/8	1	1/2	5/8	7/16	1/4	2 13/16
1	1 1/8	1/2	5/8	7/16	1/4	2 13/16
1 1/8	1 1/4	1/2	3/4	7/16	1/4	2 13/16
1 1/4	1 3/8	1/2	3/4	1/2	1/4	3
1 3/8	1 1/2	1/2	3/4	1/2	1/4	3
1 1/2	1 5/8	1/2	3/4	1/2	1/4	3

Metric Sizes up to 36 Millimeters
All Dimensions in Millimeters

A	B	C	D	E	F	G
4	6	12	6	4	2	40
5	7	12	7	4	2	41
6	8	12	8	4	2	42
8	10	12	10	4	3	47
10	12	12	12	6	3	51
12	14	12	14	6	3	53
14	16	12	14	8	4	58
16	18	12	14	8	4	58
18	20	12	14	8	4	58
20	22	12	15	10	5	64
22	24	12	15	10	5	64
24	27	12	15	10	5	64
27	30	12	15	10	5	64
30	33	12	18	12	5	69
33	36	12	18	12	5	69
36	39	12	18	12	5	69

Dimension J should provide for clearance for the threading tool; K equals inside diameter (bore) of female gage.

TABLE II. DIMENSIONS OF REFERENCE SCREW THREAD GAGES



English Sizes above 1 1/2 inch
All dimensions in Inches

A	B	C	D	E	F	G	H
1 5/8	1 3/4	5/8	7/8	1/2	1/4	3 3/8	3/4
1 3/4	1 7/8	5/8	7/8	1/2	1/4	3 3/8	3/4
2	2 1/8	5/8	7/8	1/2	1/4	3 3/8	1
2 1/4	2 3/8	5/8	7/8	1/2	1/4	3 3/8	1
2 1/2	2 5/8	5/8	7/8	1/2	1/4	3 3/8	1 1/4
2 3/4	2 7/8	5/8	7/8	1/2	1/4	3 3/8	1 1/4
3	3 1/4	5/8	1	5/8	1/4	3 5/8	1 1/2
3 1/4	3 1/2	5/8	1	5/8	1/4	3 5/8	1 1/2
3 1/2	3 3/4	5/8	1	5/8	1/4	3 5/8	2
4	4 1/4	3/4	1	5/8	3/8	4 1/4	2
4 1/2	4 3/4	3/4	1	5/8	3/8	4 1/4	2 1/2
5	5 1/4	3/4	1 1/4	3/4	3/8	4 5/8	3
5 1/2	5 3/4	3/4	1 1/4	3/4	3/8	4 5/8	3 1/2
6	6 1/4	3/4	1 1/4	3/4	3/8	4 5/8	4
6 1/2	6 3/4	3/4	1 1/4	3/4	3/8	4 5/8	4 1/2
7	7 1/4	3/4	1 1/4	3/4	3/8	4 5/8	5

Metric Sizes above 36 Millimeters
All Dimensions in Millimeters

A	B	C	D	E	F	G	H
40	43	15	20	12	5	77	20
44	48	15	20	12	5	77	20
46	50	15	20	12	5	77	20
50	54	15	20	12	5	77	30
52	56	15	20	12	5	77	30
56	60	15	25	15	8	94	30
60	65	15	25	15	8	94	40
65	70	15	25	15	8	94	40
70	75	15	25	15	8	94	40
75	80	15	25	15	8	94	50
80	85	15	25	15	8	94	50
90	95	15	25	15	8	94	60
100	105	20	30	18	10	118	70
120	125	20	30	18	10	118	90
140	145	20	30	18	10	118	100
160	165	20	30	18	10	118	120

Dimension J should provide for clearance for the threading tool; K equals inside diameter (bore) of female gage.

It is impossible to make a reference screw gage from another female gage, even when the latter is known to be of standard size, because of the difficulty of getting both threads to conform absolutely with one another, and to try them without damage to either. Besides, two gages of exactly the same size will not "go together" at all. The best method for measuring the screw thread in making the gage is, therefore, the three-wire method, which has from time to time been referred to in MACHINERY. [See MACHINERY, January, 1904, "Measuring External Thread Diameters"; September, 1907, "Measuring Screw Thread Diameters"; March, 1910, "Ball Point versus Anvil Type Thread Micrometers."] In making working gages from the reference, or master, gage, the dimensions are also transferred by means of the three-wire method.

The writer has had considerable experience in the design and procedure of manufacture of the gages shown in Fig. 1, these gages giving the dimensions both for the screw size and for the nut-bore size. At each end of the gage is a knurled collar of larger diameter than the thread, the object of which is to prevent any inexperienced person from trying a nut over the thread. These collars also prevent damage to the thread in handling and storage. The material used for these gages

* See MACHINERY, February, 1908; "Making Thread Gages." See also MACHINERY'S Reference Series No. 31, "Screw Thread Tools and Gages."

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is a good quality of carbonized mild steel, the steel blanks being annealed before and after the rough turning. After the second annealing they are again turned all over, rough threaded and the collars knurled. They are then carbonized to a depth of from 1/32 to 1/16 inch, according to the size, and allowed to cool in the carbonizing box, after which they are reheated to a red heat (about 1500 degrees F.), quenched in water at about from 70 to 80 degrees F., and reheated or tempered to a bluish purple. They are then permitted to cool in the air in a cupboard, where they are protected from drafts. Care should be taken to heat and cool the steel uniformly, and to prevent air currents from playing upon the gage, which would distort it, or make one side harder than the other.

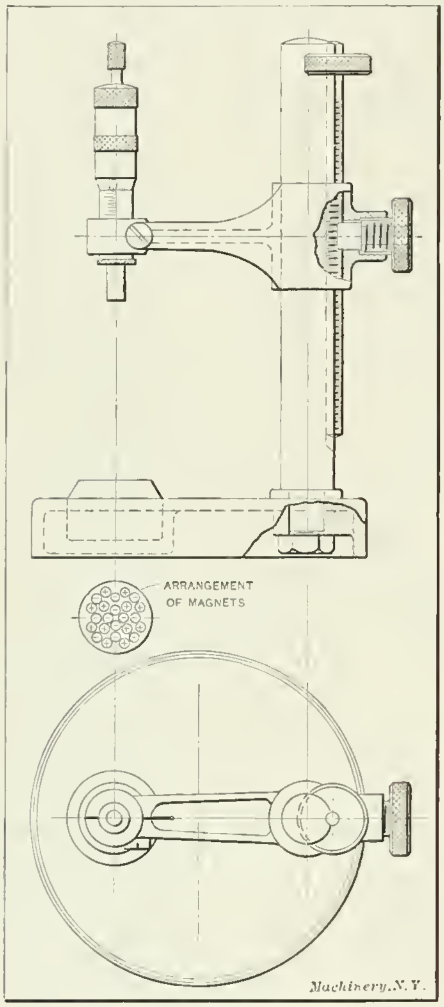

Fig. 2. Measuring Instrument for Screw-thread Diameters

After having been carbonized, the piece can still be cut conveniently, but the advantage gained is that the steel does not tear when threading, like ordinary soft machine steel, and the surface is susceptible to a high polish. After cutting, the external diameters are ground to size. It is not necessary that the reference gage should be "glass" hard, like a working gage, but it should, of course, be durable enough so as not to wear down when taking measurements for comparison. All the hardness required is obtained by the method outlined above.

An instrument for measuring the size of the thread, which has proved to be very convenient and reliable, is illustrated in Figs. 2 and 3, and consists of a cast-iron base carrying a column to which is clamped a micrometer head susceptible of adjustment by a vertical screw. Directly below the micrometer head, and imbedded in the base, is a gun-metal bushing holder in which are placed a series of magnetized cylindrical pins arranged as shown in the line engraving Fig. 2. The idea of this arrangement is to provide some means to prevent the wires from rolling off and falling, and to enable them to remain exactly where placed. The magnets have negative and positive poles as indicated.

The method of setting the instrument is merely to adjust the micrometer until it registers the exact size of the nearest size of cylindrical reference gage. Then the dimension measured over the wires can be read off directly on the micrometer, care being taken that the temperature of the reference gage and of the gage being measured is exactly the same.

The accompanying tables give dimensions of both English and metric sizes. Gages made to these dimensions have been found very satisfactory from all points of view.

* * *

The Detroit River tunnel was informally opened on July 26. The first passenger train carrying railroad officials was run through it on that date, and it is expected that regular operations will begin in October.

ALLOWABLE LOAD, AND EFFICIENCY OF WORM GEARING*

By A. P. ELTOFT†

When called upon to design a set of worm gearing for a certain drive, or select one from the catalogue of a manufacturer, the designer will find very little definite information in the standard handbooks concerning the allowable load, the allowable speed and the efficiency which may be expected—the very points which are of vital interest to him. The present article discusses these subjects.

Relation of Load to Effort

Let

P = pressure of the worm-wheel on the worm parallel to the worm-shaft,

F = force which must be applied at the pitch radius of the worm at right angles to the worm-shaft to overcome P,

α = angle of thread with a line at right angles to the axis of the worm,

f = coefficient of friction,

l = lead of worm thread,

d = pitch diameter of worm.

The normal pressure between worm and wheel then equals

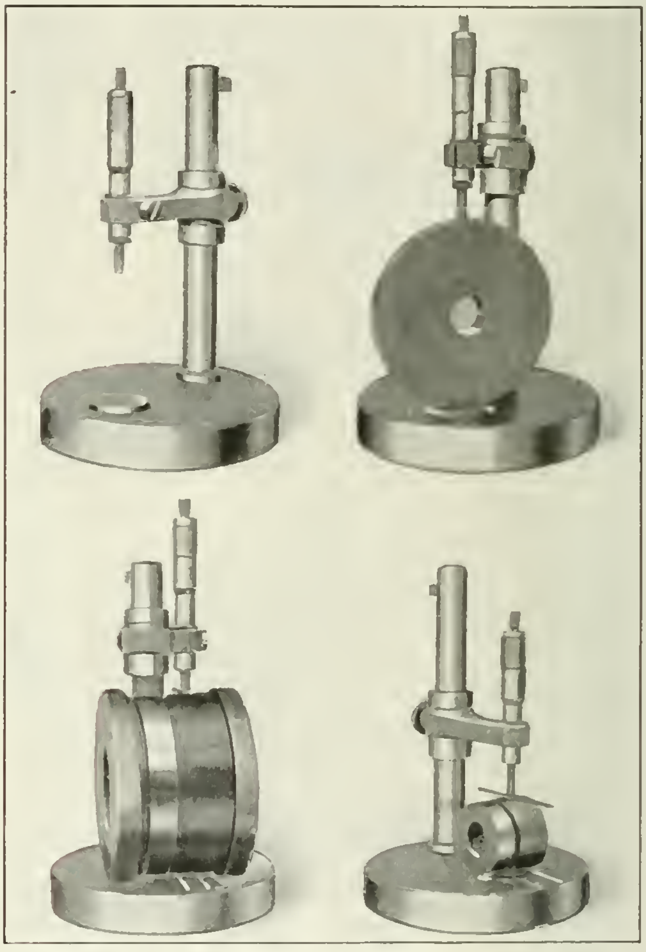
Fig. 3. The Screw-thread Measuring Instrument and its Application

$F \times \sin\alpha + P \times \cos\alpha$, and the friction $f\,(F \times \sin\alpha + P \times \cos\alpha)$.

Now, if the worm is revolved once, we obtain the following relation between F and P:

$$F \times \pi d = Pl + f\,(F \times \sin\alpha + P \times \cos\alpha)\,\frac{\pi d}{\cos\alpha}$$

As $\frac{l}{\pi d} = \tan\alpha$, the formula above may be written:

$$F = P \times \frac{f + \tan\alpha}{1 - f\tan\alpha} \qquad (1)$$

* For articles on worm gearing, previously published, see MACHINERY, December, 1908, "The Hindley Worm and Gear"; September, 1907, "Hobs for Worm-Gears"; August, 1907, "Calculating the Dimensions of Worm Gearing"; May, 1907, "Suggested Refinement in the Hobbing of Worm-Wheels"; December, 1902, "The Design of Self-locking Worm-Gears." See also MACHINERY'S Reference Series No. 1, "Worm Gearing," and MACHINERY'S Data Sheet Series No. 6, "Bevel, Spiral and Worm Gearing."

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This relation, giving the force F which must be applied at the pitch radius of the worm to overcome the load P at the pitch radius of the worm-gear, is often required by the designer.

Efficiency

If there were no friction, or if f equalled 0, we would have:

$$F_1 = P \tan \alpha :$$

The efficiency of the worm gearing is therefore:

$$E = \frac{F_1}{F} = \frac{\tan \alpha \,(1 - f \tan \alpha)}{f + \tan \alpha} \qquad (2)$$

Equations (1) and (2) are, strictly speaking, only correct for worm threads with vertical sides, but the sloping thread side commonly used affects the result but little.

To demonstrate the influence of the thread angle on the efficiency, the curve represented by Equation (2) with α and E as variables, and for a certain assumed value of f, has been

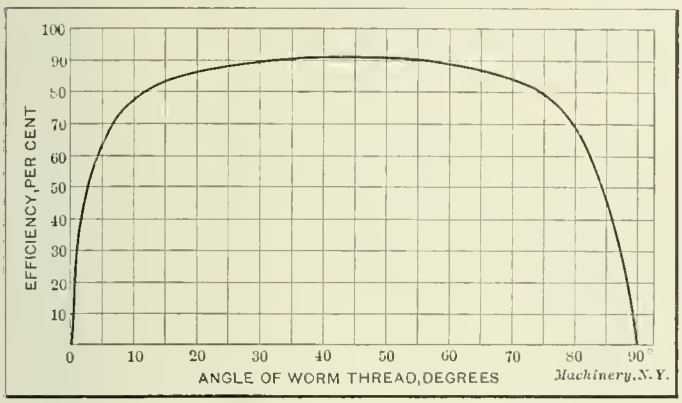


Fig. 1. Relation between Worm Thread Angle and Efficiency

plotted in Fig. 1. This curve is reproduced from "Worm and Spiral Gearing," by F. A. Halsey. It shows that the efficiency increases very rapidly with the thread angle for small angles, while for angles near the maximum efficiency, there is very little drop for a wide range of angles. It is, therefore, essential, for high efficiency, not to use thread angles that are too small. The value of f is found by experiments to vary with the speed of the rubbing surfaces. (See Transactions of the American Society of Mechanical Engineers, Vol. 7, page 273.) For values of f for various speeds, see the accompanying table.

Allowable Load

It would seem reasonable to assume the allowable pressure on gear teeth under otherwise equal conditions to be expressed by

$$P = Cpb \qquad (3)$$

where p = pitch, b = width of gear teeth, and C = a constant for the given speed.

For very slow speed, where there is no danger of over-heating, and where the only questions to be taken into account, are the strength and the resistance to abrasion, the above equation is obviously correct if we assume some standard ratio of worm diameter to wheel face. A pitch diameter of worm equal to 1.5 times the face of the wheel (corresponding to a face angle of 76 degrees) is about right.

For higher speeds, the amount of frictional work transformed into heat may cause an excessive rise in temperature before the worm, or casing surrounding the worm, is able to carry off the same amount of heat as is developed, and the limiting load will be determined thereby. The ability of the worm or casing to carry off heat is proportional to the surface, which, again, is approximately proportional to the product pb of the pitch and width of the gear teeth; hence, Equation (3) is approximately correct in this case also. [This equation is given in "Des Ingenieurs Taschenbuch" (Hütte).]

The value of the factor C varies with the speed and must be determined by experiment. The most complete experiments to this effect are, to the writer's knowledge, those of C. Bach and E. Roser, published in *Zeitschrift des Vereines Deutscher Ingenieure*, Feb. 14, 1903. These experiments were made with a three-threaded steel worm, not hardened, 76.6 millimeters (3 inches), pitch diameter; 25.4 millimeters (1 inch), pitch; 17 degrees 34 minutes, thread angle; 148 millimeters (5 13/16 inch) long. The worm-wheel was of bronze, 242.6 millimeters (9 9/16 inch) pitch diameter, with milled teeth, 78 millimeters (3 1/16 inch) wide measured on the arc, 30 teeth, speed ratio 1 to 10, with ball bearings for worm shaft, and oil bath of extremely viscous oil.

In the experiments, the load on the teeth varied from 111 kilograms (244 pounds) to 1257 kilograms (2765 pounds) and the speed varied from 2185 R.P.M. to 64 R.P.M. The temperature of the oil bath and that of the surrounding air was observed until the difference reached a constant value. Corresponding values of load and speed for constant temperature difference were ascertained and an attempt to express the relation by an equation gave the following rather lengthy expression:

$$P = Cpb = [a\,(t_o - t_e) + d]\,pb. \qquad (4)$$

in which

$$a = \frac{0.0669}{V} + 0.4192$$

$$d = \frac{109.1}{V + 2.75} - 24.92$$

t_o = temperature of oil in degrees C.,

t_e = temperature of air in degrees C.,

V = sliding velocity at pitch line in meters per second.

The curves represented by Equation (4) are distinctly hyperbolic in character. Two of these curves have been plotted in Fig. 2, one for a temperature difference of 50 degrees C. and one for 70 degrees C.

The accompanying table shows the loads for various speeds, calculated from Equation (4) and transformed into English units, for a difference in temperature of 90 degrees F. (50 degrees C.). In the same table are given coefficients of friction as deduced by Unwin from Lewis's experiments. This table of load used with discretion and with due consideration for the various individual conditions associated with the drive in contemplation, may, in the writer's opinion, very well be made the basis for worm-gear design in average cases and where a temperature rise of 90 degrees F. (50 degrees C.) is al-

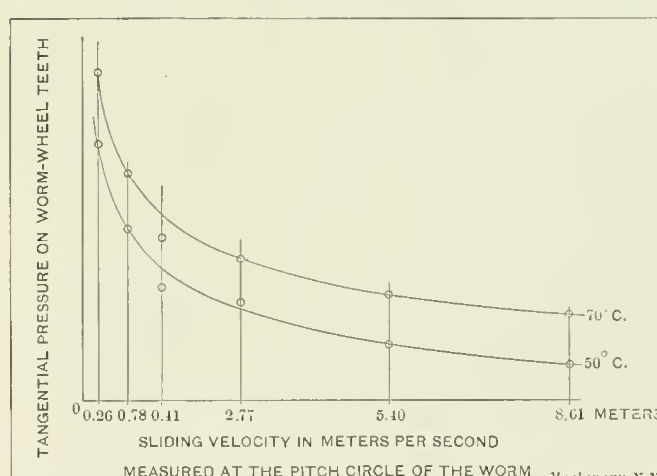


Fig. 2. Relation between Tangential Pressure and Velocity

lowable. The loads given are for continuous service, and as it will take several minutes, perhaps hours, before the constant temperature is reached, a higher load will be justified for intermittent service, where the oil has time to cool down. It should be kept in mind that the danger of abrasion will, of course, depend, on the temperature of the oil, and not on the temperature difference; if, therefore, the gearing is installed in a place where the surrounding temperature is kept low, the temperature difference can be correspondingly increased and *vice versa*. The danger of abrasion will also, to a large extent, depend on the character of the lubricant, in that a very viscous oil will offer greater resistance to the squeezing out of the oil film between the rubbing surfaces than the less viscous.

It should be remembered also that a gear with many teeth gives a better contact with the worm both on account of the

flatter curve of the engaging segment and the larger average radii of curvature of its teeth. This has particular reference to the heavy loads at slow speed, where the question of temperature does not enter.

The angle of thread (the helix angle) does not appear in the formula given, as it has no direct bearing on the question of allowable load and speed of rubbing surfaces. As previously mentioned, the angle of thread has, however, a direct influence on the efficiency of the gearing. Given, for instance, two worms of the same diameter, one having a thread angle twice as great as the other, carrying the same load on the gear teeth and running at the same speed; there is no reason at all why one should be more successful than the other as far as wearing qualities are concerned, but it must be remembered that the first one is transmitting twice the horsepower of the other, and will obviously give much better efficiency.

With the allowable load decreasing as the speed increases, as provided for by the formula and table given, a speed of rubbing surfaces as high as 1000 feet per minute, or even higher, can undoubtedly be used with success for cut gearing, which also has been demonstrated repeatedly in practice. In the tests by Bach and Roser, the speed was carried as high as 8.76 meters per second (1724 feet per minute), with a load of 370 kilograms (814 pounds) and a temperature difference of 80.5 degrees C. (126.9 degrees F.) with no apparent cutting. The loads given represent tangential loads at right angles to the worm-gear shaft. The actual pressure between the rubbing surfaces will be more, and will increase with the angle of thread, but the increase for gears in common use (less than 20-degree thread angle) is not very great.

TABLE OF LOAD ON GEAR TEETH

Load per unit of the product (pitch × width of tooth), for 90-degree F. temperature difference between oil and surrounding air. More than 1000 pounds per unit of product (pitch × width of tooth) should not be allowed under ordinary circumstances. Cut-bronze gear, cut-steel worm.

Velocity in feet per minute	Load in pounds per unit of (pitch × width of tooth)	Coefficient of friction	Velocity in feet per minute	Load in pounds per unit of (pitch × width of tooth)	Coefficient of friction
5	1000	0.146	200	403	......
10	1000	0.116	250	371	......
20	956	0.090	300	341	......
30	790	......	350	315	......
40	703	0.070	400	292	......
50	646	......	500	257	.....
75	564	......	600	228	......
80	....	0.054	700	206	......
100	514		800	185	......
125	477	......	900	167	......
150	448	......	1000	151	......
175	424	......	1200	128	......

Concerning the coefficient of friction f, this has not been deduced for higher speeds than 80 feet per minute, but it will be seen that there is a general tendency for the value of f to decrease as the speed increases.

Except for hand-operated gearing, or for machinery which is only operated occasionally and for a very short time, the worm and gear should be enclosed in an oil casing and the worm always placed below the gear to insure the submersion of the rubbing surfaces in oil. Except in the above-mentioned cases, machine-cut worms and wheels should also always be used. Hardened steel worms working with bronze wheels have proved to give good satisfaction, because this combination wears longer than cast iron or steel and cast iron.

Self-locking Worm Gearing

A set of worm gearing will be self-locking when the thread angle is equal to, or smaller than, the angle of friction. From Equation (2) we obtain, by making $f = \tan \alpha$, the efficiency of worm gearing having a thread angle just small enough to be self-locking, as follows:

$$E_1 = \frac{\tan \alpha\,(1-\tan^2\alpha)}{2 \tan \alpha} = \tfrac{1}{2}\,(1-\tan^2\alpha) \qquad (5)$$

Equation (5) gives a maximum of E_1 for $\tan \alpha = 0$ or $\alpha = 0$, and this value is E_1 max. $= \tfrac{1}{2}$.

From this it will be seen that it is impossible to obtain an efficiency greater than 0.5 if the gears are to be self-locking in themselves. Of course, there will always be some friction in the worm shaft bearings and other parts of the machinery which may prevent the pressure on the worm-gear from actually turning the machinery as a whole backwards even if the angle of thread is larger than that of friction. This, in connection with the fact that the efficiency for backward movement is low, is probably the reason why many worm-gear drives, applied as self-locking, have angles of thread far in excess of the friction angle, and still seem to work satisfactorily.

On account of the variable coefficient of friction, the angle of thread which may safely be used for self-locking gears will also depend largely on the speed with which the machine is run backward, or, in other words, the speed with which the load is lowered or eased off by means of the worm-gear. If the machine is never run but one way, and the worm-gear applied as safety device to prevent backward movement in case of accident, then the load would have to start the worm shaft rotating, and a larger angle of thread could undoubtedly be used.

An Example from Practice

To indicate the use of the formulas and table in practical work, the following example has been prepared: Assume a set of worm gearing used for driving a package elevator with the worm-gear shaft running at a speed of 5 R.P.M. The required turning moment is 42,000 inch-pounds. It is desired to have the worm gearing self-locking to prevent the elevator from running backward in case the driving belt breaks or jumps off.

As the elevator must come to a stop before it can commence to run backward it is only necessary to have a thread angle equal to or smaller than the angle of friction for rest. Assuming the coefficient of friction to be at least 0.15 at rest, the thread angle α will be determined by $\tan \alpha = 0.15$, or $\alpha = 8\tfrac{1}{2}$ degrees. If the speed of the worm shaft is not dependent on other conditions, we have a choice between a single- and a double-threaded worm. A single-threaded worm of $1\tfrac{3}{4}$ inch pitch would have a diameter $= \dfrac{1\tfrac{3}{4}}{0.15\pi} = 3.71$ inches. This may not be enough to allow for a worm shaft of sufficient strength; besides it would give a very narrow face to the worm-gear. We, therefore, probably prefer to use a double-threaded worm, the pitch diameter of which will be $\dfrac{1\tfrac{3}{4} \times 2}{0.15\pi} = 7.42$ inches. The face of the worm-gear will then be

$$2/3 \times 7.42 = 4.95 \text{ inches, or, say, 5 inches.}$$

Assuming a worm-gear of 28 inches pitch diameter, $1\tfrac{3}{4}$ inch pitch, and 50 teeth, the worm shaft will be running $5 \times \dfrac{50}{2} =$ 125 R.P.M., which gives a speed of rubbing of $\dfrac{\pi \times 7.42 \times 125}{12 \times \cos 8\tfrac{1}{2}\text{ deg.}} = 247$ feet per minute.

Looking at the table, we find for a speed of 250 feet per minute an allowable load of 371 pounds per unit of product (pitch × width of tooth). The total allowable load in our case will be $371 \times 1\tfrac{3}{4} \times 5 = 3246$ pounds. This load at 14 inches radius gives a turning moment of $14 \times 3246 = 45{,}444$ inch-pounds, while only 42,000 inch-pounds is required.

If the above machine were applied for lowering packages instead of elevating same as previously assumed, the gearing would have to lock while running at a full speed of 247 feet per minute, at which speed we would not have a friction coefficient of more than 0.05, at the most, which would correspond to an angle of thread determined by $\tan \beta = 0.05$, or $\beta = 2$ degrees 50 minutes approximately, and the gear with a thread angle of $8\tfrac{1}{2}$ degrees could not be expected to lock.

To find the efficiency of the above gearing when running at full speed, assume a coefficient of friction of 0.05, and apply Formula (2) which gives

$$E = \frac{\tan \alpha\,(1 - f \tan \alpha)}{f + \tan \alpha} = \frac{0.15\,(1 - 0.05 \times 0.15)}{0.05 + 0.15} =$$

74 per cent.

This is the efficiency of the worm gearing only and does not allow for the friction loss in the worm-gear shaft nor any frictional loss in the other parts of the machine.

To find the effort F which must be exerted at the pitch radius of the worm to turn the worm shaft with a load $= \frac{42000}{14} =$ 3000 pounds, at the worm-gear periphery, apply Formula (1) which gives (for $f = 0.15$ at starting):

$$F = P \times \frac{f + \tan \alpha}{1 - f \tan \alpha} = 3000 \times \frac{0.15 + 0.15}{1 - 0.15 \times 0.15} = 921 \text{ pounds.}$$

To this should be added the friction in the worm-shaft bearings reduced to the same radius.

* * *

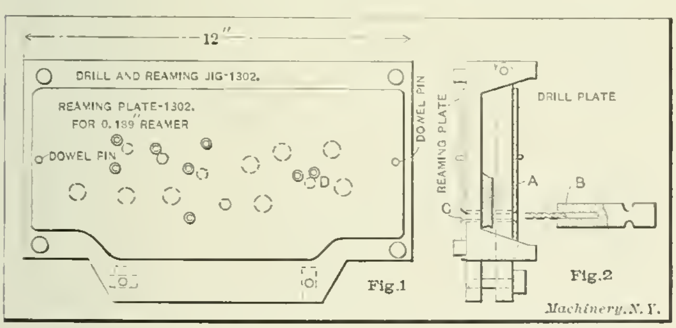
DRILLING ADDING MACHINE SIDE FRAMES BY PLATE METHOD

By A. C. LINDHOLM*

The following problem of drilling and reaming a delicate casting having forty-one holes, varying in diameter from 0.125 inch to 0.375 inch, making sure that all holes were finished before removing the casting from the jig, was my lot to solve. Not having a multiple spindle drill press, so as to be able to drill a number of holes at once, the job had to be done on a three-spindle drill press, one hole being drilled at a time. Various schemes were tried to make time on the job, but somehow there were always one or more holes that were omitted, and most always the reaming, so that when the work was gaged the error was found out, which necessitated rejigging the piece. A method which proved a failure was tried previous to the adoption of the plate method, involving the following idea:

The holes were marked on the jig by numbers and on the drill and reamer holders likewise. For example: 0.156-inch holes were marked Number 2; 0.189-inch holes, Number 3; 0.250-inch holes, Number 4, etc. The time expended in looking for the right number of hole for the corresponding drill or reamer, besides the liability of skipping holes and of forcing a large reamer into a small bushing, was enough to abolish the idea.

Referring to Figs. 1 and 2, in explaining the plate method, it will be seen that a simple drill jig of the leaf type is shown,



Figs. 1 and 2. Method of Using Plates on Drill Jigs to insure All Holes being drilled and reamed

in which the work A is drilled from one side and reamed from the opposite; that is, drilled from the leaf or hinged side and reamed from the solid or positive side to insure correct alignment of the hole with the flat side of the work. In this casting eight holes 0.189 inch diameter, ten holes 0.177 inch diameter, four holes 0.125 inch diameter, and four holes 0.375 inch diameter, were to be reamed. To drill or ream the 0.189-inch diameter holes, a plate was made from 1/16-inch thick sheet steel and located on the dowel pins. In this plate the holes correspond with the 0.189-inch holes in the jig, showing the operator just where these particular holes are located, and covering all others, thus eliminating all chances of placing the reamer anywhere but in the proper holes. The holes in the plate are about 1/32-inch diameter larger than the drill or reamer holes in the bushings and chamfered at C, so that, when machining, the drill or reamer will have perfect freedom to enter, and when withdrawing them, small chips or dust will be deposited around the hole, indicating that the hole has been drilled or reamed. Having drilled or reamed this size, the plate is removed and another put on having the 0.177-inch size, and then the plate containing two sizes, 0.125 inch and 0.375 inch. These sizes vary greatly, and the operator is not so likely to try to enter a 3/8-inch reamer into a 1/8-inch hole. Each plate has marked on it the size of the drill or reamer to be used, as has also the holder B, which is of the slip chuck type.

Another case for the plate method is presented in Fig. 3, which is a little different; that is, the requirements are not the same as for the casting A (Fig. 2), inasmuch as some of the holes in the work W are drilled only part way through. However, the same idea is carried out in regard to selecting and locating the holes, but the plate A has bosses or shouldered bushings C and D of various heights, so that a holder containing a drill, set out far enough to drill the proper depth for one hole, will also drill the proper depth for the other. For instance, if the drill in holder B (Fig. 2) is set so that it will drill the center hole in W (Fig. 3) to the proper

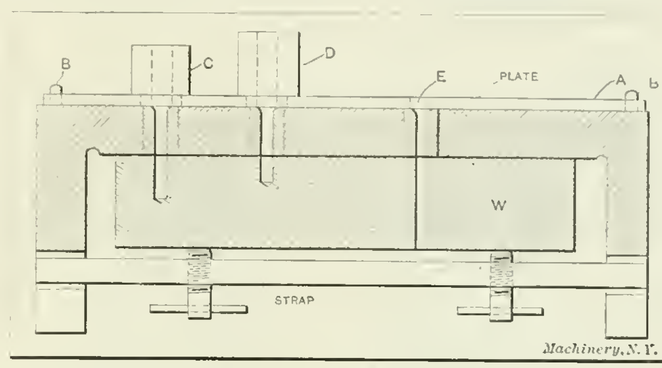


Fig. 3. Simple Method of Drilling Holes to Various Depths

depth, the same tool will drill C and E. This obviates the necessity of setting the spindle to obtain different depths, and in this case a drill press with but one spindle can be used as advantageously as one with two or three. In the case of Fig. 3, W is a rectangular block 60 inches by 4 inches by 1 3/16 inch, having 30 holes drilled to various depths. Some of these holes are tapped, and as this is done in a tapping machine, the plate method is again used for selecting the proper holes to be tapped.

For obtaining results satisfactory as to the quantity and quality of the work produced, by the adoption of as near a fool-proof method as possible, the writer has found this simple and inexpensive idea the best.

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* * *

POWER REQUIRED TO DRIVE CRANES

The following data on the power required to drive cranes, representing the practice of the Morgan Engineering Co., Alliance, Ohio, are given by the *Industrial Engineering and Engineering Digest*. The power required to drive the different parts of cranes is determined by allowing a certain percentage for friction over the power required to move the dead load without friction. On hoist motions 33.3 per cent is allowed for friction of the moving parts, the capacity of the motor thus being one-third greater than if friction were neglected. For bridge and trolley motions a journal friction of the track wheel axles of 10 per cent of the total weight of the moving parts of the crane and the load, is allowed. To this is added an allowance of 33.3 per cent of the horsepower required to drive the crane and load with the track wheel axle friction taken into account. This additional amount covers the friction of the gearing.

* * *

A transformer for a current of 500,000 volts has been built by the General Electric Co. of Berlin, Germany, for experiments with insulating materials. The voltage of the current transformed is from 1,040 to 2,080 volts. The transformer proper is immersed in an oil tank containing 2,000 gallons of oil which acts as insulating material. The transformer weighs 11,000 pounds without the oil, and has with the oil tank, a length of 10 feet, a width of 6 feet, and a height of 8 feet. With the projecting high pressure insulators the total height is nearly 15 feet.

PRACTICAL HINTS FOR DIEMAKERS—1

BLANKING AND PIERCING DIES

By RICHARD L. BREUL*

Richard L. Breul†

It is absolutely necessary if accurate work is to be produced by punches and dies that the templet be accurate. This is one of the first points which the diemaker should be sure of before commencing to make the punch or die. When templets are made from copper and brass, a good method of coloring them is to apply some ordinary steel coppering solution, and mix with this a little steel filings; then rub this around on the brass sheet.

Always remove at least 1/16 inch from the top face of the die blank, as this amount is generally decarbonized and will not harden perfectly. In laying out the blanking and piercing die always allow for scrap between the blanks. This amount should never be less than the thickness of the stock. When putting on a gage plate, always allow for variations in the stock, and the spreading of the metal while being worked. A good method of working out die blanks after the core has been removed, is to set them up in the shaper vise between two parallel strips which should hold them at the angle required for clearance, and then remove the stock with a tool made similar to an ordinary internal keyseating tool. If the hole in the die is large enough to permit adopting this method, it has an added advantage of leaving the sides perfectly straight, which simplifies the operation of filing them to shape. The stock should be removed to within about 1/64 inch of the finish line, and then the mouth of the die beveled with a file to the line, before the finishing cut is taken. When filing out the die, the angle to which the die is beveled should be adhered to as much as possible, as trouble will occur after the die is hardened, if it has not been filed on a straight bevel but is slightly larger at the mouth. This will cause the blanks to scrape on the sides of the die when being forced through, which sometimes bends them out of shape. The templet should be worked through the die from the back, as in this way the correct shape is more easily attained. All the guide pins in the punches should be located by means of this templet.

Do not stamp any necessary information on the top face of the blanking die, as it is generally removed when the die is ground. It is usually advisable to stamp whatever is necessary on the front edge of the die; but, if that is not convenient it should be put on the stripper plate. The bottom of the die should be ground level if good results are to be expected. In filing out the die, it is convenient to have a set of small squares which are set off from ninety degrees, an amount equal to the angle required on the die for clearance. These may be made from 1/16-inch sheet steel with the base ½ inch wide by 2 inches long, and the beam ⅛ wide by 1½ inch long, or they can be made to suit the requirements. It is generally found advisable to have these ranging from ½ degree to 2 degrees varying by ½ degrees. The number of degrees that these are set off from 90 should be marked on the various squares to designate them. It is generally advisable to harden a blanking die at a low heat to prevent it from springing out of shape and cracking. The following is a solution which has been found to give very satisfactory results for this purpose. Into pure rain water mix enough salt to float a raw potato. To eight gallons of the brine, add one pint of oil of vitriol. After hardening the die in this solution it should be dipped in strong, hot soda water, which will keep it from rusting.

When machining a punch which has inside corners, holes should be drilled in the corner close to the finished line, and as deep as the straight part of the punch extends. The size of the drill, of course, should correspond to the radius required on the punch. The punch should be beveled on the edge at an angle of about 45 degrees to a little below the finished line. This enables the punch to start centrally when shearing it into the die, and also simplifies the locating of it. This beveled portion can be ground off after the punch is hardened. When shearing the punch through the die, be sure that it stands perfectly square with the top face of the die. Care should be taken when shearing the punch through the die to see that it does not remove too much stock. If the die removes a nice curling chip from the punch it is not removing too much stock, but if the chip cracks and breaks as it is severed, it is obvious that it is removing too much stock, and before going any further the punch should be removed and reduced in size, at the point or points where the die was removing too much stock. It is advisable always to use oil on the punch when shearing it through the die.

Punches for piercing and blanking copper should be polished quite smooth, as copper clings tightly and is difficult to strip from the punch. If, on the other hand, the punch is left rough, the force necessary to strip the blank from the punch is very likely to bend it out of shape or to break the punch.

When making blanking or piercing punches for plain circular work, hold the punches by the shank in a punch bolster, and set this up to run true in the lathe. The outside diameter is then turned to the required size and the hole for the guide pin is also drilled. Making the punch in this way insures the guide pin being in the exact center of the punch.

Small perforating punches should be hardened their entire length, otherwise they will be upset or bent, if thick metal is to be perforated. The punches should also be carefully examined after hardening and tempering, and those which have been bent or sprung in the hardening should be carefully straightened. Piercing punches in compound dies are steadied by the knock-out while operating on the stock. The punch is made a sliding fit in the knock-out, and the knock-out is also made a sliding fit in the die. When perforating thick metal where the strain on the press is great, a good method to reduce the pressure, is to make each second punch lower than the preceding one an amount equal to the thickness of the stock. This, as can be seen, will reduce the pressure, as half the punches are through the stock before the remaining half operate. When heavy stock is being blanked or pierced, punches are not required to fit as snugly as when the metal is thin. It is generally found after hardening small piercing punches, that although the holes in the punch holder are true with the die, the punches do not line up. This is because they have bent slightly in hardening. They can usually be brought into alignment by giving those that do not enter half a turn, but if this does not work, they should be removed and straightened. When a large and a small piercing punch are too close together to allow both being set in the punch holder, the smaller punch is set in the larger one, and securely held in position.

In fitting the punch into the die, scrapers can generally be used to good advantage, as the points which are high can be reduced by scraping where it would be more difficult to file. These scrapers may be made in various shapes to suit the requirements. When piercing holes in a circular piece of work, the radius on the bottom face of the punch should be less than the radius on the piece, so that the outer edge of the punch will strike the metal first. If this precaution is not taken and the punch made the same or a greater radius than the piece, the work will be changed from its original shape.

Compound dies are made without clearance, and the blanks are ejected by the knock-out as soon as the punch leaves the die. The piercing holes in the punch, however, should be taper reamed and larger at the top so that the piercings will pass up through the punch easily. The throwing out of the piercings from a compound die is aided by setting the die in an inclined press. If a double compound die is required to

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produce two blanks on one stroke of the press, care should be taken to see that the knock-outs are ground to the same height, and also that the blanking punches are perfectly level, so that both blanks will be flattened alike. The spring or rubber pad which operates the knock-out in the compound die should be adjusted tighter than necessary to insure the blanks being removed. The knock-out should just bring the blank to the surface of the die.

Guide pins should be made slightly smaller than the hole in the blank and should be straight for the thickness of the stock, and then rounded off similar to the point of an acorn. The heads of all guide pins should be turned true with the shank. Care should be taken to see that the guide pins are also exactly in line with the piercings. If they are not in line they have a tendency to twitch the metal around, so that after a few blanks have been punched, they will be found to run off the strip. Precaution should be taken to see that the stock does not cramp between the guide pins and the stop, or between the guide pins and the back gage, because if this is neglected it will generally result in some broken punches. When the piercings are very small the punch should be provided with a spring guide pin, so that if the pin misses the pierced hole in the blank, it will spring back into the punch and nothing is spoiled except the blank.

When a number of small round piercing dies of the same size are to be made, after having turned and bored them all to the same size they can be taper reamed from the back very readily by holding them in a chuck which runs true, and using a taper reamer with a bushing located on it, this bushing acting as a stop. The piercing bushings can then be reamed out from the back to the exact size by using the bushing located on the reamer as a stop. Always provide clearance holes in the die bed under the piercing bushings for the piercings to drop out. These holes should be larger than the holes in the piercing bushings, so that the latter can easily be driven out. After having completed the die and punch, before taking them to the press, see that all guide pins when in the punch locate accurately in the piercing holes in the die, and also see that all the punches line up perfectly.

* * *

From an early treatise by Moxon, published in 1680 in England, it is certain that at that time the lathe was developed to a point where it was possible to turn out high-class ornamental woodwork, including oval shapes, but anything more than this was beyond its power until the slide-rest was invented. Devices for clamping the cutting tools in a fixed position were employed comparatively early, but the first appearance of the slide-rest dates from 1772. Complete drawings and details of an excellent slide-rest were given in tnat year in a French encyclopedia. As early as in 1741, Hindley, a York clock-maker, produced a screw-cutting lathe with change gears. This, of course, was a very small machine, and in fact the clock-makers of that day seemed to have a monopoly of mechanical ingenuity. Attempts to produce machinery to replace the work of human hands were made early; thus, for example, in 1732 Wyatt endeavored to make a machine for cutting files, but was not successful.

* * *

According to the *Foundry*, the proper proportions of a copper alloy for soldering irons, copper hammers and all copper castings which do not require high electric conductivity, are obtained by mixing 96 pounds of copper and 4 pounds of zinc. Two tablespoonfuls of salt should be added to the copper when first charged. The zinc should be added after the copper is melted. The mixture is thoroughly stirred and the metal is allowed to superheat for a few minutes before being cast.

* * *

The record for altitude in aeroplane flying was broken by Walter Brookins with the Wright biplane at Atlantic City on July 9, when the aeronaut, by a steady ascent of fifty-three minutes, reached the height of 6175 feet, as observed from the ground. At this height his fuel gave out and he was obliged to descend in a gliding flight from this altitude, which was done successfully in ten minutes. Through this flight he won a prize of $5000.

MACHINE SHOP PRACTICE*

SOME POINTS ON LATHE WORK

By W. S. LEONARD†

As the work described in the Shop Operation Sheet accompanying this number of MACHINERY, which explains the turning operations on a chuck-plate casting, is typical of much of the work that is done on the ordinary engine lathe, it may not be amiss to offer some further considerations of a general character on the subject.

When setting a casting in a lathe chuck (as explained in the sheet referred to) unevenness on that part gripped by the chuck jaws will sometimes cause it to run "out of true," even when held in a self-centering chuck. This trouble is usually caused by a ragged edge or ridge along the parting line of the casting where the foundry flasks come together, and generally this and all rough bumps should be reduced on the grinder or removed with a chisel and old file before the casting is brought to the lathe.

The side tool referred to in paragraph 4 (Operation Sheet No. 145) is not the old-style thin-edge side tool (though such a tool would answer for the finishing cut), but it is one of

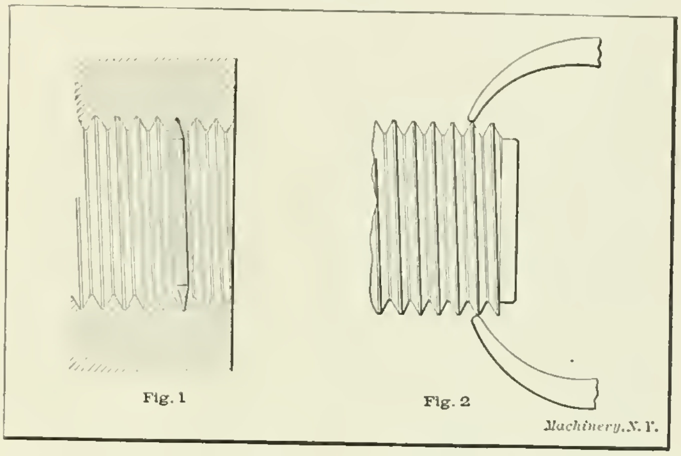


Fig. 1. Internal Thread Gage Fig. 2. Calipering Thread

the stouter variety, which may be used advantageously for both roughing and finishing. Skillful machinists can take a fine finishing cut with a side tool that will make the face of the work look as though a scraper had been used. In fact, these fine cuts are scraping cuts, and it is the practice of the writer to run the lathe almost as fast for this work as is done when a scraper is used. To avoid chattering, the face contact of the tool should be reduced by setting the tool at a slight angle, giving it a slight bearing near its point. If the fine effect alluded to is not required, the tool should be given a wider bearing and be fed faster, and the speed of the lathe should be reduced. It should be understood that a diamond point, half-diamond point, or other roughing tool might be used for both roughing and finishing cuts, either on the face or cylindrical part of such work. It is largely a matter of adjustment for contact, and perhaps slight modification of the point of the tool by grinding. Where much duplicate work is done there should be a separate tool for finishing, if a fair finish is required. The roughing tool soon gets too dull for nice cuts, and it saves time in grinding to have two tools. When a large quantity of duplicate work is to be done, it will pay to determine by experiment the best shape of tool, speed of lathe, etc., with reference to economy of time and quality of work.

In paragraph 7 the operator is reminded of the necessity of rounding the inner corner of the hub if the lathe spindle is filletted under the collar. The casting would be less likely to get bruised in such a manner as to cause the chuck to run out of true if both the inner and outer hub corners were rounded, whether this were otherwise required or not. The corners may be rounded by tools filed to the shape of the curve, when a large quantity of duplicate work is to be done. When cutting a thread in the average casting of the character

* With Shop Operation Sheet Supplement.
† Address: 100 Josephine St., Atlanta, Ga.

referred to in the Operation Sheet, there will be little or no time lost if the lathe be reversed for successive cuts; but if the hole to be threaded is long, it would save time to "catch the thread" without reversing the lathe. To do this, stop the lathe just after the tool reaches the end of the thread and make a chalk mark on the periphery of the chuck in line with some fixed point on the lathe. Next disengage the lead-screw nut and move the carriage back for the next cut a distance which must be divisible *without a remainder* by the lead of the thread being cut and that of the lathe lead-screw. As most threads are integral to the inch, it is a common practice to move the carriage back a whole number of inches as measured by a steel scale, the distance being marked by chalk on the lathe ways. If the lathe is provided with an adjustable carriage stop, this should be used to mark the return position of the carriage. If this position be determined according to the foregoing instructions, the lead-screw nut will engage correctly and the tool will follow the thread as accurately as though the lathe had been reversed. For each succeeding cut the lathe spindle must be brought to rest at the position established for the first cut, and it must be kept in that position until the lead-screw nut is re-engaged for another cut.

In paragraph 7 of Operation Sheet, No. 146, the workman is instructed to use either a threaded plug gage or inside thread calipers for testing the thread. In some small shops neither of these tools is available. In such a case a piece of wire about 1/8 inch in diameter, cut to the required length, and having its ends filed to conical points, will answer very well in place of the calipers; indeed, many machinists would prefer the wire. When making a gage of this kind, the calipers are first set to the outside diameter of the thread as indicated in Fig. 1; the gage is then fitted to the calipers and used as shown in Fig. 2. Care must be taken to file the wire to a point fine enough to enter to the extreme bottom of the thread. If by accident this gage be filed too short it may easily be stretched by holding it on a solid piece of metal and giving it a few peening blows near the middle with the hammer. It may be stated in this connection that, generally, when a piece of work (whether threaded or plain) is to be machined to fit some repair job outside of the shop, a wire gage "made on the spot" is more dependable than calipers, because the latter may happen to fall or otherwise be altered. In some cases the wire gage is sent through the mails, it being accompanied by a letter of instructions to the shop which is to make the repair piece.

If the compound rest be set parallel with the lathe ways while cutting a thread, care must be taken to have the gib screws adjusted tightly; otherwise the rest may be drawn forward and spoil the thread. This is most likely to occur when cutting a thread in a hub having foundry "blow holes." When the tool comes in contact with the blow hole, it may spring forward, if the rest be sufficiently loose to permit this. Many workmen prefer to set the rest to the angle of the thread and use its crank to feed the tool instead of the cross-feed crank. In any case, the gib screws for both the cross-feed and the compound-rest should be snugly adjusted when cutting threads.

The experienced machinist knows that if oil by any means gets on the thread of a casting while the thread is being cut it will cause the fine chips and dust to adhere to the thread, and give trouble while the casting is being tried on its mating piece. Because of this difficulty some machinists will try a chuck-plate casting on its spindle without using any lubricant. In a number of cases in which this plan was followed, the writer has known the casting to be so firmly galled on the lathe spindle as to necessitate its being cut off with a hammer and chisel, or turned off with a lathe tool. It is necessary, therefore, to use some lubricant. A few drops of oil on clean waste, the latter being wiped around the thread of the spindle (not in the casting), will answer the purpose of lubrication without causing grit and chips to adhere.

An old chuck that has not been properly taken care of will sometimes stick and refuse to go up against the lathe spindle collar. This is caused by grit in the thread. It has been the practice of the writer to cut a narrow groove like a keyway in the chuck-plate bore. The grit rubs off into this groove. A similar groove cut on the spindle would be an additional advantage. The practice of dropping chucks and faceplates under the lathe where they catch oil, dirt and grit should not be tolerated, and such slovenly methods will not be followed by the conscientious workman. It is a good plan to have a rack with stout wooden plugs projecting outward and hang all chucks and faceplates on these plugs. Each lathe might have its rack, which should, of course, be near the lathe.

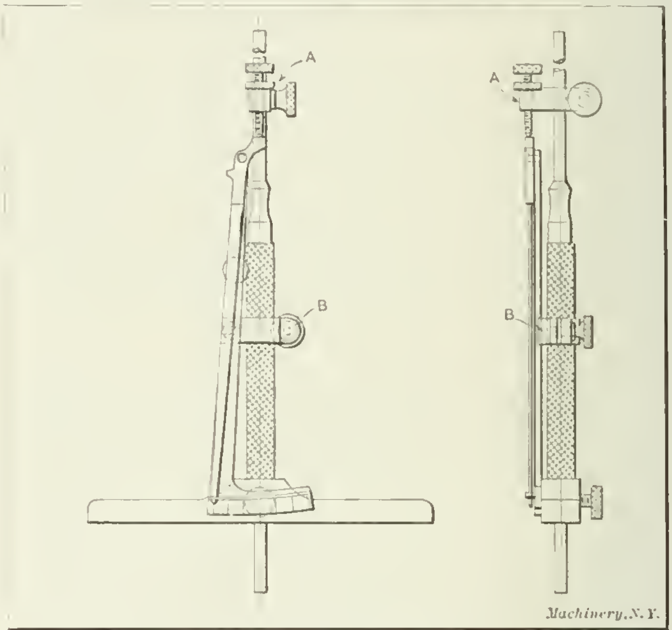
* * *

DEPTH GAGE WITH INDICATOR ATTACHMENT

By JETHART

The accompanying engraving shows a Brown & Sharpe spring depth gage to which has been attached a Starrett test indicator. This combination I have found very useful when working out recesses in dies, etc., which have to be scraped parallel with the face of the die, and similar work.

The indicator is attached to the depth gage by the clip *B*. The rod which carries the clamping disks on the indicator, which was riveted to the indicator frame, was removed and the hole tapped for a suitable sized screw, by which the indicator is attached to clip *B*. By threading the end of the clamping rod to fit the tapped hole in the indicator frame, it takes only a minute or so to change from the depth gage to the regular indicator again. The clip *A* is attached to the upper end of the measuring rod of the depth gage. The vertical screw with the check nut, allows the indicator to be adjusted to any graduation desired. The end of this screw is rounded and hardened.



Combined Depth Gage and Indicator

The action of this combination will be clearly seen from the illustration. The spring in the depth gage forces the measuring rod always to the bottom of the recess or hole, and as the vertical screw in clip *A* is adjusted to some graduation on the indicator, when the gage is moved from one end of the recess to the other, the indicator shows any variation in depth.

As the measuring rod in the depth gage was free to revolve, some means had to be found to keep it from turning. This was done by removing the rod from the gage and catching it by the measuring end in a draw-in chuck in the lathe. A piece of steel was bent to the required shape and clamped to the carriage and a V cut in it at the height of the lathe centers to form a back-rest for the rod. A very narrow, round-nosed tool was then caught in the toolpost with the cutting face vertical, so that when the carriage was moved along the bed of the lathe, the tool, being fed into the rod, planed out a narrow slot. A blunt, thin chisel was then tapped lightly on the beveled edge at the top of the gage body, turning in the edge at one point until it filled the groove cut in the rod. It was then smoothed off so that the rod was a nice sliding fit through it but couldn't turn, the turned-in edge acting as a key.

Anyone having much die sinking to do will find this tool a great improvement over the regular depth gage.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

METHOD OF ATTACHING PUNCHES TO THEIR HOLDERS

In the June number of MACHINERY, under the heading, "Out-of-Date Die-Making Methods," Mr. Shailor calls attention to a blanking punch attached to a punch holder so as to obtain greater rigidity and durability, by saying: "The method illustrated in Fig. 4 is the best that has come under the writer's experience of sixteen years for easily making a rigid, altogether satisfactory punch and die. If any reader knows of a better method we would all like to know of it, and I for one will adopt it."

What I believe to be a still better method of securely holding the odd-shaped blanking punch referred to by Mr. Shailor is shown in Fig. 1. This method is somewhat similar in construction to his except that a slot is planed part way through the punch holder, as shown at *A*, in which the blanking punch is made a driving fit. The round shank *B* is made a driving fit in the hole, and, after hardening, is slightly upset, as shown at *C*, to prevent the punch from pulling out.

In Fig. 2 is shown this same method used in holding two blanking punches in the punch holder. These punches are used in connection with a double blanking die for cutting

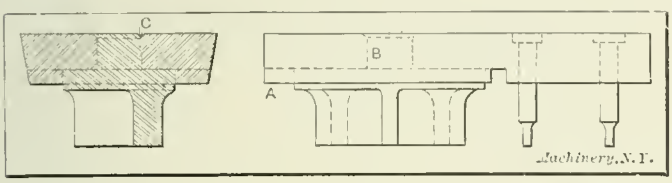


Fig. 1. A Substantial Method of attaching a Punch to a Punch Holder

two blanks at one stroke of the press. In this case the slot is milled through the entire length of the punch holder, as shown at *A*, and the punches driven in and securely held in position in the same manner as that shown in Fig. 1.

The advantage of attaching an irregular-shaped blanking

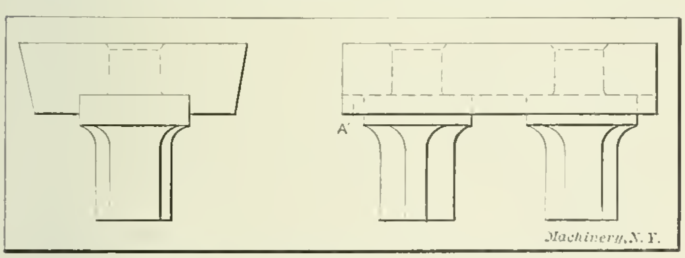


Fig. 2. Punch Holder with Two Blanking Punches attached in a Similar Manner

punch to a punch holder in this manner over the one described by Mr. Shailor, is that it does away with all tapered holes, screws and dowel pins, and forms what may be called a solid or compact mass, which can be depended upon to stand up and hold its own at all times.

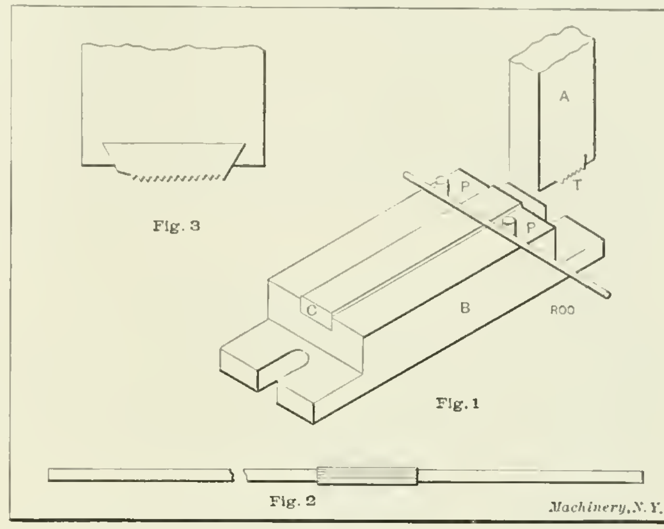
In conclusion, the writer would say that he does not claim that the above is a new or an original method, as it is one that is used by various shops in this city, but, nevertheless, it is one which he considers to be the peer of them all.

Waterbury, Conn. CHARLES DOESCHER

KNURLING IN THE SHAPER

Sometimes those things which at a passing glance appear simple, prove to be the more difficult to solve. This was the case with a few thousand pieces of drill rod which were to have a knurled portion ¾ inch long. The knurling had to be put on to make them a drive fit in a bushing which had a hole 0.108 inch, the same diameter as the rod. This was at first thought to be a good job for the lathe, but experiments proved that even with proper supports a slight kink was developed in many of the rods. It also took considerable time to raise a "burr," owing to the small diameter of the rods.

When knurling in the lathe was found to be unsatisfactory, rolling in the shaper was resorted to, and this was found very satisfactory. A base casting *B*, Fig. 1, having a strip *C* of cold-rolled steel inserted as shown, was used for rolling the rods on, and when it became too rough it was renewed. The base *B* was bolted to the shaper table, by bolts inserted in



Figs. 1, 2 and 3. Details of Knurling Tool and Piece to be knurled

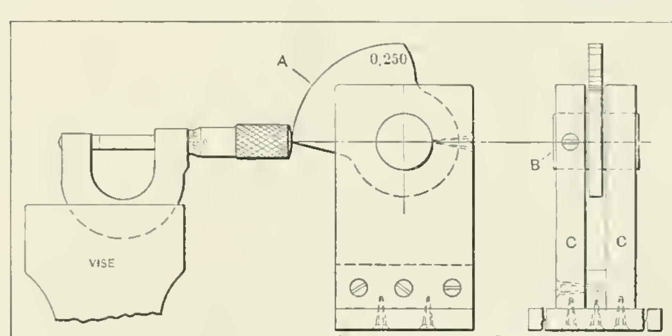
the slots shown. Two stop-pins *P* were also provided for locating the rods at right angles to the stroke of the shaper. A tool-holder *A* carrying a tool-steel die *T*, which had nicks to suit the knurling required on the rods, was clamped in the tool-post in the usual manner. This die *T* is shown enlarged at Fig. 3, and as will be seen, the starting edge is tapered slightly, thus allowing the rods to enter and become confined before any great amount of rolling is done.

In operation, the rods are placed against the stop-pins *P*, and against a longitudinal stop (not shown), while the shaper is completing the rear stroke. The stroke is made long enough so that after passing over the rods there is ample time to take them out before the tool advances. By running at a moderate speed it was possible to turn out a rod for every complete stroke of the shaper, giving an output far in excess of our most sanguine expectations for the lathe method. The rod as it appears when finished is shown at Fig. 2.

Middletown, N. Y. DONALD A. HAMPSON

MEASURING SCREW MACHINE CAMS

In the screw machine department of most shops, there are many screws, pins, etc., made on the Brown & Sharpe automatic screw machine with what are known as "pick-up" cams. These cams are odds and ends of cam sets which are no longer used regularly, and are often used in making small



Device for Measuring Rise on Screw Machine Cams

quantities of screws, when it would be unprofitable to make up a set of cams especially for the job on hand. In order to determine the suitability of a certain cam, it is necessary to measure the travel or throw. This measurement is generally difficult to accomplish. The method most used is for the oper-

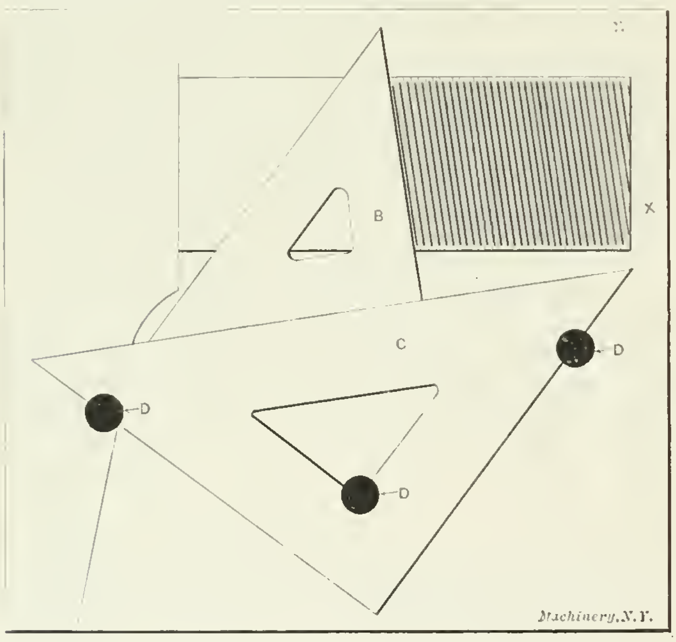
ator to measure with a scale, the distance from the high point of the cam to the center hole, and then subtract the distance from the low point to the center hole, the difference being the travel on the cam. This method takes a great deal of time and patience when hunting through a pile of cams, and often after the job is set up the operator finds the cam selected to be a few thousandths short in travel owing to the inaccurate method of measuring.

The accompanying sketch shows an improved method of measuring cams to thousandths of an inch. *A* is the cam shown placed on the steel shaft *B* held between the wooden supports *C*, which are, in turn, fastened to the work bench. A micrometer is held in the vise as shown, being so placed as to read zero when the end of the barrel touches the high part of the cam lobe. After the cam is revolved the micrometer is adjusted until the end of the barrel is in contact with the lowest point of the cam. The resulting reading will then show the travel of the cam, which is stamped on the face of the cam as shown. DESIGNER

[The method of measuring the rise of cams described in the above no doubt is effective, but is limited to cams having a slight rise. It can be seen that the radius on the head of the micrometer barrel will govern to a large extent the amount of rise that can be measured. Why not stamp the rise on all cams when made and thus avoid the necessity of measuring? Although the practice is not common, it seems to us that the rise should be plainly stamped along with the other data usually put on cams to identify them.—EDITOR.]

METHOD OF DRAWING PARALLEL LINES

Very frequently in making drawings it is necessary to draw a series of parallel lines which are not at such an angle that a thirty-, forty-five-, or sixty-degree triangle can be used in conjunction with an ordinary T-square or parallel straightedge, as would be the case in cross hatching, drawing threads, and similar work, where considerable time is often lost for lack of a simple, quick and inexpensive method of procuring parallelism and accuracy. The method shown in the accompanying engraving has been found by the writer to be very useful in



A Simple Method of Drawing Parallel Lines

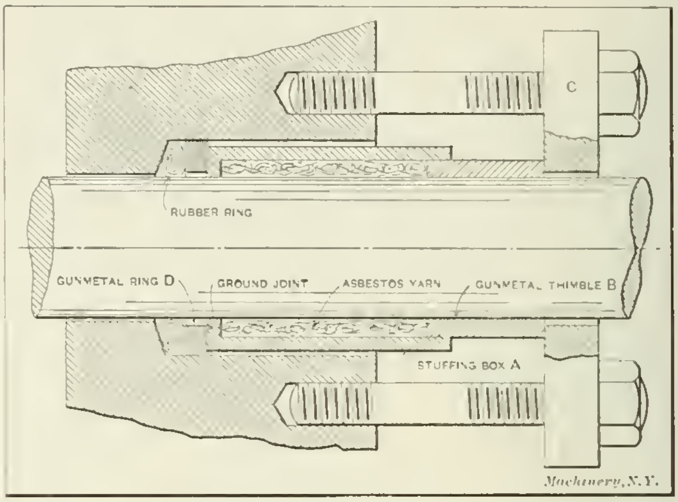
overcoming this difficulty. The line *X-X* is a line drawn at some desired angle, and with which it is desired to draw other lines parallel. To accomplish this, place the triangle *B* with its edge on the line *X-X* and the triangle *C* with one edge against the triangle *B* as shown. Fasten the triangle *C* to the drawing board with thumb tacks *D*. Then by sliding the triangle *B* along the triangle *C* any number of lines may be drawn parallel to the line *X-X*.

This scheme will also be found very useful in making sketches on the road or about the shop where a T-square and drawing board are not at hand. F. B. HAYS

Indianapolis, Ind.

PACKING FOR PISTON-ROD

The piston-rod packing of an engine used in driving a paper-making machine was a constant source of annoyance and trouble. The engine, which was of the horizontal type, had been running twenty-four hours per day for seventeen years without necessitating the reboring of the liner. No doubt the wear on the bottom of the liner and piston caused a certain want of alignment with the guides, thus producing a slight up-and-down movement of the rod, which helped to cause this trouble. It will also be seen from the accompanying illustration that the stuffing-box is very shallow, so that very little packing could be introduced. The constant effort to keep the gland comparatively tight with any packing hitherto tried resulted in heated and scored piston rods. About two years ago



Improved Method of Packing Stuffing-box

the writer designed and applied the device shown in the illustration. Since then this has been running twenty-four hours per day without any attention, except that about a year ago a little additional asbestos yarn was inserted. Steam-tightness is secured with only a very slight tension on the screws, and the rod is smooth and shows scarcely any wear. Before devising this arrangement some form of metallic packing was thought of, but as the steam is very wet it was feared that this might not be successful. A feature of the device is its simplicity and the fact that it can be applied to an engine without any alteration to stuffing-box or gland-studs.

Referring to the illustration: *A* represents the floating stuffing-box made of gunmetal, which is a very loose fit in the old stuffing-box, so as to allow freedom of alignment. The inner flange of this is a sliding fit on the rod. To obtain sufficient strength in the walls of the box, only $\frac{1}{4}$ inch was left all around for the packing, which was asbestos yarn rubbed with graphite. A gunmetal thimble *B*, which is a sliding fit on the rod and also in the stuffing-box, compresses the packing when pressed forward by screwing up the gland nuts. *C* is a cast-iron plate bearing on the end of the thimble, with the central hole large enough to clear the rod. A gunmetal ring, *D*, which is drilled to clear the piston-rod, rests on a ring of $\frac{3}{8}$-inch round rubber placed in the bottom of the old box. The faces of the ring and the new box, which are in contact, are carefully faced true, and afterward ground together to make a steam-tight joint. JOHN PEDDIE

Southland, New Zealand.

PRINTING THROUGH THICK DRAWING PAPER

A man working in a drafting-room is sometimes called upon to make blueprints from drawings that are inked on heavy paper, such as patent office drawings. Now, if a print is made in the usual way, by putting the paper face down in the printing frame, placing the blueprint paper on top and printing through it, the thick paper separates the inked lines from the blue paper and allows diffused light to get under and blur the print.

Now, if the paper is turned over so that the inked lines come in contact with the blueprint paper, it makes a good

print, but it will be a negative. However, if thin blueprint paper is used and the back of that put next to the inked lines, you only have the thin paper between the inked lines and the chemical surface, so that a good print is made, which will be a positive. AUSTIN G. JOHNSON

Two Harbors, Minn.

EXPANSION MANDREL FOR TURNING CONES

We had a large number of four-step cones to turn up on the lathe, and in order to save time and expense, I made them in the following manner:

The diameter of the steps were 4½, 6, 7 and 9 inches, respectively. The bore was 1⅛ inch, and the bearing 4 inches long, which leaves the two larger steps without any support, as shown at *A* in Fig. 1. This made it difficult to turn them up without bending the mandrel. An expansion disk, as shown at *B* in Fig. 1, was made. This disk had six slots,

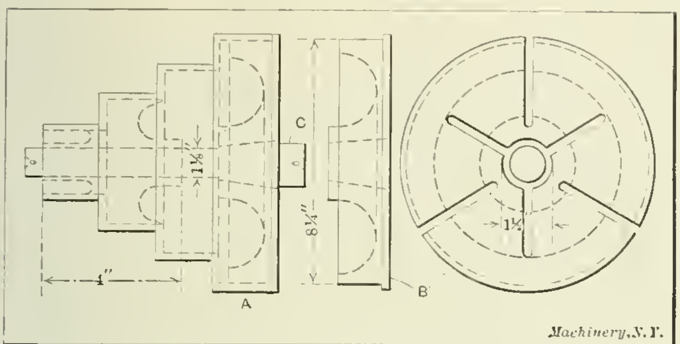


Fig. 1. Details of Expansion Mandrel and Disk for Turning Cones

three extending to the edge. The hole was bored, and tapered ⅝ inch to the foot, the largest diameter being 1½ inch. The outside diameter of the disk was turned to fit the inside of the largest step of the cone. A mandrel was then made, as shown at *C*, and turned to fit the bore of the cone and the taper in the disk. By driving this mandrel into the disk, it expands and grips the inside of the large step, which makes it easy to turn the cones. The mandrel has a feather peened in the tapered part, as shown at *A*, in Fig. 2, which fits one of the three slots in the disk. In this way the mandrel has no chance of slipping in the cone. By using this expansion disk, about twice as many cones were turned out in a day as by using a common 1¼-inch mandrel, and it also saved the expense of making and straightening so many mandrels. This

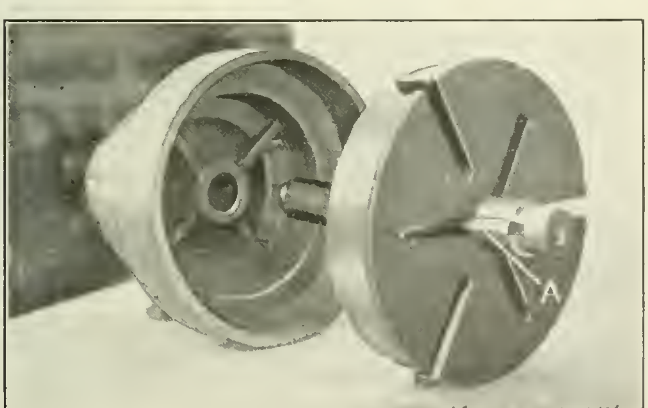


Fig. 2. View showing Manner in which the Disk is expanded

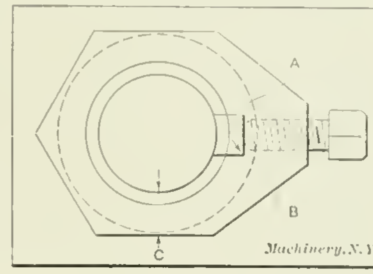
expansion mandrel allowed us to use a much higher speed and feed than was possible by using a 1⅛-inch mandrel.

Salem, Ohio. L. J. GETZ

AN EFFICIENT LOCK NUT

Having seen from time to time a great variety of lock nuts described in MACHINERY, I wish to add one more to the collection, which I believe to be new to many designers. It is one which has been successfully used, and has never been known to let go or work loose. The way in which this nut is made is as follows:

The key (or feather) *A* is fitted into the nut before it is bored to the finished size or threaded. After the key is inserted the nut is bored to the finished size and tapped, which also cuts a thread in the key, so that when it is screwed onto the shaft and the set-screw is tightened, it will not bruise the thread. When designing this nut it is advisable to make the part indicated at *B* as thick as the part indicated at *C*. A special wrench is generally made for this nut, but where one is not at hand an ordinary wrench can be used. H. E. WOOD



A Simple and Effective Lock Nut

Newark, N. J.

HEIGHT GAGES FOR INSPECTING

Some years ago I made two gages for testing milling fixtures and drill jigs having working faces and bushing holes in such places that it was impossible to measure with the ordinary height gages in use. The two gages were used in conjunction with each other—that is, the testing gage shown in Fig. 1 was used on the work, and the measurement recorded on the gage shown in Fig. 2. The long arm with the multiplying levers on the testing gage (Fig. 1) is brought into contact with the surface or hole to be inspected, and by adjusting the nut *C* a proper reading at *B* is noted. This arm is now brought into contact with one of the steps *A* on

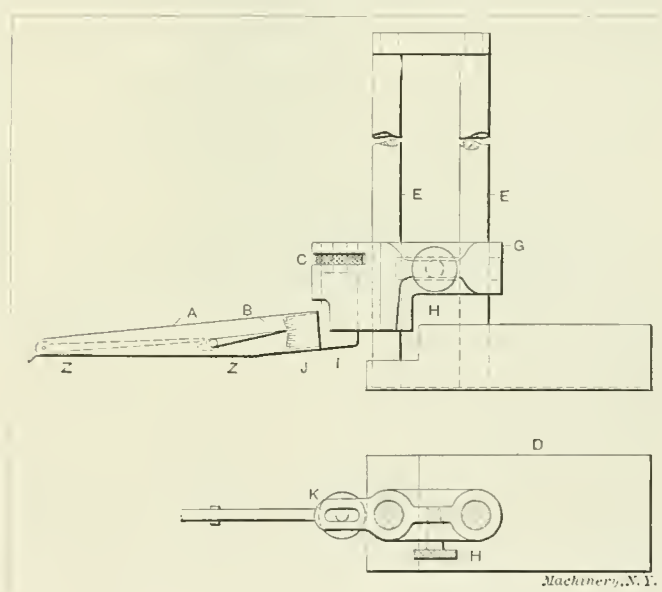


Fig. 1. Testing Gage used in taking Measurements

the recording gage (Fig. 2), and the barrel *B*, which was previously set to zero, is now turned until the testing gage registers the same as on the work. The reading which is noted will give the height from the base of the recording gage.

The testing gage shown in Fig. 1 consists of a tool-steel base *D* having two shafts *E* fastened to it and connected at the top by a link. On these shafts the sliding member *G* is operated, and can be locked securely in any position by means of locking screw *H*, which acts upon two clamping bolts. This method of clamping obviates all springing and is positive.

The adjusting nut *C* operates the part *I*, which is carefully fitted in the slot. On this same part is a shoulder at *J*, to which is fastened the arm *A*. This arm is made from tubing and formed similar to the opening at *K*. The part *A* is made a tight fit at *J* on the part *I*, and a pin put through to fasten it securely. This oblong tube *A* is now cut along the line *Z*, *Z*, and inside of it are placed the levers which are arranged to

give a reading of one-half thousandth of an inch. This gage has a wide working range, and can be applied in some very small places. Its usefulness as an accurate testing instrument has convinced the writer and others that it is a valuable addition to the tool-room equipment.

The recording gage shown in Fig. 2 is made accurate and tested thoroughly. The base C is of tool steel, having a stud E driven in perfectly square with the base. On this stud a sliding member D is operated by means of the barrel B. A good fit must be made at f, f to insure against lost motion when turning B. The hub end of D is provided with an internal thread, which is 40 threads per inch, to fit the threaded part on the barrel B. This hub is split and a threaded ring P is fitted on the outside, which is also threaded and slightly tapered, so that proper adjustment can be made for back lash

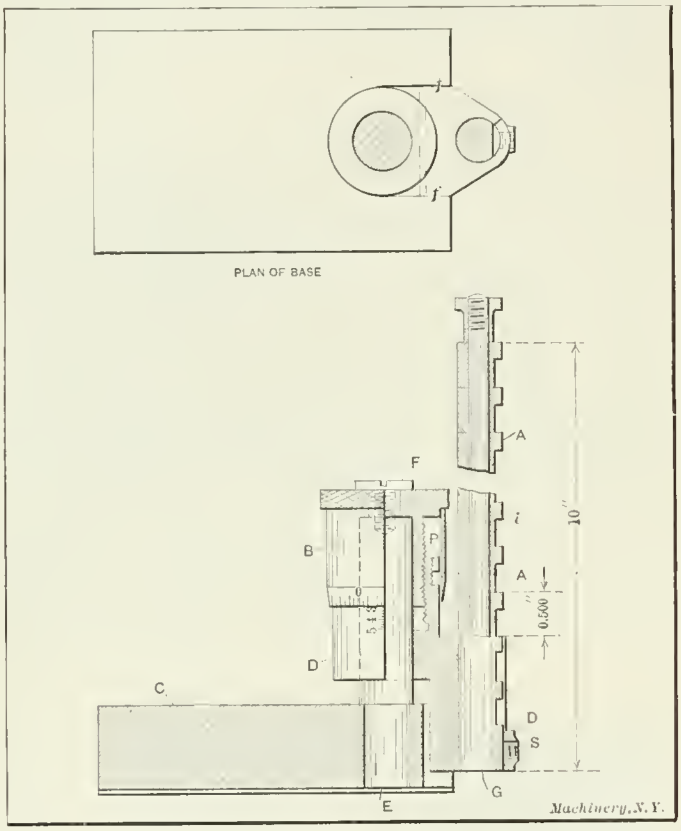


Fig. 2. Gage on which Measurements as taken by Testing Gage are recorded

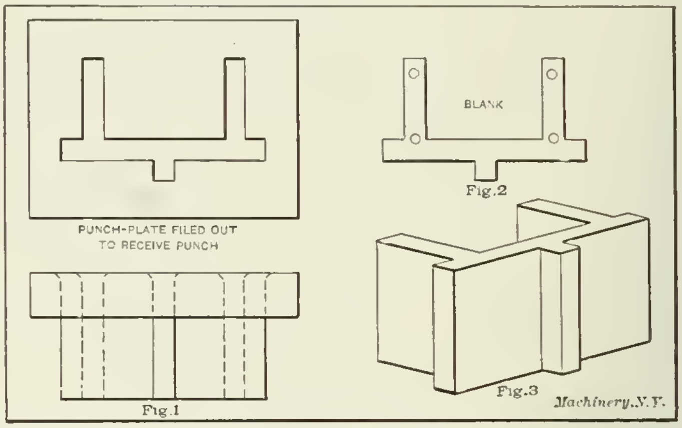
in the thread. The stud E is of tool steel, hardened and ground, as is also screw F. The shaft G is also hardened and ground, and the steps or bushings A are made as accurately as possible, the length being exactly one-half inch. Provision is made at i so that the pointer on the testing gage can rest properly on the ledge. The shaft G is fastened to D by means of set-screw S. In assembling the shaft and bushings care should be exercised in tightening the nuts so as not to spring them. A. C. Lindholm

New Haven, Conn.

REMARKS ON OUT-OF-DATE DIE-MAKING METHODS

I have read with much interest the article on "Out-of-Date Die-Making Methods" by F. E. Shailor, in the June number of Machinery, and while I agree in general with his conclusions, I think he is unduly severe in his criticism of the two particular methods of securing the blanking punch to the punch plate, which he has singled out for attack, and which he calls "out-of-date methods."

It is quite true as Mr. Shailor says, that these methods are still in use in "some large (up-to-date) ? factories," and I prefer to believe that there are reasons for this, other than that of ignorance of what Mr. Shailor calls "an improved method." In fact, I have seen both methods used at the same time in the same shop, with honors about even. For the sake of distinction, we will call the method shown in Figs. 1, 2 and 3 the "old method" and that shown in Fig. 4, the "new method." Let us first look at the objections raised to the "old method." The first objection raised is the difficulty of filing out the punch plate to fit the punch exactly. In speaking of this, Mr. Shailor says, "We know that a plug and ring gage will 'shake' if there is a difference of 0.0001 inch. Can we expect to file perfectly straight and within one-tenth



Figs. 1, 2 and 3. Objectionable Method of Attaching Punch to Plate (Taken from "Out-of-Date Die-Making Methods," by F. E. Sheilor, in the June issue)

of a thousandth?" In this, Mr. Shailor has let his zeal get the better of him. If it is true that one-tenth of a thousandth inch too small will make a plug and ring gage "shake," it is also true that one-tenth of a thousandth inch the other way will make a tight fit, so that the argument works both ways. But it is not necessary to file this style of punch plate either perfectly straight or to a "tenth of a thousandth," for the hole in the punch plate may be made slightly tapered and sufficient material left on the punch-plate end of the punch to make a tapered fit, and the punch may be driven or pressed home after the working end has been hardened; after which it may be riveted over into the countersunk edges of the punch plate and planed off flush with the plate. In this way a fit may be secured which will be of equal rigidity to the "new method." If anyone will take the trouble to calculate the area of the bearing surfaces which come in contact with the

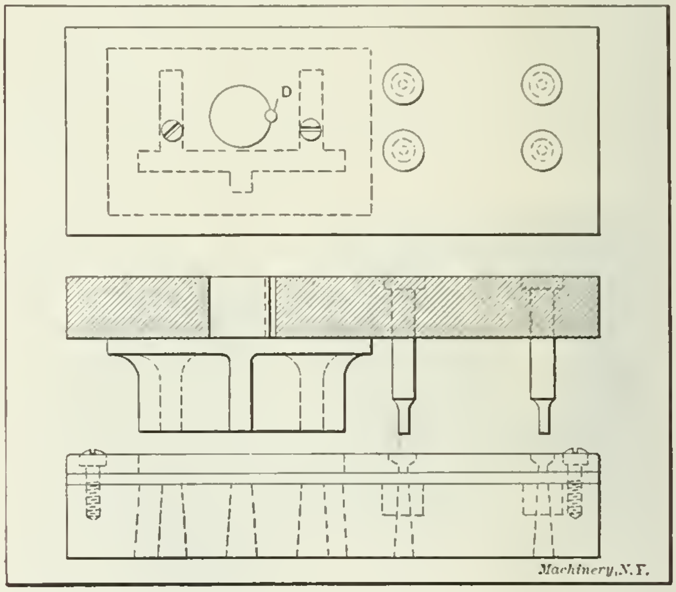


Fig. 4. Punch Attached to Holder so as to obtain Greater Rigidity and Durability (Taken from "Out-of-Date Die-Making Methods," by F. E. Sheilor, in the June issue)

punch plate in this inserted method of holding the punch, I think they will find that it is equal to the area of the average base used with the "new method."

One advantage which the "old method" has over the "new method" is the ease with which the punch may be machined. With the "old method," the punch may be held in the jaws of the shaper or milling-machine vise and milled or shaped across the entire length of the punch. This is quite a consideration in small shops where there is no milling machine; but even where there is the full equipment, the "old method" punch is easier to machine than the "new method"

punch, which has to be worked out on the milling machine with end mills and various shaped cutters, after which it is necessary to use the point of your file on account of the radius left by the milling cutter.

Another great advantage of the "old method" is that the punch has more wearing surface. The working part of the punch extends close up to the punch plate so that the punch can be used until it has become so short, that the punch plate strikes the stripper before the punch engages the die. This cannot be done with the "new method," owing to the space taken up by the base and radius of milling cutter.

Still another advantage of the "old method" is that the punch can be made short to obtain greater rigidity and still have as much wearing surface as a much longer punch made by the "new method." This is a great advantage where very

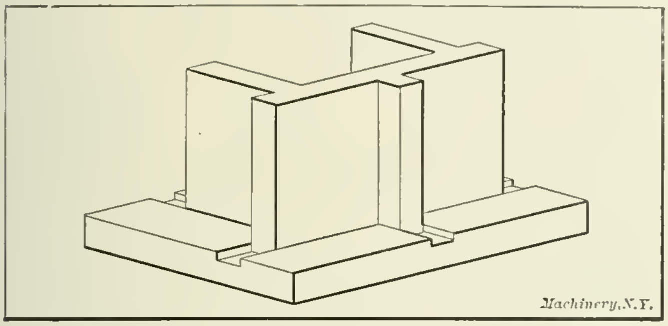


Fig. 6. Another Objectionable Method of Attaching Punch to Plate. (Taken from "Out-of-Date Die-making Methods," by F. E. Shailor, in the June issue

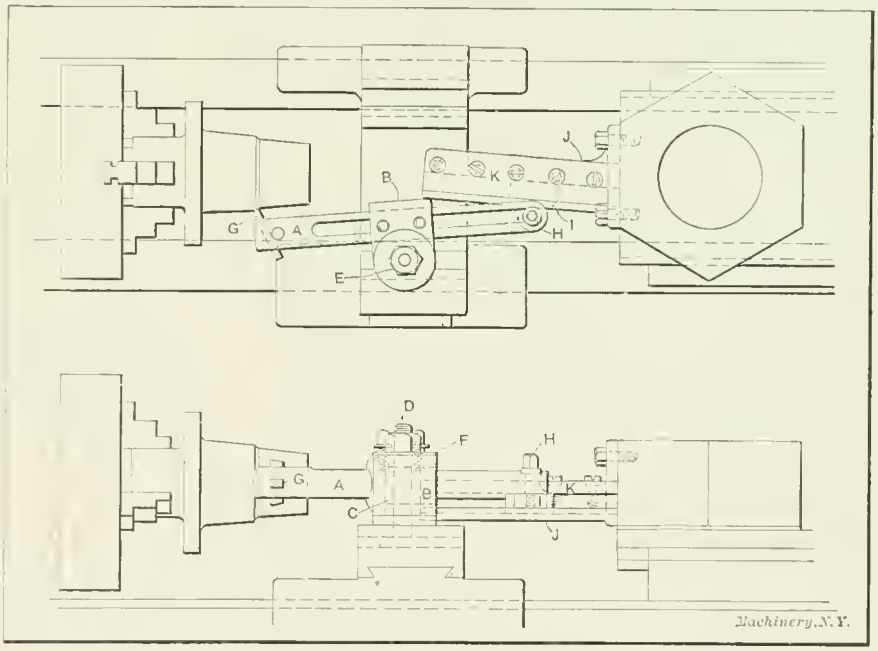
small piercing punches are used with the blanking punch, because the piercing punches may be made shorter also, and therefore more rigid and less likely to break.

We fail to see any difficulty in transferring the holes for the piercing punches from the die to the punch plate. To turn the die upside down on the punch plate and use the piercing die as a drill jig is a sure way to invite trouble, and is certainly an out-of-date method. It is not necessary to do it in this way. A much better way is to first transfer the dowel pin holes (used to hold the die in position on the die block) from the die to stripper and punch plate. Next place the die on the faceplate of a lathe, clamp lightly, and indicate the hole to be transferred with a center indicator, and then clamp it tightly. Next place the dowels in the holes and then place the punch plate on the dowels, with the punch inserted in the die, and clamp it on parallels sufficiently high to prevent the punch plate from coming in contact with the clamps holding the die. Now drill and bore the hole in the punch plate and it will be found exactly in line with the indicated hole in the die. Then remove the punch plate, leaving the die set as before, place the stripper on the dowels in the same manner, and drill the same sized hole through the stripper. Next remove the stripper and move the die so as to bring another hole central; get it running perfectly true and then transfer to stripper and punch plate as before. Continue this process until all the holes have been transferred, and you will have a die that will be in perfect alignment and it will not be necessary to knock over any of the piercing punches.

Fig. 6 in Mr. Shailor's article is styled "another objectionable method of attaching the punch to the punch plate." A punch is shown, set in grooves in the punch plate and presumably fastened by screws through the plate. Your readers are asked to imagine a punch one inch long and one-half inch wide, made in this way. Now, we are ready to admit that a punch of those dimensions would be a complete failure if attached to the punch plate by the method objected to; but this does not prove that the method is without merit. It only proves that it is not the proper method to use in this particular case. Suppose, on the other hand, the punch was one inch long and two inches wide, would not the weight of the "insufficient base" argument be somewhat decreased? A punch of these dimensions would have ample base without going to all the trouble of machining your punch so as to form a base. If all punches were made one-half inch wide and one inch long, then Mr. Shailor's argument would hold good, but of course that is not the case; therefore the argument fails. Then look at the simplicity of this so-called "objectionable method." See how easily the punch can be machined and how quickly, and therefore cheaply, it can be fastened to the plate, and above all notice the greater length of wearing surface, when this method is used, than can be obtained by the so-called "improved" method. We have then in this "objectionable" method the following advantages: simplicity, cheapness and maximum length of the working part of the punch. Surely these are things to be considered in the choice of a method of making a punch. The fact that punches made in this way have been relegated to the scrap heap by some manufacturers does not prove that they are without merit. It only proves that another method has been found to be better adapted to their particular class of work.

The writer's private judgment is, that no fixed rule can be laid down, but that one must be guided by circumstances. He should adapt his method to the class of work to be done and should consider the character and quality of the work to be done, the quantity to be done, and the cost of making the tool. I believe it is this fixed method idea of making punches and dies that oftentimes runs the cost up so high, and causes a great deal of trouble in the press-room.

In conclusion, let me say that in these days when so many thousands of minds are concentrated upon the problems of punch and die work it is, to my mind, impossible with any degree of certainty to decide who is the originator of any particular method, unless it is a patented method or process. To say that this or that method originated at any particular



Elevation and Plan of a Taper-turning Attachment for Turret Lathes

place is equal to saying, "I know the methods used by every maker of punches and dies in the world. Therefore I know that this method originated with Mr. So and So." I sincerely hope that these criticisms will be taken in the spirit in which they are given.

WILLIAM BROWN

Frankford, Pa.

SPECIAL TAPER-TURNING ATTACHMENT

A large number of valve bodies for gas engines had to be bored and turned, and the job could be done economically on a turret lathe, with the exception of the outside taper. As there was no taper attachment on the machine, it looked at first as if the taper turning would necessitate a separate operation in a center lathe, and consequent increase of cost. The outcome of some consideration of the subject is shown in the

accompanying sketch, which illustrates the attachment for turning the taper in the turret lathe. It might be well to mention that the taper was not an important one, it being done merely to give a finished appearance to the engines.

The device consists of a bar *A*, 1¾ inch in diameter, held by set-screws in the desired position in the steel holder *B*, which swivels upon the steel bushing *C*. This bushing is bored to fit the bolt *D* which holds it firmly in place, and it is made of sufficient length to allow the holder *B* to swivel without shake when nut *E* is screwed tight.

The turning tool *G* is held at one end of the bar, and the other end is flattened and drilled to receive the coller screw *H*, which attaches it to the guide-block *I*.

Attached to the face of the turret is a casting *J* having a groove in it which is at about the same angle to the turret face as the taper it is desired to turn. Into this groove fits a tongue on the guide-block *I*, and the top plate *K*, fastened by five screws, forms a slide along which the guide-block moves when the carriage is fed along the lathe bed (the turret being fixed) thus causing the tool *G* to recede from the work as it is being fed towards the chuck. The requisite adjustment of taper is obtained by altering the distance between the cutting tool and the swiveling block; that is, by loosening the set-screws and sliding the bar farther out or in, a taper is obtained more or less steep according to requirements.

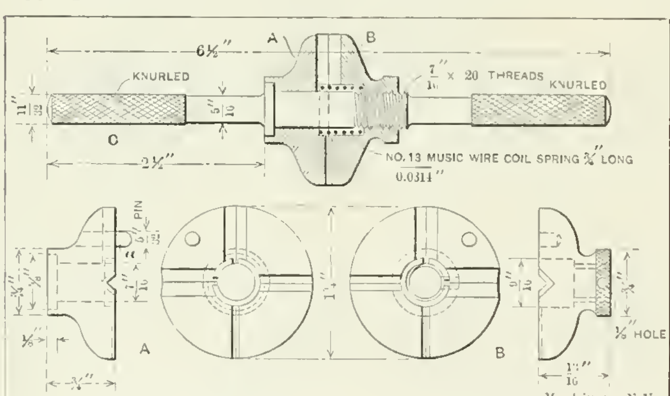
The other five faces of the turret are, of course, set up with tools for the boring operations. The device is detached from the tool-slide for every valve body machined, by loosening the nut *E* and removing the screw *H*.

This device does the work in a very satisfactory manner and has now been in use for some years. G. H. Gibbs

Loughborough, England.

A TOOLMAKER'S TAP WRENCH

The accompanying illustration shows a very useful and efficient tap wrench for tapping holes varying from 1/16 to 3/8 inch in diameter. This wrench is especially adapted for tapping very small holes, as it is not necessary to apply any pressure to force the tap into the work on account of the weight of the segmental holders *A* and *B*. All that is necessary when tapping a small hole is to grip the knurled ends of the handle



An Efficient Tap Wrench for Toolmakers' Use

C lightly in the fingers, keeping the tap vertical and turning it slowly.

To give good results, this tap wrench should be made so that it will balance when tapping; and when made in this manner it will be found to be very efficient for small and delicate work especially. The holders *A* and *B* have four grooves in each, which when brought together form squares varying from 1/16 to ¼ inch; where a greater range of holes is necessary, six or more grooves may be cut in each segment to suit the requirements. The segment *A* is held in the correct location with *B* by the pin *a*. A small coil spring is inserted as shown, which keeps the part *A* up against the shoulder and also tends to separate the two segments, facilitating the insertion of the tap.

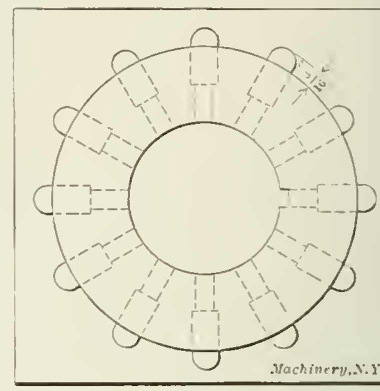
This holder can also be used as a small hand chuck for holding drills when drilling in the lathe, as the grooves are diametrically opposite, enabling one hole in the wrench to be placed on the center of the lathe similar to an ordinary hand chuck. A small 1/8-inch hole is drilled in the part *B* so that it may be screwed up to hold the drill firmly.

The segmental holders are made from tool steel, as is also the handle *C*. The parts *A* and *B* should preferably be hardened to prevent wear. The proportions given in the engraving will be found ample for taps varying from the smallest size up to 3/8 inch. G. Murray

WHAT IS MODERN PRACTICE?

In the July number of Machinery, L. Rosenthal asks "What is modern practice?" I am afraid that if we should ask a number of machine shop foremen this question, we would get a different answer from each of them. For my part, I would like to have these men send in their answers, as this is a very interesting question.

"Modern practice" as far as the machine shop is concerned, is the doing away of all hand work as far as possible, and by doing the work on machines, using high-speed steel cutting tools, and seeing that the proper speeds and feeds are used in the manufacturing department and toolroom. I might add that machine operators are taking the place of the toolmaker at the machine, leaving him to do what hand or bench work is required, and which cannot be done otherwise. These machine operators doing the machine work cheapen the job, and, being constantly at one machine, they become very proficient.



Modern Method of Making Male Embossing Rollers

We all know that hand work is slow, and if the work must be accurate we might have to put a first-class toolmaker on the job, thereby increasing the cost. To make my point clear, let us take the two rolls which Mr. Rosenthal made, and do away with the time he spent laying out the holes in the female roll, and laying out and filing the projections on the male roll, and see if by omitting all the hand work, we cannot give the customer as good a job and at less cost, and at the same time, prove out my answer as to "what is modern practice."

Referring to the illustration in Mr. Rosenthal's article, it will be seen that the male roll was made solid and that all the projections were first made square by removing the superfluous material between them in the shaper, and then filing them to shape. Now, the filing took considerable time, and if we can get away from this, we will accomplish the job in a modern way.

To proceed with the modern method we will first give the stock to a lathe hand who will bore the hole, face, and turn the outside diameter of the two blanks, making them both the same size. Then we will give the rolls to the milling machine hand, who, putting the male roll on an arbor, will set it on the centers, using the dividing head to space and drill each hole to the same depth, making the holes a driving fit for the drill rod pins, which have been formed on one end and cut off 3/16 inch plus the depth of the hole in the roll. This roll will have at least one advantage over Mr. Rosenthal's, because if one or more of the pins should break, we could drive the broken pin out and replace it without annealing the roll, as is clearly shown in the accompanying illustration. The blanks are now ready for hardening, after which an apprentice can assemble the pins and hand the job in as finished.

I have worked in several shops and have met the "old timer" with his "old-time" ways of doing certain jobs, and being a "modern practice" school graduate myself I have found their ways very interesting though slow. In my opinion "modern practice" is doing away with as much hand work as possible, and having machine operators do the machining.

Harrisburg, Pa. E. L. Pickering

PLATE FOR INDEXING IN DEGREES

At one time it became necessary to affix an indexing plate to one of our machines so as to be able to set a pointer at any one of the 360 degrees of a circle. The ratchet *A* was not large enough to allow cutting 360 teeth in it, as these teeth had to withstand a moderate straining due to a flat coiled spring not shown in the illustration. Accordingly 120 divisions were provided in the ratchet and the pawls *B* were made so that they differed in length by 1/3 the distance between two of the ratchet teeth, or in other words by 1/3 the pitch of the teeth. The action of the pawls is, therefore, consecutive; No. 1 first engages the ratchet, then if the pointer is moved 1/360 of a revolution, or one degree, No. 2 engages and so on. The pawls are kept in engagement with the ratchet by means of the flat steel springs *S*, as shown. The whole fixture is supported on the plate *F*, which is part of the machine. F. B.

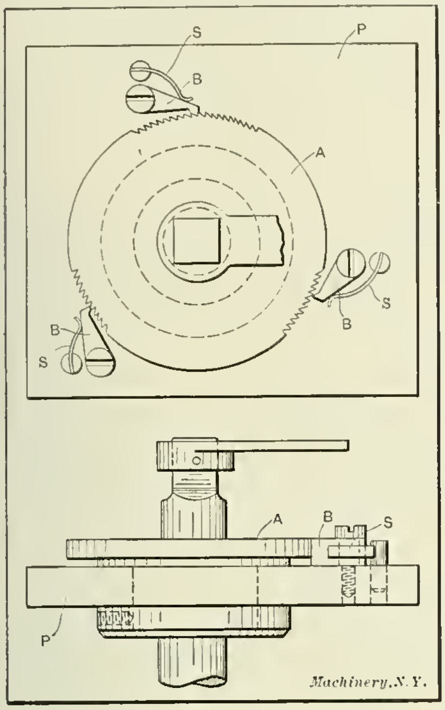
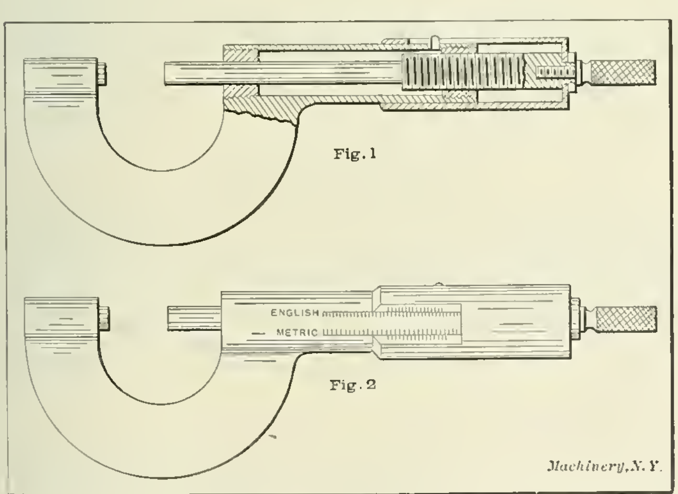


Plate which, by the Aid of Pawls of Unequal Lengths, indexes to Degrees

MICROMETER FOR READING DIRECTLY VARIOUS SYSTEMS OF MEASUREMENT

Mechanics have doubtless often realized the need of some precise measuring tool that would show various systems of measurement in their relation to each other, so that English measurement could be converted to metric, fractional parts to decimal parts, wire gages or rolling mill gages to parts of an inch or millimeter, drill gage sizes to fractional or decimal parts of an inch or millimeter, or, in brief, any desired system of measurement in proper relation to any other. Of course, the caliper square fulfills to a limited degree such a requirement, as some of these tools are so graduated that either English or metric measurements may be read directly. To make it possible to read various systems of measurement, I designed the universal sliding micrometer shown in the engraving.



Figs. 1 and 2. Universal Sliding Micrometer which may be graduated with Various Systems of Measurement

This micrometer is designed along the principle of the ordinary micrometer in combination with a sliding caliper. It consists, as may be seen in the sectional view Fig. 1, of a body and barrel, a sleeve, and an operating screw. The action of the measuring bar is practically the same as with the ordinary micrometer, but the sleeve of this tool, instead of rotating, slides along the barrel, any rotary movement being prevented by a small pin which engages a longitudinal guide slot that is parallel to the axis of the screw. This sleeve has a concentric bore at its end, which fits a shoulder on the screw body and it is held in place by a nut that is adjusted so as to permit a free rotation of the screw in the sleeve without any play. It will thus be seen that by operating the screw, a longitudinal motion is imparted to the sleeve. It is therefore immaterial what the pitch of the screw is, as in this case it serves simply to move the sleeve along with it. The position of the micrometer spindle with relation to the anvil, is determined by a scale on the barrel and a vernier scale on the sleeve, as illustrated in Fig. 2. Thus the barrel serves the same purpose as the beam of the caliper square and the sleeve acts as a vernier scale. It will be seen that this construction allows the micrometer to be designed for measuring according to a number of different systems, which are shown in their correct relation to each other. The zero mark, of course, coincides for each system of graduation on the micrometer, and the barrel can be made of any suitable diameter to permit the easy reading of the graduations. MAX MUNZNER

Newark, N. J.

SIMPLE TABLES FOR CALCULATING CIRCUMFERENCES AND AREAS OF CIRCLES

The simple tables given herewith may be used for calculating the circumference and area of circles without multiplication. The first table for the circumference of circles gives the value of π for diameters from 1 to 9 inclusive. To use the tables for larger numbers, proceed as follows: Suppose the circumference of a circle 32 inches in diameter is required: Change the decimal point of 9.4248 one place to the right and underneath write the value of 2 taken from the same column. The sum, or 100.531, is the circumference for a circle 32 inches in diameter. In the same way, the circumference of smaller or larger diameters can be obtained by simply changing the position of the decimal to the left or right according to the number of places. In the case of a number having four places, four numbers will be added. Example: Find the circumference of a circle 3,486 feet diameter.

Circumference for diameter.......	3,000 = 9424.8
Circumference for diameter.......	400 = 1256.4
Circumference for diameter.......	80 = 251.3
Circumference for diameter.......	6 = 18.8
	10951.3

The table for finding the areas of circles is used in the same manner except that the diameter of the circle must first be squared and then the areas taken from the table and added as directed for obtaining the circumferences. Example: $12^2 = 144$.

Area for diameter................	100 = 78.54
Area for diameter................	40 = 31.416
Area for diameter................	4 = 3.1416
	113.0976

Circumferences of Circles

$1\pi = 3.1416$	$6\pi = 18.8496$
$2\pi = 6.2832$	$7\pi = 21.9912$
$3\pi = 9.4248$	$8\pi = 25.1328$
$4\pi = 12.5664$	$9\pi = 28.2744$
$5\pi = 15.7080$	

Areas of Circles

Area diameter.... 1 = 0.7854	Area diameter.... 6 = 4.7124
Area diameter.... 2 = 1.5708	Area diameter.... 7 = 5.4978
Area diameter.... 3 = 2.3562	Area diameter.... 8 = 6.2832
Area diameter.... 4 = 3.1416	Area diameter.... 9 = 7.0686
Area diameter.... 5 = 3.9270	

Roxbury, Mass. LOUIS F. LANG.

[The same expedient may be profitably employed for transforming English and metric measures.—EDITOR.]

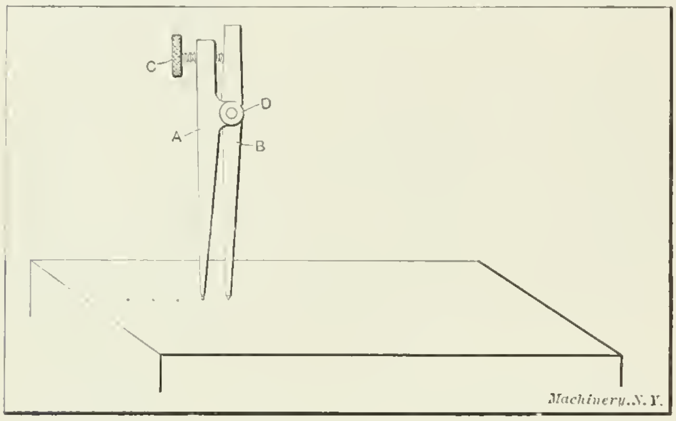
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

COMBINATION DIVIDER AND PRICK-PUNCH

A handy combination divider and prick-punch for laying out evenly-spaced holes on a die or similar work, is illustrated herewith. A divider leg *A* and a prick-punch *B* are combined. These may be adjusted by the screw *C*, and clamped by the nut

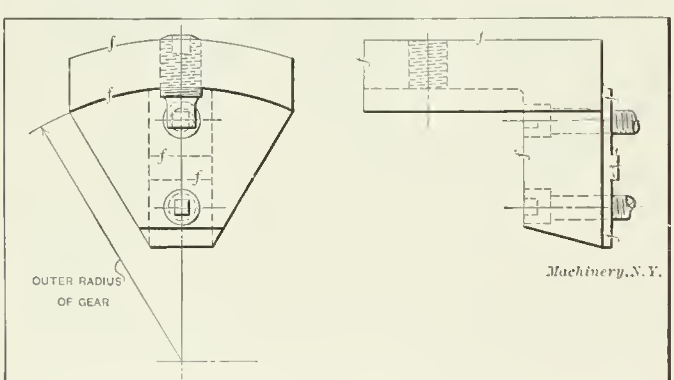


D. Obviously, only a light hammer blow should be used on this tool as it is intended for merely laying out holes accurately. The marks should afterward be enlarged by a heavier prick-punch. This tool might be improved by the addition of a spring hammer attachment similar to that used on a B. & S. prick-punch. CHARLES WESLOW

Buffalo, N. Y.

CHUCK JAWS FOR GEARS

The accompanying engraving shows two views of a chuck jaw that has proved very satisfactory for heavy turret lathes. It is sometimes hard to hold large cast gears while boring, facing and turning the hubs in a heavy turret lathe, but by using this design of jaw I find that large cast gears can be machined with good results. These jaws are attached to the plain jaws of a three-jawed chuck by screws. One jaw is fitted



with a large screw as shown, which acts as a driver, by engaging a tooth space. The broad face with a radius to fit the outside of the gear teeth insures the gears being bored true in relation to the teeth, and at the same time provides a method for securely holding heavy work.

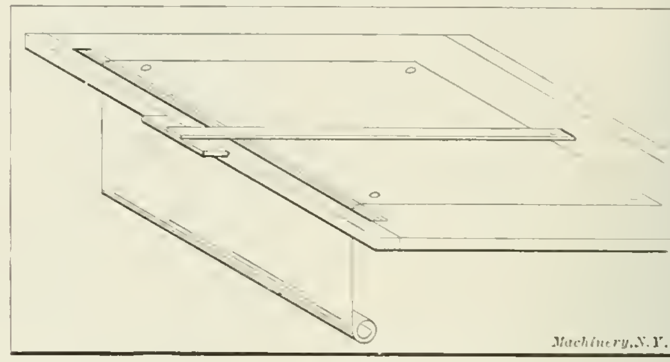
JIG AND TOOL DESIGNER

PREVENTING TRACINGS FROM STRETCHING

Every draftsman is more or less familiar with the tendency of tracing cloth to stretch and wrinkle, especially on damp days. The common method of working in one direction on the tracing and taking up the slack from time to time does not always prove satisfactory. To obviate this the following method was adopted: A couple of ordinary incandescent lamps with shades attached were hung over the drawing, the heat generated keeping the cloth in fine shape, and by moving the lamps from place to place over the drawings, the job was accomplished with less trouble than formerly. F. B.

DRAWING-BOARD FOR LARGE DRAWINGS

As there were a lot of long drawings to be made and no large board or T-square handy, some scheme had to be devised for working on them. I removed one strip from the side of a board that happened to be a castaway, and cut out a space that would allow the drawing to pass between the strip and the board proper. The upper corner or edge of this notched part was then rounded so that the tracings would not be

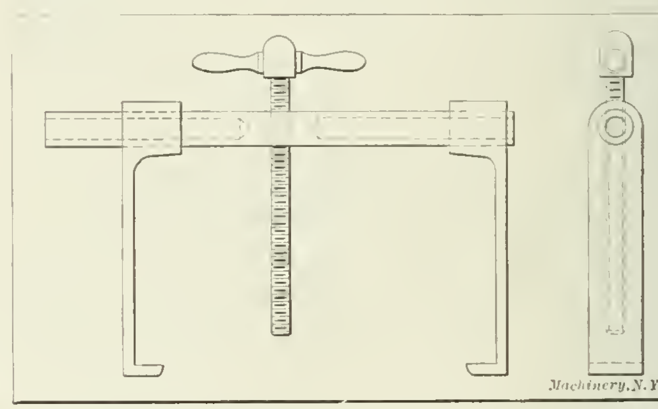


creased. The strip was then re-nailed in place, thus making a board similar to the one shown in the illustration, which became the most useful board we had.

Wilkinsburg, Pa. D. F. HUDDLE, JR.

DIEMAKERS' CLAMP

The accompanying illustration shows a clamp which was made by Leo Hill of Sargent & Co., New Haven, Conn. This clamp was made from a piece of cold-rolled stock with holes drilled in each end to lighten it. The two clamping strips

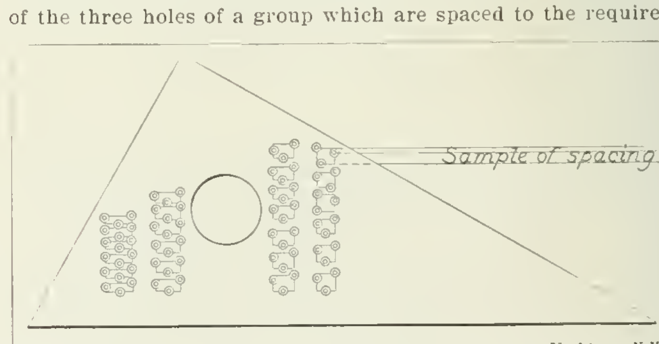


are made a good sliding fit on the rod and can be adjusted to the distance required. This clamp has been found very efficient for diemakers' use. JAMES FRASER

Marshallton, Del.

LETTERING TRIANGLE

A sixty-degree lettering triangle is shown in the accompanying illustration, which is provided with a number of taper holes in groups of three each, that are used for drawing guide lines of different types for lettering. When guide lines are to be drawn, the pencil point is inserted successively into each of the three holes of a group which are spaced to the required



height, and the triangle is moved along the T-square. By having these holes tapering, it is easier to insert the pencil point in them and the pencil can also be inclined at a considerable angle without danger of breaking the point.

Braddock, Pa. A. C. COCHRAN

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

LUBRICANT FOR SMALL OIL-STONES

As a lubricant to use on an oil-stone, for honing-out dies or other similar work, kerosene oil gives the best results as it not only enables the stone to "take hold," but also keeps it clean and prevents it from filling up. C. F. Emerson

TO REMOVE DRIED OIL

To remove dried or gummed oil from finished machine surfaces, try the paint and varnish removers sold by the painters' supply stores. They work admirably, if applied with a stiff brush, dissolving the hardened oil easily.

Norwich, Conn. George W. Armstrong

TO WATERPROOF CEMENT

To waterproof cement, apply a finishing coat of cement mixed with sour milk to the consistency of paint. The curd of the milk fills the interstices of the cement making it proof against water seepage. Certain colloids or clays also may be used with success. M. E. Canek

INCREASING DURABILITY OF WELL-PLUNGER LEATHERS

The durability of the leather cups that are used on deep well plungers as packing, is greatly increased if they are dipped in hot paraffine before being used. When treated in this manner they do not harden and crack as soon as otherwise. John B. Sperry

Aurora, Ill.

OXIDE OF LEAD AS A LUBRICANT

The best lubricant for lathe and grinder centers is a mixture of powdered red lead (oxide of lead) and lard oil. When using this lubricant, if the oil dries out the centers do not cut, but simply take on a high polish. This mixture also works well for thread cutting, and a much smoother thread can be cut in tool steel than with plain lard oil. John B. Sperry

Aurora, Ill.

WORN MACHINERY OIL SUBSTITUTE FOR LARD OIL

In a parsimoniously conducted shop, the management refused to furnish lard oil for cutting purposes. The men discovered an efficacious substitute in the machinery oil that had been through the line-shaft bearings. The old oil which was removed from the drip cups, proved an excellent lubricant for threading, etc. Geo. W. Armstrong

Norwich, Conn.

VALVE GRINDING MIXTURE

The following mixture will be found very good for the grinding of valves in gasoline and steam engines or for those used on steam, gas or water pipes. Take one pound of vaseline and into it thoroughly mix about two tablespoonfuls of the number of emery that is to be used. Care should be taken to have the proportion of emery to vaseline the same as that given, as too much emery does not work so well.

Indianapolis, Ind. J. B. Kemp

COMPOUND FOR LEAKY PIPE CONNECTIONS

In automobile work it is often difficult to keep intake pipes, carburetors or water connections from leaking. In cases where a paper gasket has been used, the following compound will be found very good, as it will stop all leaks and make the use of the paper gasket unnecessary. Into one pint of shellac thoroughly mix three tablespoonfuls of dry red lead in powder form. If the shellac seems too thin after the red lead is mixed into it, leave the contents exposed to the air until of the desired consistency. J. B. Kemp

Indianapolis, Ind.

ANNEALING NOVO STEEL

In annealing some Novo steel cutters I heated them to a white heat and buried them in charcoal, but on trying to recut the cutters I found them to be very hard, being almost as hard in fact as before annealing. The job was put aside and later it was turned over to another workman who annealed them as follows: The cutters were heated to a yellow heat and then cooled to a dull red, when they were rubbed with yellow laundry soap until they were cold, when they were found to be thoroughly annealed. W. C. Betz

New Britain, Conn.

LUBRICANT FOR LOW TEMPERATURES

Because of the congealing or thickening of the greases customarily used, the oiling of machinery, particularly that used in unwarmed places, is in winter sometimes difficult. Oils thinned with kerosene do not readily thicken or congeal. A combination of cylinder oil, kerosene, and graphite will stand a temperature several degrees below zero without losing its capacity for flowing freely. The cylinder oil and graphite should be mixed to the consistency of a thin paste, and this thinned by the addition of kerosene until it flows quite freely. B.

COMPOUND FOR CREAKY SPRINGS

As an automobile repair man, I have had a great many owners complain to me about their springs creaking. A mixture of oil and graphite is often used as a preventative, but its use does not improve the appearance of the springs if they are painted a light color, as the lubricant will continue to work out for a considerable time after its application. The compound obtained by the following recipe is the best that I know of for this and similar purposes: Shave, with a knife, about three pounds of beeswax and heat the wax until it becomes a liquid; then remove it from the fire and add from 1 to 1½ pint of either turpentine or wood alcohol. Stir the ingredients and then let the compound cool off; it can then be applied between the leaves of the springs with a brush. One coating or application of this compound will do for years and it will never show on the paint. J. B. Kemp

Indianapolis, Ind.

HOW TO BLUE STEEL SCREWS

First, see that the screws are made of steel, and not iron. Next, smear them over with a little common soap, which prevents them scaling. Then heat them to a dull red, and quench in water. If a screw-head tool is available, such as watchmakers use, put the screws into that, and with a piece of stone first, and afterward with crocus emery cloth, polish the head. Finish off with rouge on a buffing wheel and see that there is no grease left on the heads. Now take a piece of thin brass, drill some holes in it, and in these drop the screws —say half a dozen, and heat them over a lamp. Watch the color as it turns from yellow to purple and then to blue. The finest blue is just before it turns to a slate color. They must be heated very gradually or you will not be able to stop the color in time. The method has proved a success where the finest blue is expected. H. D. Chapman

Washington, D. C.

METHOD OF PREPARING TRACING CLOTH

I notice that Mr. Robert Lachmann, in the July issue of Machinery, speaks of the use of powdered soapstone and chalk for removing the greasiness of tracing cloth. In this connection I should like to mention that it is unnecessary to apply any kind of powder to the tracing cloth or paper. For some time past I have been using a piece of chamois leather to rub the paper or cloth, with perfect results. It seems to have an abrading effect, and a greasy surface that will not take the ink is instantly cured by a little rubbing with the chamois leather. A piece from 9 to 12 inches square is most convenient. It is gathered up loosely in the hand, and rubbed with a circular motion, as though polishing, applying considerable pressure. This method is handy for eliminating greasiness in any local spots on a tracing which has been touched by the fingers, as there is no powder or dust to brush away, or to get onto the inked lines.

Bath, England. Fred Horner

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

FARWELL AUTOMATIC GEAR-HOBBING MACHINE

The Adams Co., 840 White St., Dubuque, Ia., is now manufacturing the automatic gear-hobbing machine shown in the accompanying engravings. This machine, which is known as the No. 3, is much heavier than the No. 1 size that was described in the June, 1908, number of MACHINERY, and there are also a number of interesting changes in the design.

This larger size is intended for handling work up to 24 inches in diameter, and teeth as coarse as 3 diametral pitch may be cut. The head or saddle has an unusually long bearing upon the face of the column and it has sufficient travel to permit cutting a stack of gears having a face width of 12 inches. The spindle has no unnecessary overhang and it runs in adjustable bronze bearings of ample size and length, which are rigidly attached to the saddle, as may be seen by referring to Fig. 2. As this machine was designed for cutting coarser pitches than the No. 1 size, a slide has been provided in the side of the column in Fig. 1. A horizontal feed mechanism is incorporated in this new design that is employed when the machine is being used for cutting worm-wheels, as shown in Fig. 3. This is supplied without extra charge as is also the special support for the upper end of the work-arbor. This arbor support is only necessary when gears must be swung on centers, for wide-face gears, or when cutting a stack of gears of small diameter, as in Fig. 4. A more rigid support can be secured in other cases by the use of faceplates or rings which rest upon the table and support the blanks immediately below the rim.

As the engravings indicate, the spindle on this machine is driven by a universal-jointed shaft and bevel gears, instead of by a belt as on the smaller size. The 3-step cone at the rear is connected by bevel gears with the driving shaft which, in turn, transmits the power through bevel gearing to the hob spindle. This form of drive was adopted on this machine owing to the comparatively coarse pitches that it cuts, which

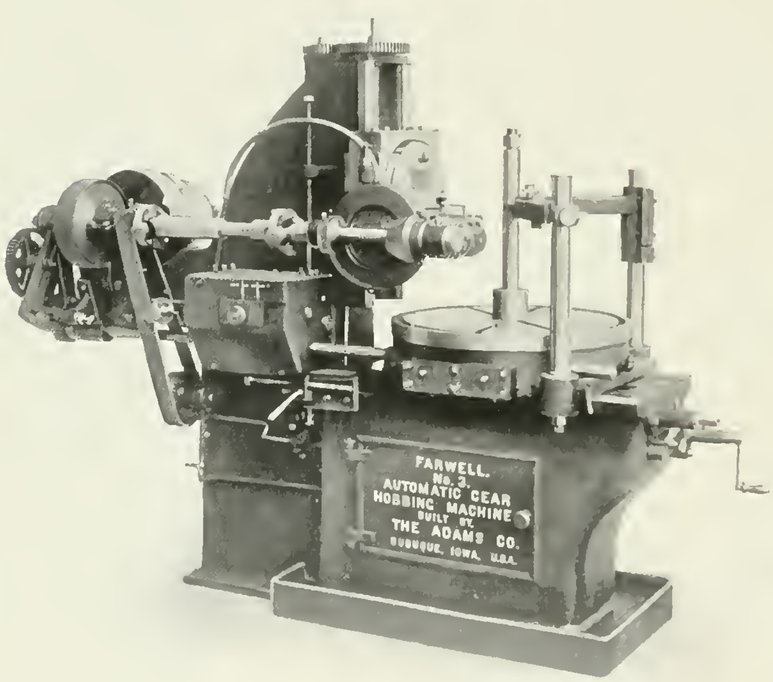


Fig. 1. Farwell Automatic Gear-hobbing Machine

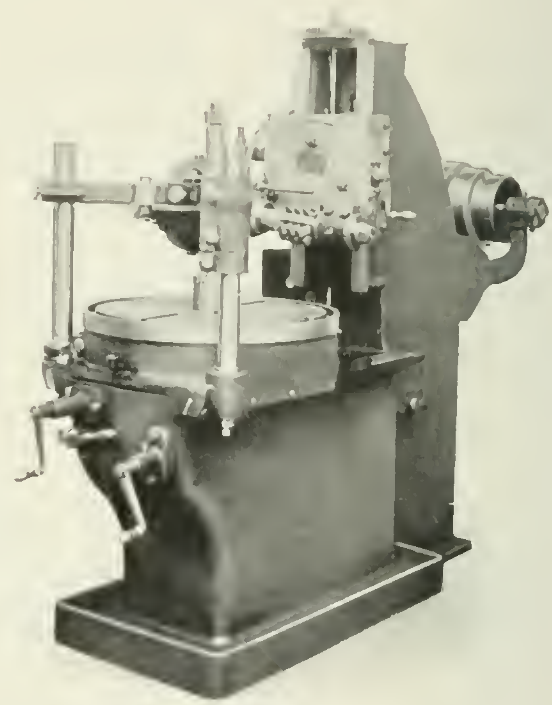


Fig. 2. Right Side of the Gear Hobber

saddle that carries the hob, thus making it possible to adjust the hob spindle longitudinally in order to bring any tooth exactly central with the work-arbor. The way the slide is mounted in the saddle and the method of adjusting it is plainly shown in Fig. 2. This longitudinal adjustment is quite important, as it aids materially in obtaining perfect gears in coarser pitches, but it does not require attention on fine pitches as the difference in the position of two succeeding teeth is not sufficient to be noticeable in the gears. The longitudinal movement of the spindle head also makes it possible to shift the hob quickly to a new cutting position without moving the hob with relation to the spindle or arbor. Several shifts or adjustments of this kind may be made so as to bring all of the sharp cutting parts of the hob into action before grinding it.

The head has an automatic trip to stop the downward feed, and it is also equipped with a power mechanism for raising the head after the cut is finished. The head, of course, returns but once for each stack of gears, and on the small machine this operation is performed by hand. There are two extra feeds on the No. 3 hobber, making a total of ten, all of which are obtained in the gear-box shown attached to the necessitates tilting the hob to a greater angle than the belt drive referred to would allow. This angular adjustment or tilting of the hob is necessary in order to permit the cutting of various pitches with hobs of a standard diameter, the use of special hobs when required, and the cutting of both worm and spur gears on the same machine.

The proper angle and also the tooth depth are obtained by means of a hardened steel gage as on the smaller machine. This gage makes the adjustment of the machine a comparatively simple operation, and it also insures accuracy. It consists of a piece tapered to the necessary angle for a certain pitch, and of the proper thickness at one end for setting the machine to the correct tooth depth.

The blanks are, of course, rotated during the hobbing operation, and the proper speed ratio between the hob and gear blank for various numbers of teeth is obtained by change gearing not unlike that on a lathe. These gears, which are mounted at the back of the machine, connect the hob-driving shaft with the one which transmits motion to the table. The speed ratio between the hob and blank is governed by the kind of hob used and the number of teeth required in the gear, it being necessary for the blank to revolve one tooth for each

revolution of the hob when a single-threaded hob is used, and two or three teeth when double- or triple-threaded hobs are employed.

All of the important bearings have bronze bushings, and spindle and arbor bearings may be adjusted by simply loosening a lock-ring and tightening an adjusting ring nut. The design of the base and column is exceptionally rigid, as these parts, as well as the knee below the table, are formed in one casting. An oil pan is also cast integral with the base, and enclosed in the latter is a large tank for holding the lubricant, which is forced to the hob by a small gear-driven pump that has means for regulating the amount of flow. All of the gears on this machine are provided with shields for the protection of the workman, as is also the universal-jointed shaft through which the hob spindle is driven. The weight of this machine is about 2000 pounds, or approximately twice that of the No. 1 machine referred to.

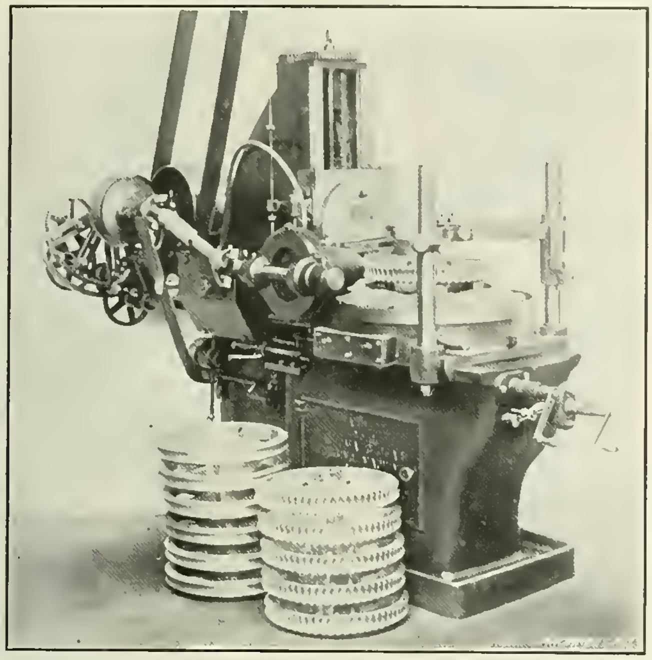


Fig. 3. Hobbing Worm-wheels on the Farwell Machine

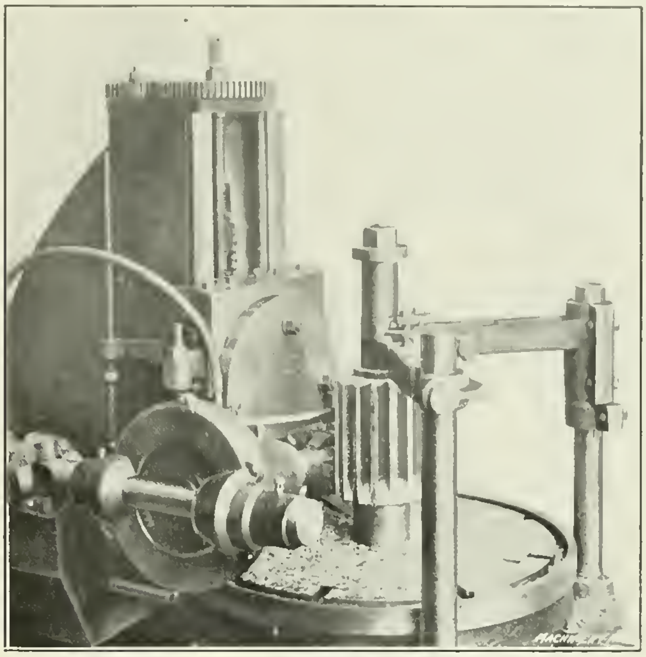


Fig. 4 Generating Teeth in a Stack of Spur Geare

CINCINNATI BICKFORD NO. 2 PLAIN RADIAL DRILL

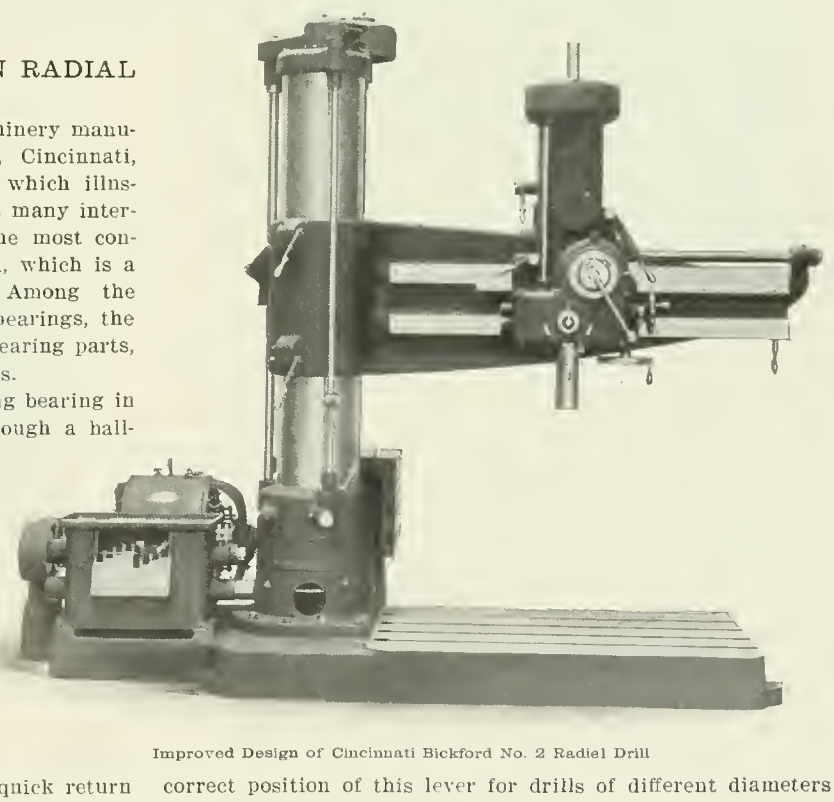
The latest addition to the line of drilling machinery manufactured by the Cincinnati Bickford Tool Co., Cincinnati, Ohio, is shown in the accompanying engraving which illustrates a design of plain radial drill that contains many interesting and important improvements. Perhaps the most conspicuous among these is the new design of head, which is a decided departure from customary practice. Among the features worthy of note are: the length of its bearings, the simplicity of construction, the durability of its wearing parts, and the convenient location of the operating levers.

The spindle sleeve, which has an unusually long bearing in the head, exerts its pressure on the spindle through a ball-thrust bearing, and it is equipped with a safety stop for tripping the feed within its limit of movement. A depth gage is also provided that is graduated to read either in sixteenths up to six inches, or in millimeters up to one hundred and fifty, and it may be set to trip the feed at any desired depth within its range.

The reversing clutch, which is operated from the front of the head, is of the well-known toggle-joint type, and it is capable of transmitting, at its lowest speed, power far in excess of that obtainable from the belt. The quick return lever which controls the vertical movement of the spindle, engages the feed the instant it is pulled, and it is provided with convenient means for regulating the amount of expansion of its friction ring.

The feeds, which are eight in number, range from 0.006 to 0.030 inch per revolution of the spindle. Any one of these feeds may be instantly obtained by means of a lever-operated dive-key. The bearings for both the driving works and feeding mechanism, are bronze bushed, throughout, and are made of such diameter and length as to insure long life. The gearing throughout the machine is completely encased and it is arranged so as not to exceed a periphery speed of 1000 feet.

The speeds, of which there are twenty-four when the machine is fitted with a speed box (as illustrated), and fifteen when fitted with a cone, are correct for a cutting speed of approximately 35 feet, on diameters ranging from 7/16 to 6 1/4 inches, the spindle speed range being from 21 to 306 revolutions per minute. The speed box, which is mounted on the base of the machine at the rear of the column, is operated by a single lever, the mere tossing of which from one notch to another furnishes any one of the eight changes. The correct position of this lever for drills of different diameters is given beneath the notches. The back-gears are incorporated in the head and furnish three changes of speed, each of which is capable of transmitting to the spindle over 2 1/2 times the pulling power of the next faster one.



Improved Design of Cincinnati Bickford No. 2 Radiel Drill

The arm lowers at twice its elevating speed and it is

strongly constructed, being made in pipe sections. The column, which extends to the top of the sleeve, is internally ribbed and is fitted with two ball bearings, one of which carries the weight and the other the side pressure of the swinging members.

The accompanying table, in which are recorded the results of drilling tests made on this machine, gives the horsepower absorbed while driving drills of various diameters through cast iron at different speeds and feeds. While in some of the tests given, as much as 16.5 horsepower was required, the makers of th s machine recommend that the size of motor be limited to 7 1/2 horsepower, as one of that capacity will usually deliver at least 11.25 horsepower. This, it will be noted by referring to the table, permits using a feed of 0.030 inch per revolution, for all sizes of drills up to and including 2 1/2 inches, at a cutting speed of 70 feet per minute or over.

These machines are built with either four-, five-, or six-foot

TABLE GIVING POWER ABSORBED BY THE BICKFORD NO. 2 PLAIN RADIAL IN DRIVING DRILLS OF VARIOUS DIAMETERS AT VARIOUS SPEEDS AND FEEDS IN CAST IRON.

Size of Drill	Speed		Feed Per Revolution			
	Revs.	Feet	0.015	0.020	0.025	0.030
			Horsepower			
1	172	45.1	4.1	4.4	4.9	5.2
1	194	50.8	4.4	4.8	5.4	5.9
1	214	56.0	5.0	5.4	5.8	6.4
1	238	62.3	5.7	6.0	6.5	7.2
1	268	70.2	6 4	6.8	7.3	8.2
1	306	80.0	7.4	7.8	8.4	9.5
1¼	172	56.4	5.3	5.9	6.6	7.1
1¼	214	70.0	6.4	7.2	7.9	8.7
1¼	268	87.6	7.8	8.7	9.7	11.0
1¼	306	100.0	8.9	9.8	10.9	12.5
1½	155	60.8	5.1	6.3	7.7	8.1
1½	194	76.2	6.3	7.7	9.3	9.8
1½	238	93.4	7.8	9.2	11.1	11.8
1½	268	105.0	8.7	10.3	12.4	13.1
1¾	134	61.2	5.5	6.9	7.3	8.9
1¾	172	78.8	7.4	8.7	9.9	11.0
1¾	214	98.0	9.4	10.6	12.7	14.1
1¾	238	110.0	10.6	11.7	14.3	16.5
2	97	50.5	6.1	7.0	7.4	9.3
2	107	55.6	6.4	7.4	7.9	9.9
2	134	70.1	6.4	7.1	8.3	10.6
2	172	90.2	7.8	9.3	11.1	13.2
2	194	102.0	8.6	10.6	12.7	14.7
2¼	121	71.1	8.4	9.3	10.9	11.0
2¼	134	78.9	7.5	8.1	9.7	9.9
2¼	153	90.1	8.2	9.3	11.3	11.9
2¼	178	105.0	9.2	10.9	13.3	14.7
2½	107	70.0	7.4	10.1	10.4	11.2
2½	134	87.6	7.9	10.0	10.4	11.6
2½	153	100.0	9.8	10.9	11.6	13.6
2¾	97	69.9	8.5	10.3	11.8	13.5
2¾	107	77.0	9.6	11.4	13.2	14.7
2¾	121	87.1	11.1	13.1	15.2	16.3
3	89	70.0	8.9	10.5	12.2	13.9
3	107	84.0	11.1	12.2	13.7	14.7
3	121	95.0	10.9	12.3	13 8	15.3

arms. Some of the principal dimensions for these three sizes are as follows, the figures being given in the order mentioned: The vertical range of the arm is 3 feet 6 inches for the three sizes, and the horizontal traverse for the head is 3 feet, 5/8 inch; 4 feet, 5/8 inch; 5 feet, 5/8 inch. The maximum and minimum distances from the spindle to the base, are 6 feet, and 12 inches, respectively for the three sizes. The bases have a working surface of approximately 3 1/2 feet by 4 feet 3 inches, 3 1/2 feet by 5 feet 3 inches, 3 1/2 feet by 6 feet 3 inches. The spindles for the three machines are bored to receive a No. 5 Morse taper, and their drilling capacities, in the plane of the base, are to the centers of 8-, 10-, and 12-foot circles.

HILL FRICTION CLUTCH—SMITH TYPE

The use of friction clutches in connection with the transmission of power, has increased to such an extent that they are now employed in almost every industry. The convenience and economy resulting from the possibility of cutting off one or more machines, shafts, or entire sections of the shop without disturbing other machinery in operation, are well-known factors in maintaining uninterrupted service and reducing the cost of production.

The latest design of friction clutch manufactured by the Hill Clutch Co., Cleveland, O., is shown in the accompanying engravings. In this new clutch, which is known as the Smith type, the same principle of action is retained that has been

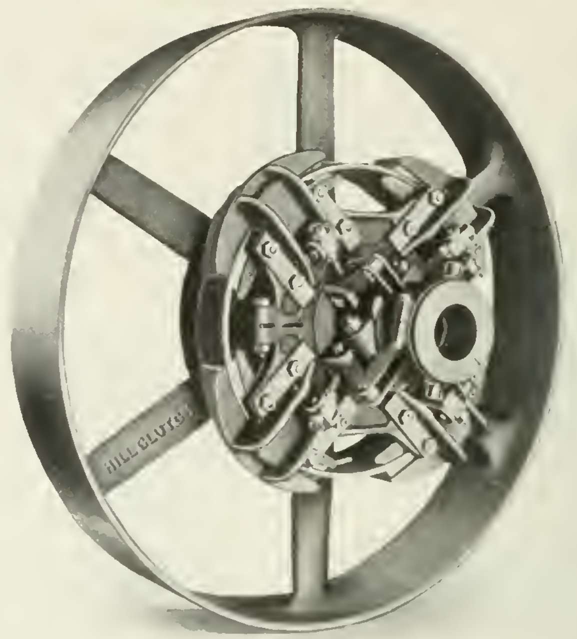


Fig. 1. Friction Clutch built by the Hill Clutch Co.—Four-arm Type

employed in the well-known standard type of clutch manufactured by this company. A number of changes and improvements in design and construction have been made, however, in this latest design to adapt it for heavier and more continuous service.

These clutches are built with three, four and six arms, according to their capacity. In Fig. 1 the four-arm type is shown, while Fig. 2 illustrates a larger size that has six arms. The friction surfaces are wood against iron, which is a combination offering great frictional resistance, and the shoe area is exceptionally large. The coefficient of friction is said

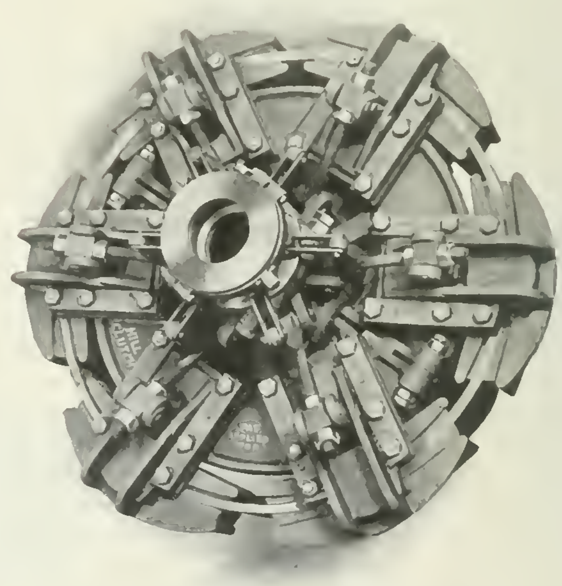


Fig. 2. Hill Friction Clutch with Six Arms

to be the same at all points, owing to the heavy cast-iron jaws, rigid guides, and the balanced toggle action through which the pressure is applied. The action of the clutch mechanism is positive, no springs being used in the construction. The sectional view, Fig. 3, shows the simple, powerful and continuous toggle connection from the cone to the jaws.

which positively releases, as well as engages, the friction surfaces. All of the toggle mechanism is of steel castings or forgings with the single exception of the connecting levers, which are of cast iron.

Another noteworthy feature in the design of this clutch is that any working part, including the inside jaws, may be removed parallel to the shaft from the mechanism side. This can be done without disturbing the main spider casting or pulley, as bolted gib guides secure the inner and outer jaws to the spider as shown in the illustrations. The entire clutch

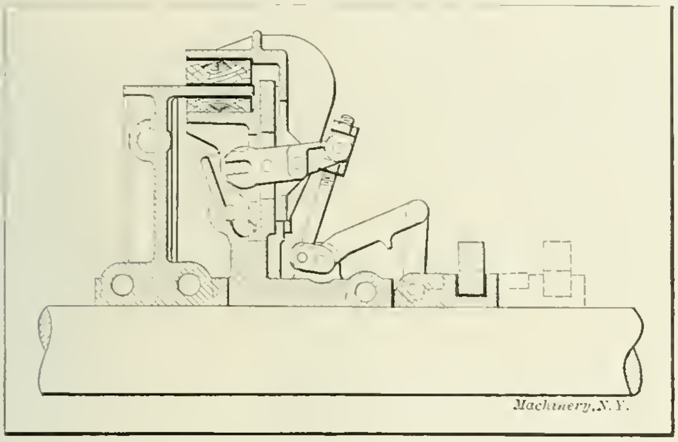


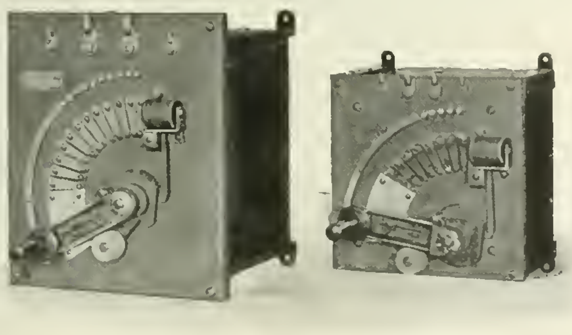
Fig. 3. Sectional View showing Construction of the Hill Clutch

mechanism is open and accessible for adjustment and the removal of shoes when necessary. The clutch pulleys are mounted upon split removable sleeves, babbitted or bronze lined as specified, which can readily be replaced without removing the pulley or clutch.

Another important advantage claimed for this clutch is its self-centering feature. As all jaws fulcrum at a point equidistant from the center of the shaft, they form a perfect centering or shaft aligning device without the necessity of troublesome shaft bushings. The clutches are built in either the solid or split types. In the split construction the bolting lugs are so distributed as to offer the greatest resistance to the forces tending to part the clutch. These clutches are built in nineteen sizes, ranging in capacity from 9 to 1,300 horsepower at 100 revolutions per minute.

GENERAL ELECTRIC SPEED CONTROLLERS

A line of speed controlling rheostats has been brought out by the General Electric Co., of Schenectady, N. Y., so designed that they combine in a single box both armature and field regulating rheostats. All speed changes are effected by movements of a single rheostat arm, which is automatically held in any position by a mechanical device. The line in-



General Electric Speed-controlling Rheostats

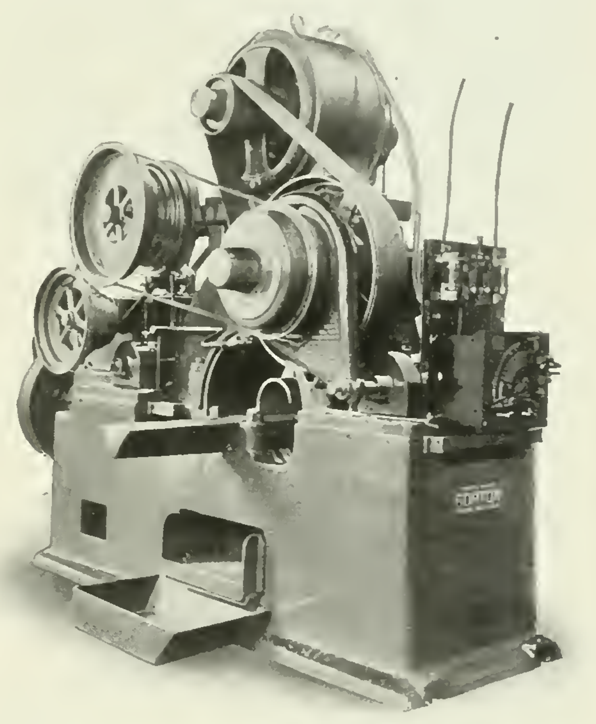
cludes rheostats designed for machine tool service, where full load current is taken at the lower speeds in order that the motors may maintain a constant torque, and also for fan service where the load increases with the speed. They permit of a 50 per cent reduction in speed by armature control and a 25 per cent increase by field control.

For protection from failure of voltage and the consequent danger of power being again thrown on the line without resistance in series with the motor armature, they are provided with a no-voltage release attachment. Upon failure of the voltage, the retaining magnet is demagnitized, thus releasing the arm which is instantly returned to the off position, by a spring, making it absolutely impossible to close the armature circuit without cutting in all the armature controlling resistance. The no-voltage release coil is connected directly across the line in series with a resistance and is thus independent of the current of the motor field and will protect any motor with which this rheostat may be used.

The contact segments are of liberal size and so designed that they may be very easily and quickly renewed. The resistance units are of an improved design and are so constructed as to be non-fragile, and thoroughly ventilated. These rheostats are designated as the CR-164 type, or CR-165, when equipped with an overload release coil.

GORTON CUTTING-OFF MACHINE

In the department of New Machinery and Tools for October, 1909, we published a description of a heavy-duty cutting-off machine built by the George Gorton Machine Co., of Racine, Wis. This machine has recently been equipped with the new type of electric drive shown in the half-tone illustration. As those familiar with the construction of the machine know, the main drive is through a large gear (not



Rear View of Gorton Cutting-off Machine showing the New Electric Drive

shown in the illustration) having an enlarged hub to which the cutter blade with its inserted teeth is attached. Meshing with this main gear is a driving pinion, to the end of which is secured the main driving clutch. On the motor-driven machines, the motor is allowed to run constantly and the machine is started and stopped with this clutch, which is operated by a lever located in a position convenient to the operator. The motors on the electrically-driven machines may be connected to the clutch pulley with an endless leather belt, as shown in the illustration, or, if desired, connection may be made with a silent chain drive. On the standard motor-driven machine, a 20-horsepower motor is installed which operates at 800 revolutions per minute. When the material to be operated upon varies from soft to quite hard, the manufacturers recommend a 2 to 1 variable speed motor.

This illustration also shows the belt feed drive which has been found preferable to an all-geared drive. Feeds ranging from 6 inches in four minutes to 6 inches in one minute, are available. The lower cone-pulley shown is connected with a gear-box containing the forward and quick-return feed clutches, which are operated either by hand or automatically

at the extremes of the stroke, adjustment being provided for various diameters of stock.

This machine, which is designated as the 2-B, is adapted to hard service, such as is found in rolling mills, etc., and it has a capacity for round steel bars up to and including 6 inches in diameter; stock as large as 8 inches, however, may be severed when necessary. This latest design has a record of 40 seconds for severing a 6-inch round steel bar, and stock of this size can be severed day in and day out in 1½ minute per cut.

QUEEN CITY SAFETY STOP-CLUTCH

A new automatic safety stop-clutch for punching and shearing machinery has recently been designed and patented by Mr. C. F. Heinss of the Queen City Punch & Shear Co., Cincinnati, O. This clutch, which is engaged or disengaged automatically,

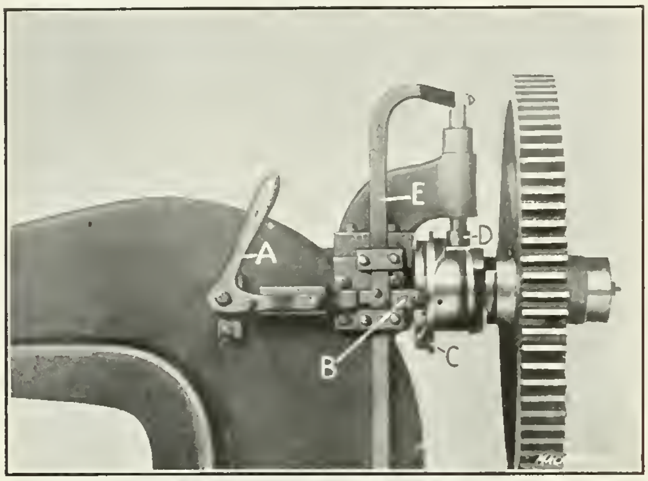


Fig. 1. The Queen City Punch & Shear Co.'s Safety Stop-clutch

is positive in its action and is so designed as to provide safety for the operator while punches and dies are being adjusted, without the necessity of throwing off the driving belt, as is commonly done.

Fig. 1 shows the clutch in the operating position, while Fig. 2 shows it in the safety position, the clutch being entirely disengaged by simply throwing hand lever *A* to the position shown. Attached to the clutch there is a ring or collar on each side of which are cams. The cam on the gear side disengages the clutch, while the one on the opposite side operates spring-plunger *B*. When the operator presses the lever or foot-treadle, thus raising rod *E* and with it plunger *D*, the spring-actuated plunger *B* comes against the collar *C*, thus forcing

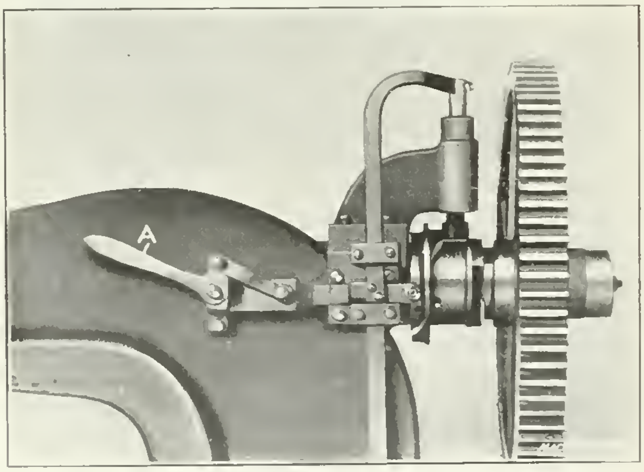


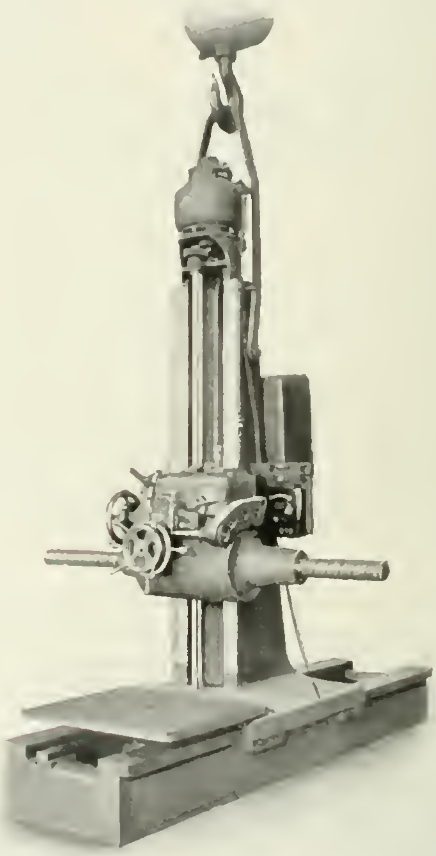
Fig. 2. Stop-clutch in the Safety Position

the clutch over and engaging it with the driving gear. After the cam has made part of a revolution, a cam surface engages plunger *B*, forcing it back and allowing rod *E* and plunger *D* to descend. As the clutch continues to turn, the cam surface on the gear side comes against plunger *D* and forces the clutch out of engagement. It will thus be seen that the release of this clutch is positive, and also that plunger *B* is locked in position after the cam forces it back, as a projecting piece attached to rod *E* engages a lug on *B* when rod *E* has descended to the position shown in the illustrations. Plunger *B* remains in this locked position until *E* is again released by the treadle, when the plunger is pushed forward and the cycle of operations is repeated.

The clutch is, of course, a very important feature in punching and shearing machinery, and the general efficiency and durability of this new design is evidenced by the fact that it is being installed on all of the machinery manufactured by the Queen City Punch & Shear Co. which requires such a device.

ROCHESTER HORIZONTAL BORING MACHINE

In the department of New Machinery and Tools for July, 1910, a horizontal boring, drilling, tapping and milling machine built by the Rochester Boring Machine Co., Rochester, N. Y., was described. The accompanying illustration shows a new application of this machine, the column and column-slide being detached from the main floor-plate so that this part may be used either as a stationary or as a portable machine, as desired. A heavy strap is attached to the column so that the



Rochester Horizontal Boring Machine Converted into a Portable Tool

machine may be conveniently moved by a crane. The side of the column-slide or base is arranged with dowel-pins so that it may be easily located with reference to the floor-plate. This slide is also equipped with screws which serve as jacks when it is being disengaged from the floor-plate.

AUTOMOBILE MANUFACTURERS BALL BEARING DRILLING MACHINES

The Henry & Wright Mfg. Co. of Hartford, Conn., has recently designed a new line of drilling machines, illustrated herewith, in which are incorporated all the good features of the smaller machines built by this company and some additional improvements which add very much to the practical value of the machines for doing the work for which they are intended. They are much heavier and more rigid than former designs, and are fully equipped with ball bearings, which are made interchangeable and may be renewed at small expense,

when required, thereby prolonging the life of the machines indefinitely.

The power of these machines is sufficient to drive high-speed drills efficiently in sizes ranging from 1 1/8 inch down to the smallest sizes. The spindle drive is located at the lower end of the spindle pulley instead of at the upper, as formerly, thus giving a more rigid drive to the spindles. The drive is encased in a cup which excludes dust and retains the oil which otherwise would be thrown about the room. The spindle pulley is supported above and below the belt instead of below only, as is the usual custom, thus relieving the spindle from all belt pull and compelling it to rotate in a correct manner, insuring accuracy at the drill point. The limit of accuracy of the spindles is 0.002 inch in an eight-inch circle. The spindle sleeve has an inserted steel rack, and adjustable stops are furnished (as ordered) to fit either the spindle at the top of the pulley or the rack. For accurate drilling or counterboring to a specified depth, the stop for the rack sleeve is recommended.

The idler pulleys are balanced, and the pulley bracket is provided with a guide which encloses the belt and prevents it from slipping off when changing the speeds. The machines are entirely belt driven and they are made with from one to six spindles each, and in three overhangs—eight-inch, twelve-inch, and fifteen-inch. The spindles are driven with an endless belt 1 3/4-inch wide, and the rear shaft is driven by a 2 1/2-inch belt. The wider belt driving the rear shaft is designed to furnish sufficient power to enable two operators to work on the same machine, when desired, and individual spindles may be started or stopped without stopping the entire machine.

The tables are made especially heavy and with extra wide

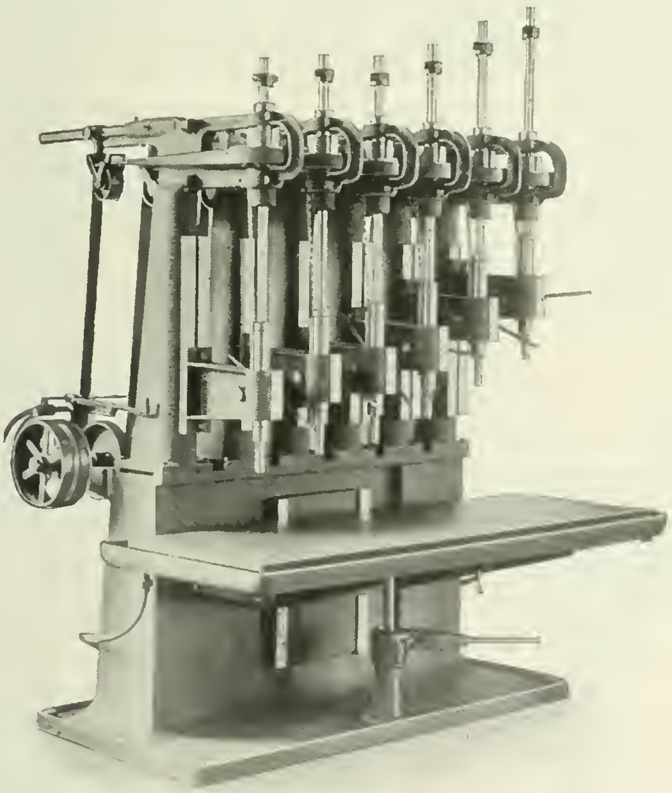


Fig. 1. Henry & Wright Six-spindle Drilling Machine

and long ways, and they are all equipped with a handwheel and raising screw. While every precaution has been taken to furnish a table as stiff and unyielding as is necessary to drill the heavy work it is designed to do on these machines, additional support is furnished by two supporting jacks at the outer corners of the table. The oil grooves around the tables are extra wide and deep, and both ends may be fitted with tubing to connect with an oil tank inside the base. A rim is cast around the foot of the base to prevent oil from flowing off the machine to the floor. The raising screw of the six-spindle machine illustrated is fitted with a ratchet instead of the usual handwheel, to furnish greater leverage to the operator in raising and lowering the heavy table.

Some idea of the proportions of these machines may be gathered from the following dimensions of the number six size: Height of machine overall, 8 feet 6 inches; height of base from floor, 36 inches; distance between the spindle centers, 10 1/4 inches; greatest distance between bottom of spindle, when raised to its highest point, and top of table when lowered to its lowest point, 30 inches; diameter of spindles, 1 1/8 inch; dimensions of table surface, 75 inches by 24 inches; floor space, 6 feet 9 inches by 5 feet 2 inches; and net weight of complete machine, 5500 pounds.

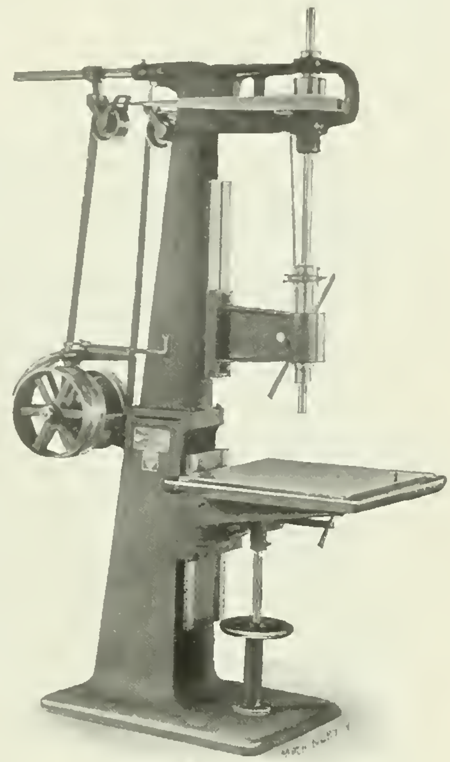


Fig. 2. Single-spindle Drilling Machine built by the Henry & Wright Mfg. Co.

These machines were especially designed to handle the variety of work necessary in the manufacture of automobiles and kindred modern manufactures. Many of the principal new features were brought out during a course of over three years of experiments which the makers conducted in connection with one of the largest users of their product. During this time the various experimental machines underwent the closest criticism by competent men, and the efficient machine, two sizes of which are shown, is the final result.

QUEEN CITY SAFETY FORMING PRESS OR MULTIPLE PUNCH

A large multiple press which is the product of the Queen City Punch & Shear Co., Cincinnati, O., is shown in Figs. 1 and 2. This machine has been built for punching angle-bars, punching two at a time on one side in one stroke, thereby completing the bar on both sides in one operation. It is similar in principle to the press previously described in the department of New Machinery and Tools for September, 1909, though much larger, heavier, and of a different design.

One of the distinctive features of these presses is the oscillating table which eliminates all danger of injury to the operators. This oscillating movement is obtained by a large face cam which, on the particular machine illustrated, is mounted on the main driving shaft. This cam transmits the required movement by suitable levers to the shaft on which the table is mounted. With this arrangement, the table and its dies are moved from under the plunger when the work is finished, so that the latter can be removed and a new blank inserted without danger of accident. Fig. 1 shows the table in the working position, while Fig. 2 shows it moved forward, where it is allowed to remain stationary long enough to permit the removal of the finished work and the insertion of a new blank.

Presses of this class are built with either a single or double set of dies. When a double set of dies is employed, two operators are required, one being stationed at the rear of the machine and the other at the front to feed and remove the work. The action of the double-action type of machine is as follows: After tne work has been formed in one set of dies, the latter remains stationary until the plunger is partly raised.

Then the dies in which the work has been formed or pressed, as the case may be, move forward to the operator, who removes the finished work and inserts another blank. In the meantime the opposite set of dies is receiving the plunger so that the machine is in operation continuously. With the single type press, such as the one illustrated, the general operation is practically the same as with the double dies, except that only one operator is required. The double-action type can be employed on a multiple punch when the work is light and can be easily handled, but when it is comparatively heavy, the single action is recommended.

It will be seen from the foregoing that the oscillating table makes it unnecessary for the workman to place his hands or fingers near the dies while feeding or removing the work, as the dies come forward to a safe position. These machines are provided with an automatic safety stop-clutch which stops the plunger when the latter is in its upward position. The particular press illustrated, measures 62 inches between the housings, and it weighs approximately 20,000 pounds. It is equipped with machine-cut gears, which insure a smooth and noiseless operation. These machines are built in various sizes and styles to meet the necessary requirements or nature of the work to be handled.

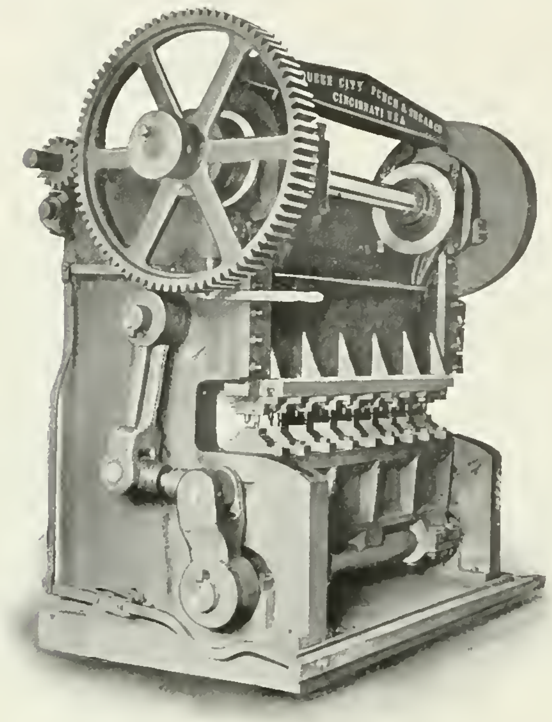


Fig. 1. Large Forming Press built by the Queen City Punch & Shear Co.

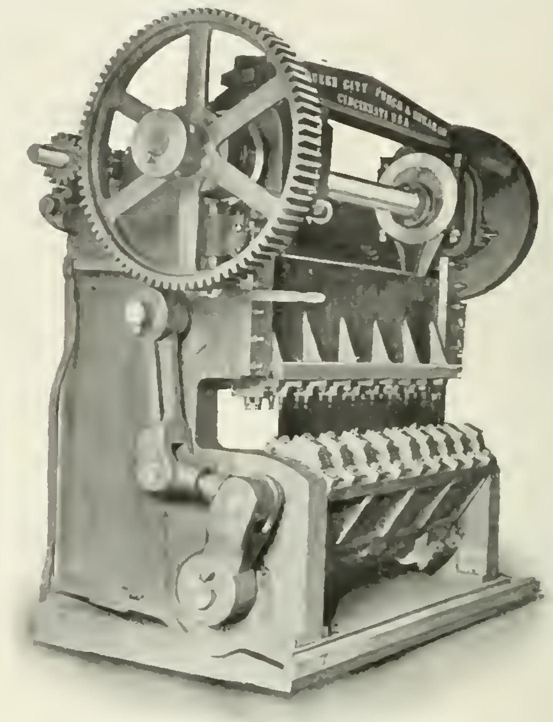


Fig. 2. Queen City Press with Oscillating Die-bed in Position for Removing Work

WILLARD HIGH-POWER 13-INCH ENGINE LATHE

The Willard Machine & Tool Co., Cincinnati, O., is now manufacturing the high-power 13-inch lathe shown in Fig. 1. This machine is designed and built to withstand the strains imposed by the use of the best high-speed steel tools. Standard jigs and gages are used in its manufacture, so that all parts are practically interchangeable. The lead-screws and feed-rods are made from special high-grade carbon steel. All sliding surfaces are carefully scraped to a bearing, and the spindles, as well as all other cylindrical parts, are ground to insure accuracy.

It will be noted by referring to Fig. 2, which shows an enlarged view of the headstock end, that all gears are covered for the protection of the workman. The large dial *B* of the cross-feed is graduated to read to thousandths of an inch, and graduations are also provided for the feed-screw of the compound rest. The feed-belt on this machine is 1½-inch wide and it runs on large pulleys of equal diameter, giving a very powerful feed. This belt can be kept at the proper tension at all times by means of a tightener. Four changes of feed are provided, any one of which may be instantly obtained by simply moving the lever *C* to one of the four positions on the quadrant. A safety mechanism in the apron prevents the engagement of the half-nuts, when either feed is connected, thus preventing breakage. This machine is equipped with double back-gears, which are operated by the handle at *A*. This handle has a latch, which by engagement with a suitable hole, locates and positively locks the back-gears in position. The countershaft has two forward speeds of 350 and 450 revolutions per minute, and these speeds, together with the changes obtained by the back-gears, give eighteen speed changes ranging from 30 to 655 revolutions per minute. The driving cone has three steps, and the width of the driving belt is 2½ inches. The headstock is heavily built and it has a bearing of 21½ inches on the bed. The spindle, which is of 60-point carbon, crucible, spindle steel, has a front journal 2⅜ inches in di-

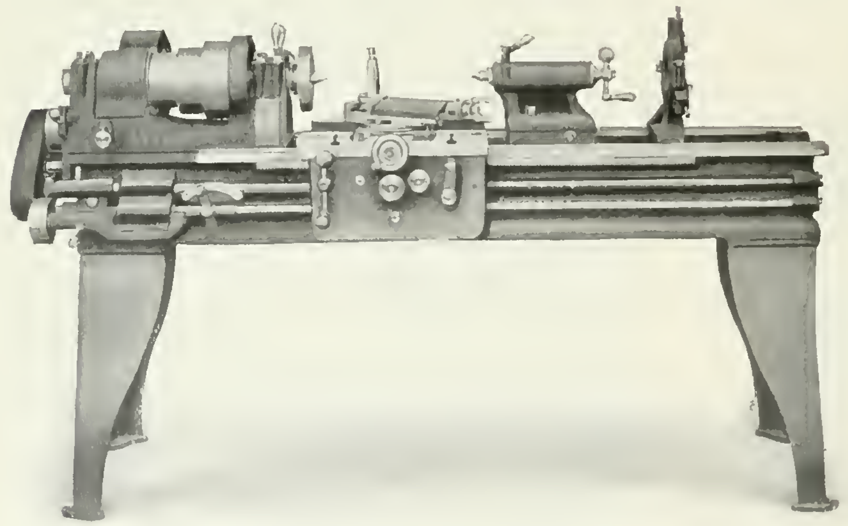


Fig. 1. Engine Lathe built by the Willard Machine & Tool Co.

ameter by 4 inches long. The bearings are of high-grade phosphor-bronze and are carefully scraped to fit the spindle. The reverse gears are of steel and the idlers are bushed with phosphor-bronze. The tailstock, which is well proportioned, has a crucible steel spindle 1¾ inch in diameter. The carriage has a bearing of 18 inches on the V's and the bridge is 7½

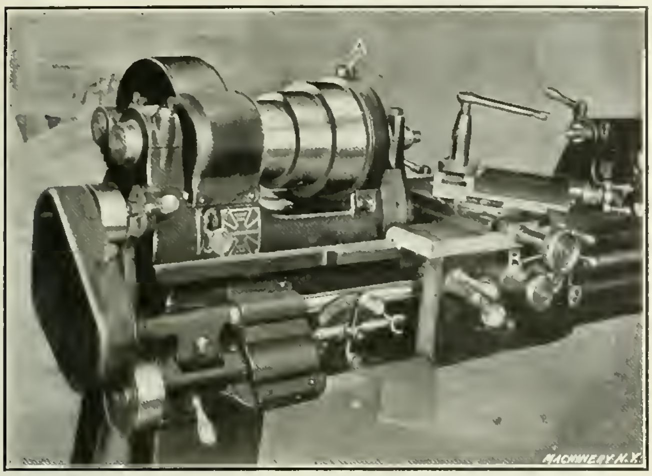


Fig. 2. Headstock End of the Willard Lathe

inches wide. The apron and the bearings in it are cast in one piece, thus making it stiff and strong. All gears located in the apron are of steel and the studs are hardened and ground.

This machine swings over the ways 13½ inches and over the carriage 7¼ inches. The maximum distance between the centers with a 6-foot bed is 37 inches. The spindle has a 1 5/16-inch hole through it, and it is bored to receive a bushing bored for a No. 3 Morse taper. The ratio of the first back-gear is 3 to 1 and of the second back-gear, 8 to 1. The weight of the machine with a 6-foot bed is 1300 pounds.

This type of lathe, while being used for turning lathe spindles, removes 203 pounds of 60-point carbon spindle-steel chips in ten hours, reducing the stock from 2½ to 2 inches in one cut, while run-

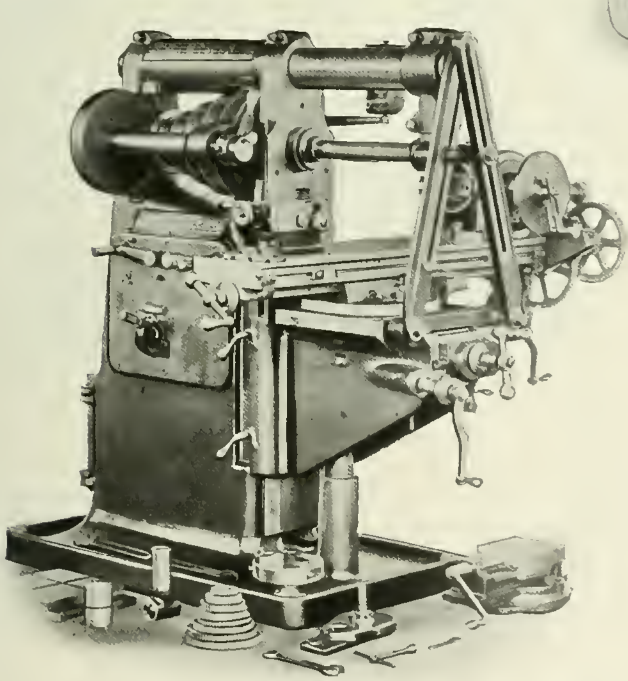


Fig. 1. Modern Cone-driven Milling Machine built by the Cincinnati Milling Machine Co.

ning at 68 feet surface travel per minute and feeding 0.013 inch per revolution. It also reduces 2½-inch machinery steel to 2 inches, while running at a surface speed of 136 feet per minute and feeding 0.013 inch per revolution. These figures speak for themselves.

CINCINNATI CONE-DRIVEN MILLER

In every shop there is a class of milling work that is comparatively light, which can be done on a modern cone-driven miller as fast and as accurately as on the more highly-developed single-pulley type of machine. It follows, therefore, that the cone-driven machine is the most economical one to use on such work. There is, of course, a recognized field for the heavy and powerful single-pulley type of milling machine, but this does not in any way restrict the field of usefulness of the cone-driven machine. That these facts are appreciated by the Cincinnati Milling Machine Co., Cincinnati, O., is evidenced by their having re-designed their entire line of cone-driven millers.

The illustrations presented herewith show the more important improvements that have been made. The column is very similar to the column used on their line of high-power machines, it being a symmetrical box section that is large enough to contain the entire feed driving mechanism. The feed changes are all obtained from a single group of mechanism which is mounted in the column at a point high above the floor, thus bringing all the levers within easy reach, and the index-plate in plain sight of the workman. The interior of this mechanism is shown to the left in Fig. 2. As the illustration shows, the various gears, when assembled in their case, form a single compact unit, which, when placed in the column, becomes an integral part of the machine. This mechanism provides sixteen changes of feeds ranging from 0.007 to 0.300 inch per revolution of the spindle or cutter, and all of these changes are obtained by means of the twelve gears located between the two housings of the gear case. The drive is direct from the face-gear which meshes with gear *A*, and

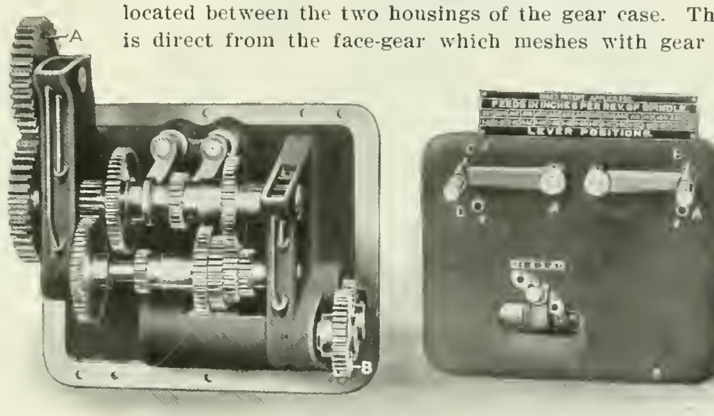


Fig. 2. The Feed Changing Mechanism and Controlling Levers

power is transmitted through the change gears to the gear *B*, which drives the universal-joint shaft. An exterior view of the feed-box, showing the lever arrangement and the feed index, is shown to the right in Fig 2. All the sixteen feed changes are obtained by manipulating the three levers shown, and their positions are clearly indicated by the feed index plate which is mounted just above them. This plate is of the same simple form that is used by this company on their line of high-power machines. It is so arranged that there is no chance for confusion, because the exact lever positions are plainly given below the figures representing the feed rates, so that it is simply necessary for the operator to move the levers to these positions. For example, if a feed of 0.088 inch per revolution of the spindle were required, the mark "3-BC" on the plate, just below 0.088, would show that the tumbler should be moved to position "3," the right-hand lever to position "B," and the left-hand lever to position "C," as illustrated.

The most striking feature in the design of this feeding mechanism is the tumbler construction. This tumbler is made in the form of a cylinder of large diameter, which supports the tumbler shaft and gear and is itself supported in the frame of the feed-box. This construction obviates all bending of the tumbler-shaft as well as all vibration in the tumbler itself. The tumbler-operating lever projects through a hole in the feed-box in the usual way, as shown, but this opening is completely closed at all times by the tumbler, thus thoroughly protecting the inside mechanism from dust.

ROWBOTTOM BALL-BEARING DISK GRINDER

The Rowbottom Machine Co., of Waterville, Conn., has designed and is placing on the market a new line of disk grinding machines, the 18-inch size of which is shown in Fig. 1. This company has departed from the regular method of construction in this class of machinery by mounting the spindle in ball bearings. The sectional view, Fig. 2, shows the construction of these spindle bearings. The ball bearings, which are of the well-known Hess-Bright type, are connected with grease cups, which insure a supply of lubricant without attention, for months at a time. On the right-hand end of the machine a sliding table is provided having two T-slots for fastening angle-plates or fixtures. This table is controlled by a hand lever, and an adjustable stop-screw limits the inward motion to insure a uniform thickness of the work being

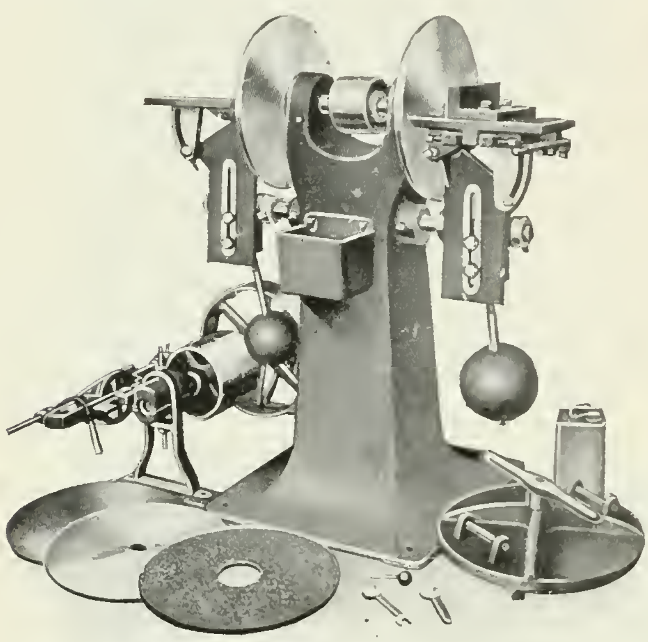


Fig. 1. Rowbottom Ball-bearing Disk Grinder

ground. The table also has an angular adjustment with relation to the face of the disk, and the whole has a balanced swinging motion across the disk face. The table on the opposite side of the grinder is of the plain type, and it has a lip or projection on the front edge which is square with the face of the disk. This is very convenient for grinding the ends of pieces square with the edges. This table also has the angular adjustment and the balanced swinging motion. Provision is made for fastening either table in a fixed position when desired, and both tables are adjustable in a vertical direction to allow the greatest surface to be presented to the

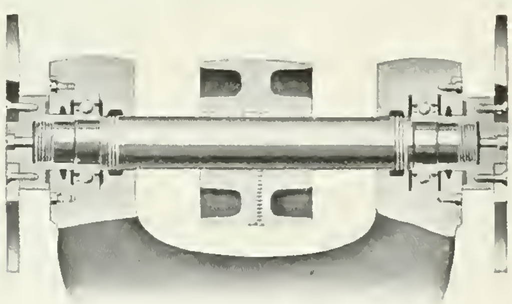


Fig. 2. Sectional View of Disk Grinder Spindle Bearings

most effective cutting part of the disk. A water pot is attached to the machine, as shown, which is convenient for cooling pieces on which heavy grinding has been done. Three sizes of these machines are made, the disks of which are 12, 18 and 26 inches in diameter, respectively. After thorough tests, the builders are convinced that they have a machine that is not only durable, but also economical in the use of power, both of which are valuable and important features.

LANDIS STATIONARY DIE-HEAD FOR PIPE THREADING

A stationary die-head for pipe threading, which is now being manufactured by the Landis Machine Co., Waynesboro, Pa., is shown in Fig. 1. This head, which is manually operated, is equipped with the Landis type of die, and is made especially for use on pipe threading machines wherein the

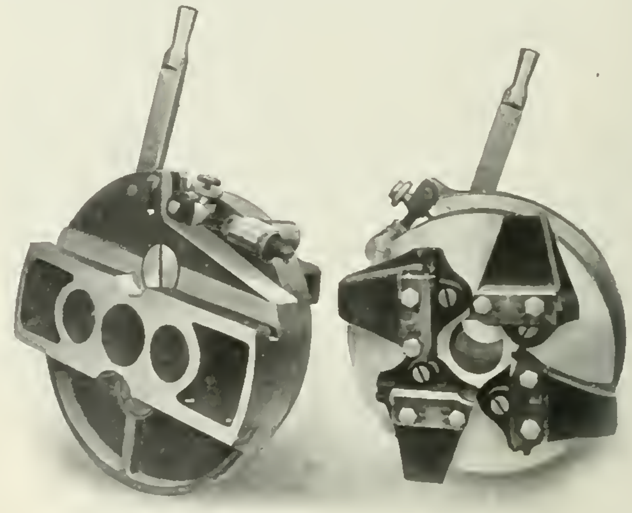


Fig. 1. Landis Manually-operated Die-head for Pipe Threading

pipe revolves and the head remains stationary, the dies being opened and closed by hand. It is made entirely of steel, as are also the die-holders, and it can be mounted on the carriage of any of the standard pipe machines. The chasers used in this die-head are of the company's regular type, in which the teeth are milled; they can be advantageously made from high-speed steel as they never require to be annealed, re-hobbed or re-tempered. (An illustration showing this type of chaser appeared in the department of New Machinery and Tools, for February, 1908.) The sharpening of the die is a simple operation as it consists simply in grinding the ends of the chasers, and again setting them to the correct cutting position in the holders by means of the small gage furnished.

In Fig. 2 is shown one of the holders that is used for pipe threading when it is not necessary to cut very close to a

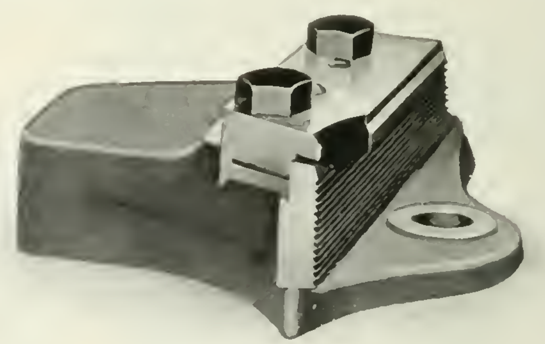


Fig. 2. Detail View showing One of the Chaser Holders

shoulder. The clamp by which the chaser is held in place, is what is known as a "mill" clamp. This clamp, besides holding the chaser rigidly, protects it in case the pipe splits, which is a frequent occurrence. As the illustration shows, the clamp extends down over the throat of the chaser, and it is rounded out near the cutting point so as to act as a guide for rough ends and to protect the die from breakage when a "twister" occurs in the pipe, as the greater part of the strain is thrown on the clamp. When it is desired to thread close to a shoulder, as when threading short nipples, etc., a clamp is used which comes flush with the front edge of the chaser only, thus permitting the die to run close up to the shoulder.

Durability of the chasers, high cutting speeds, and the adaptability of the die to the different qualities of material, are among the important advantages claimed for this die. It is said that it permits of cutting speeds from 25 to 100 per cent higher than those employed with the hobbed type of die, and

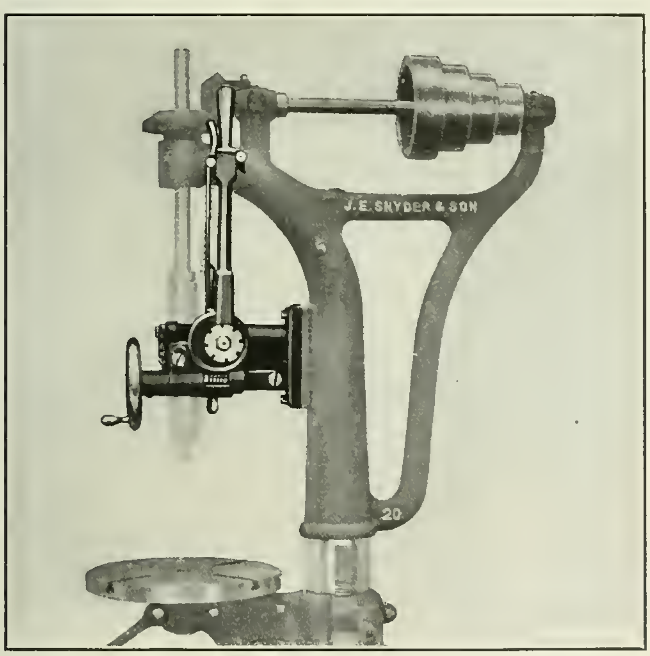
the rake on the chasers can be ground to suit the quality of the material in the pipe to be threaded. This is important, as much of the pipe on the market to-day is stringy and tough so that a change in the angle of rake is essential.

The heads are graduated for setting the dies to different diameters. They are opened and closed by a hand-movement of the lever shown, and when in the closed position the die is rigidly locked. All dies are made to interchange perfectly and if one chaser of the set should be worn out before the others, this single chaser can be replaced without replacing the entire set. Dies of any one pitch will interchange on any of the die-heads so long as the pitch is within the range of the head. For example, dies for threading 1-inch pipe on the 1-inch head, will also thread 1-inch pipe on the 2-inch head or *vice versa*, thus avoiding the necessity of carrying a large assortment of dies to cover the range of work when using a number of heads.

These heads are made in four standard sizes with capacities as follows: from ¼ to 1 inch, inclusive; from ¼ inch to 1½ inch, inclusive; from ½ to 2 inches, inclusive, and from 1 inch to 4 inches, inclusive. One set of dies will cut all diameters of pipe coming within the same pitch. For example, there is but one pitch covering the sizes ranging from 1 to 2 inches, inclusive, therefore one set of dies covers this range, and the same is true of the other sizes.

SNYDER 20-INCH UPRIGHT DRILL

In the New Machinery and Tools department for August, we described a 20-inch upright drill recently brought out by J. E. Snyder & Son, Worcester, Mass. We failed to mention, however, the new design of head which is an important feature, as it adds considerably to the convenience of operation.



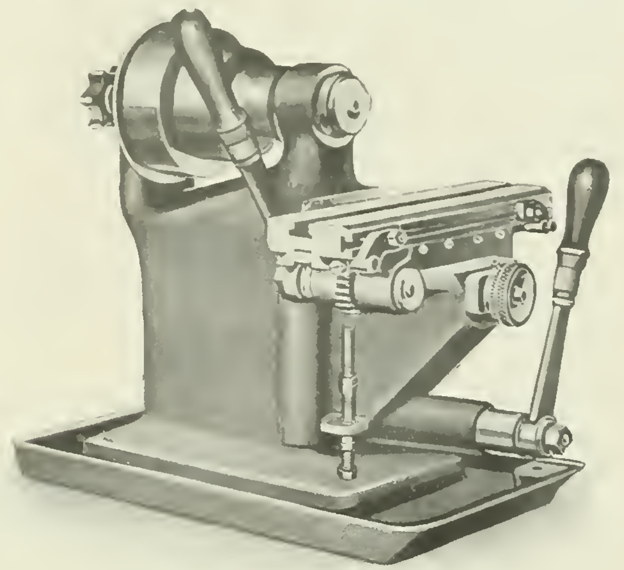
New Design of Head on 20-inch Upright Drill built by J. E. Snyder & Son

By referring to the accompanying illustration, it will be seen that the wheel-shaft bracket which contains the worm-shaft and worm for the hand feed, is pivoted at the outer end so that the worm may be engaged or disengaged by simply raising or lowering the wheel. When the wheel is pushed up, it is held by a latch which drops into place automatically. The economy resulting from this device is apparent.

CARTER & HAKES BENCH MILLING MACHINE

A bench milling machine that is adapted for a large variety of light work, such as is found in the manufacture of guns, sewing machines, typewriters, electrical supplies, etc., is shown herewith. This machine is a recent design of The Carter & Hakes Machine Co., Winsted, Conn. It is built in two styles, the first being a hand milling machine with or without a vertical attachment, and the second a machine with both hand and power feeds for the table, the power feed being engaged or disengaged by simply tightening or loosening a screw.

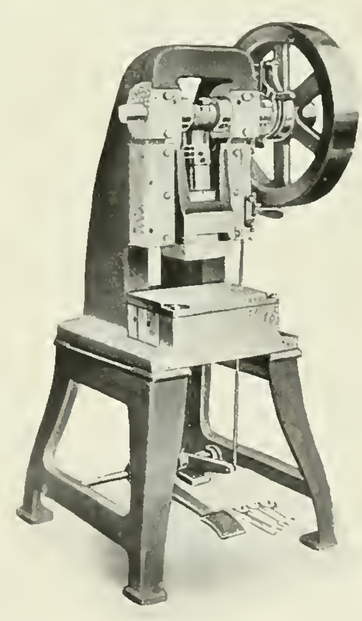
The column is designed to give strength and rigidity where it is most needed, and it is for this reason that the spindle cone has been reversed, which allows giving the front bearing a rigid support. The knee is of the box design and it is counterbalanced by a weight within the column. The carriage projects well out on each side of the knee, thus providing a good support for the table. The latter has a longi-



Carter & Hakes No. 3 Hand Milling Machine

tudinal feed of 4 inches and a cross movement in line with the spindle of 2¾ inches. The feed-screw for the transverse adjustment is furnished with an index graduated in thousandths. The spindle, which is of special forged steel, has a Brown & Sharpe No. 9 taper hole. The bearings run in bronze bushings of the split taper type, thus providing means for taking up wear. Both the vertical and horizontal feeds are through rack and pinion movements, and eccentric bushings are used as bearings for the operating levers, so that backlash can be eliminated at any time by simply adjusting these bushings. The vise furnished with this machine is the company's regular No. 2 quick-operating lever vise, which has a maximum opening of 3¼ inches.

The machine can be set on a bench or platform, or, if desired, a column for floor use can be furnished. The weight with vise and countershaft is 150 pounds. The greatest distance from the top of the table to the center of the spindle is 4 inches, and the table is about 3 inches wide by 12 inches long. The knee has a vertical range of 4 inches, and the total height of the machine is 16¾ inches. The regular equipment for both hand- and power-fed machines includes an overhanging arm for the support of the cutter arbor; a taper spindle sleeve bored to receive a Rivett collet; one collet with a draw-in attachment; a lever vise, countershaft, and the necessary wrenches.



Baird Blanking and Stamping Press

BAIRD OPEN-BACK PRESS

A new design of open-back press which has recently been brought out by the Baird Machine Co., Oakville, Conn., is illustrated herewith. This press has been heavily designed

as it is intended for performing heavy blanking and stamping operations. The machine illustrated is of the plain type, but several unique attachments have been designed which can be applied when necessary. Among the good points in the design may be mentioned the long slide, the strong support given to the bearings, the heavy balance wheel, and the convenient positions of the hand lever and foot-treadle for operating the clutch mechanism. As the illustration shows, the machine has finished seats which make the application of attachments comparatively easy. If desired, either the back or side roll feed transfer attachment, or dial attachment, can easily be applied to one of these plain presses without the necessity of shipping it to the factory, as the attachments are carried in stock. This machine is built in four different sizes.

NEW MACHINERY AND TOOLS NOTES

Crankpin Turner: Schwinebraten Portable Crankpin Turner Co., Birmingham, Ala. Portable machine for turning worn locomotive or other crankpins. It is attached to the end of the pin to be turned and is motor driven. The weight of this machine is 80 pounds.

Tempering and Hardening Furnaces: C. U. Scott, Davenport, Ia. The tempering furnace is so designed that the heat can be held at any desired point for any length of time. The lead bath or crucible furnace is so arranged that it can be used for bluing or hardening as desired.

Drop Press: United Engineering & Foundry Co., Farmers' Bank Building, Pittsburg, Pa. Line of drop presses of the geared type, built in sizes ranging from 1000 to 3000 pounds, inclusive. When above 2000 pounds, cast-steel bases, lifter frames and extra-heavy cast-iron uprights are used in the construction.

Vertical Boring Mill: London Machine Tool Co., Ltd., Hamilton, Canada. Special design of vertical boring mill for turning elevator drums. A 3-horsepower variable-speed motor drives the boring spindle independently, while the table is driven by a 20-horsepower variable-speed motor, and it is provided with an electrical brake.

Quick-Acting Wrench: George W. Jessup, Jr., Newton, Mass. Wrench which may be quickly and conveniently adjusted to the desired size; if desired, it may be locked and used as an ordinary monkey wrench. A detachable pipe jaw, which when not in use may be kept in the hollow handle, makes it possible to grip pipe or other cylindrical work.

Trimming Press: United Engineering & Foundry Co., Farmers' Bank Building, Pittsburg, Pa. Trimming press designed to carry extra-long bed and slide and an extra-heavy side cut-off attachment. The main frame is bronze bushed and the clutches are equipped with steel jaws. This clutch mechanism is so arranged that the treadle can be reversed from front to back, when desired.

Locating Machine: Beacon Tool Works, Naugatuck, Conn. Machine for accurately and quickly locating centers on dies, jigs, templets or similar work, where accurate locating is essential. This machine is provided with micrometer adjustment, and it is accurately built throughout. Three sizes are manufactured, the smallest taking a block up to 4 inches square, and the largest one, 12 by 14 inches by 8 inches high.

Shop Stands, Racks and Vises: Western Tool & Mfg. Co., Springfield, O. Line of shop equipment including toolmakers' vise stand, portable shop stands and compact stock-rack. The vise stand permits the vise to be set to any convenient position, and, attached to the supporting column, there is a tray or shelf for holding tools. One of the shop stands is designed for use in connection with the lathes, while the other is mounted on wheels and can be employed for conveying parts about the shop.

Channeling Machine: Kane & Roach, Niagara and Shonnard Streets, Syracuse, N. Y. Machine for forming cold, flat stock into channels, half circles (as for tire rims) or into complete circles, or tubes. If desired, the metal can be turned out in a straight strip by equipping the machine with straightening rolls. When making automobile tire rims the flat bar is formed into the proper shape for the rim and bent into a circle in one operation, by using rolls of the proper shape and size. These machines are built for either belt or electric drive.

Electric Drill: New York Electric Tool Co., 136 Liberty St., New York City. Well-built portable electric drill that is driven by a substantial type of motor which transmits power through hardened steel and phosphor-bronze gears. The body of the drill is made of a soft, tough grade of steel, which is thoroughly annealed to offer high magnetic permeability for the motor fields. This casing also forms a strong protector for the working parts of the machine. Ball bearings are used throughout, and the drill has a capacity for holes up to 3/4 inch in diameter in steel.

Adjustable Spring Collet: National Tool Co., Cleveland, O. Adjustable spring collet for automatic screw and turret machines. This collet is said to be non-breakable and it does away with the necessity of having a whole set of collets. It will grip all sizes of stock of either round, hexagon, square or octagonal shapes within its capacity. The full length of the jaws grips evenly on the stock, which is held true. These collets are made in seven sizes, the No. 1 size having a gripping capacity ranging from 1/16 to 1/2 inch, inclusive, and the No. 7 size, a capacity of from 2 1/2 to 4 inches, inclusive.

Cam and Valve Grinder: Bay State Grinder Co., Worcester, Mass. Combination cam and valve grinder which is equipped with two wheels, one operating in connection with the cam grinding attachment and the other for valve grinding. If desired, however, two cam grinding or two valve grinding attachments may be used. Valves may be ground true by the stem and without using centers, though a special attachment for grinding them on centers is also made. When the machine is to be used for cam grinding, master cams are generated from approved models furnished by the customer. This machine is simple in construction and compactly designed.

Sensitive Drill Press: Albany Hardware Specialty Mfg. Co., Albany, Wis. Sensitive bench drill press in which power is transmitted from the driving pulley to the spindle by means of two friction wheels and a hemispherical plate. This plate is mounted on a pivoted support so that its position with relation to the wheels may be changed. As it is swung about its pivot, one of the friction wheels is continuously moving on a larger circle while the other is being moved to a smaller one, which causes variations in the spindle speed. Ten speeds are available and the lever which controls the hemispherical idler has an index-plate which shows the proper position for the lever for drills of different sizes operating in either cast iron, steel or brass. The machine is equipped with a depth gage, and also an adjustable stop so that a number of holes may be drilled to the same depth. This machine will drive drills up to 1/2 inch in diameter and it will drill to the center of a 12-inch circle.

Power Press: Walsh Press & Die Co., 4709-4711 W. Kinzie St., cor 47th Ave., Chicago, Ill. Special double-crank power press fitted with gang dies and automatic feed for the rapid production of drawn shells. These shells are approximately 2 1/8 inches in diameter, with drawn edge or side of 3/8 inch. The number of dies in the gang is eight, and these cut, draw and emboss or letter the covers in one operation. The press proper is swung by trunnions at the front and it is supported in the rear by heavy upright adjustable jack screws which allow the machine to be inclined to suit the requirements of the work to be done. The feeding mechanism is so arranged that it places the sheet of tin automatically in the feed proper, thereby giving the operator ample time to adjust another sheet in place, making the production of these shells a continuous operation. As the press is run at a speed of 90 strokes per minute, and the dies produce eight covers at each stroke, it would, if run continuously for ten hours, have an output of 432,000 finished shells or covers. Allowing for reasonable stoppages, the builders claim that from 250,000 to 300,000 pieces such as described, or work of a similar character, can be produced in ten hours. This machine was designed by Mr. H. C. H. Walsh.

Horizontal Milling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Heavy design of 50-inch horizontal milling machine which is convenient as to operation and capable of producing accurate work in quantity. The diameter of the spindle in the parallel bearings is 7 inches, and, in addition, there is a double taper bearing in front of the spindle sleeve, with a maximum diameter of 11 inches. The greatest distance between the spindle saddle and the outboard bearing is 51 inches; the minimum distance from the center of the spindle to the top of the work table, 5 inches, and the maximum, 31 inches. The spindle is arranged to drive a 4-inch cutter arbor by a broad key face. The spindle is driven by a 62-horsepower motor, which gives it a speed range of from 15.55 to 31.11 revolutions per minute. The work table has a spiral gear and rack drive, with three changes of feed for each of the spindle speeds. The spindle saddle and outboard bearing, in addition to having a convenient hand adjustment, may be elevated or lowered by an independent 3-horsepower motor, mounted on top of the housing. The outboard bearing also has an independent horizontal adjustment of 8 inches, in its saddle. All the gears on this machine are of hammered steel with teeth cut from the solid, with the exception of the worm-wheel by which the fast traverse is obtained, which is of Tobin bronze.

Engraving Machine: Keller Mechanical Engraving Co., 570 West Broadway, New York City. Motor-driven engraving machine for forming dies mechanically. This machine has two chucks, one of which holds the work and the other the pattern to be reproduced. Ordinarily, the pattern and work revolve at the same speed. A double-pivoted tool-arm which carries a stylus or pointer for following the form of the pattern and a cutting tool is fed across both pattern and work. In this way the cutter arm is given a movement by the guiding

point on the pattern, which reproduces the design of the pattern to a diminished scale on the die. The rotation of the work and pattern, as well as the motion of the tool-arm across the work, is comparatively slow, to insure more accurate detail. By means of a special governor the speed of the work is automatically reduced as the cutter travels toward the periphery. When sinking a die with this machine two cuts are ordinarily taken, one for roughing and the other for finishing. The patterns employed are usually made of hardened plaster or cast-bronze electros made from plaster molds. In addition to cutting dies for metal stamping, this machine can also be used for making coin or medal dies and other similar work, and the quality of the product turned out is said not only to rival, but to outclass that produced by the most skillful hand operators.

* * *

THE JOINT MECHANICAL ENGINEERS MEETING

The American flag flying over the Queen's Hotel in Birmingham, England, looked natural and proved a token of the more than generous welcome given by the British Institution of Mechanical Engineers and the city of Birmingham, to the visiting American engineers. The three days' meeting at Birmingham was crowded with receptions, luncheons, garden parties, excursions and entertainments of all kinds, but the various functions were arranged with true British system, so as to eliminate all confusion and crowding.

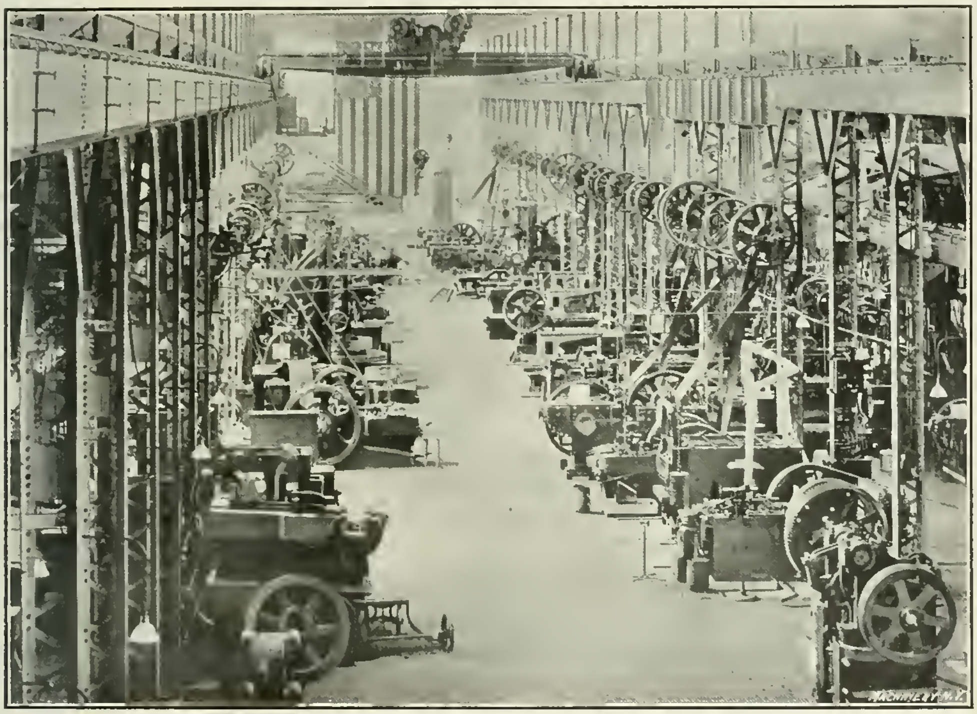


Exhibit of Forging, Nut and Bolt Machinery in Main Bay of National Machinery Co.'s Plant, Tiffin, Ohio, August 19-24

The official program was a folder of convenient size, comprising thirty-two printed pages and six excellent maps, one of the city of Birmingham, showing all the public buildings, and transportation lines, as well as the places where entertainments were to be given, and the others showing all the near-by points of interest, as well as the River Thames from Henley to Windsor. Within a short distance of Birmingham are Lichfield, Stratford-on-Avon, Kenilworth and Warwick, some of the most beautiful of England's show places; and excursions to all of these points were enjoyed by the members and guests. Some thirty individual works in Birmingham and vicinity also opened their doors to the visitors, and one of the most interesting of these was the machine tool works of Alfred Herbert, at Coventry, where American methods of manufacture adapted to British requirements are found in their perfection. The fourth and fifth days of the convention were spent in London and Windsor, and included a grand banquet.

The joint meeting was most successful in every way, and Mr. Calvin W. Rice, the secretary of the American Society of Mechanical Engineers, to whose efforts this result was largely due, is to be congratulated.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN

The first meeting of the American Society of Engineer Draftsmen, embracing every branch of the profession, including mechanical, electrical, civil, architectural, marine, sanitary and automobile draftsmen, was held on July 27 in New York. The formation of this organization marks the first effort to form a national society among draftsmen. The need for such an organization has long been felt by the profession, both from an engineering and fraternal standpoint. The qualifications for membership are such that a standard will be established, and it is the aim of the society to maintain this standard and to secure recognition from concerns employing draftsmen. Mr. E. Farrington Chandler was elected president, Mr. William B. Harsel, vice-president, and Mr. Henry L. Sloan, secretary and treasurer. The headquarters are at 116 Nassau Street, New York City.

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DETROIT MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The three-day meeting of the Society of Automobile Engineers held in Detroit, July 28-30, was an important event in the annals of the automobile industry. It brought together a large number of engineers who seek to cooperate in improving methods of manufacture and to harmonize discordant elements that are the natural result of an industry that has sprung up like a mushroom, in the night. Important advances have been made in the work of standardization and in preparation of standard reference tables for general practice. The society has a membership of about 400, and is growing rapidly.

Mr. Henry Souther, metallurgist of Hartford, Conn., and state chemist of Connecticut, gave an address entitled "The Specification and Heat Treatment of Automobile Material." Prof. R. C. Carpenter, of Cornell University, presented a paper by L. R. Evans, and R. P. Lay, entitled "A Test of a 20 H.P. Franklin Air Cooled Motor." Other papers were "Variations of Current Practice in Anti-Friction Bearings," by D. F. Graham, Bristol, Conn.; "Testing the Hardness of Metals," by A. F. Shore, of New York, and H. G. McComb, of Buffalo, N. Y.; "The Pyrometer—Its Development and Use," by W. H. Bristol.

The engineers visited a number of manufacturing plants, including the Aluminum Castings Co., Burroughs Adding Machine Co., Cadillac Motor Car Co., Chalmers Motor Co., Detroit Steel Products Co., E-M-F Co., Gear Grinding Machine Co., Packard Motor Car Co., Timken-Detroit Axle Co.

* * *

NATIONAL MACHINERY CO.'S EXHIBIT OF FORGING MACHINERY

About 250 delegates and ladies from the convention of the International Railroad Master Blacksmiths' Association at Detroit, left Friday morning, August 19, by special train, for Tiffin, Ohio, where they were guests of the National Machinery Co., who had on exhibition a complete line of forging machines, thread rollers, bolt cutters and other products of their big plant. While the blacksmiths were inspecting the machine exhibits, entertainment was provided for the ladies at one of the local parks. Both dinner and supper were served to the visitors, after which a special train took them back to Detroit. The National Machinery Co. is to be congratulated on the manner in which the event was managed.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION CONVENTION

The eighteenth annual convention of the International Railroad Master Blacksmiths' Association opened at the Hotel Cadillac, Detroit, Mich., August 16, with President George W. Kelley in the chair, and with an unusually large number of members in attendance. Papers were read on tools and formers, frame welding, the oxy-acetelyne welding process, spring making, casehardening and several other subjects, all of which were discussed, the members giving their personal experiences and opinions thereon.

About twenty-five supply dealers had exhibits and furnished an interesting program of entertainments, including automobile, trolley and boat rides, and a final complimentary excursion by the National Machinery Co., by special train, to Tiffin, Ohio.

At the close of the morning session, August 18, the following officers were elected for the ensuing year: John Conners, A. & W. P. R. R., Montgomery, Alabama, president; F. F. Hoeffle, L. & N. R. R., Louisville, Ky., first vice-president; J. T. McSweeney, B. & O. R. R., Baltimore, Md., second vice-president; A. L. Woodworth, C. H. & D. R. R., Lima, Ohio, secretary and treasurer, and G. H. Williams, Boston, Mass., chemist, after which the convention was adjourned, instructions being given to the executive committee to select the next meeting place from the cities of Toledo, Boston or Denver.

* * *

SIXTY YEARS SERVICE WITH ONE COMPANY

Thomas Ogram who has been employed by William Sellers & Co., Inc., for over sixty years

At a time when employers are troubled by the unreliability of employes and the difficulty of holding them in continuous faithful service, as probably never before, it is refreshing to hear of the long, honorable career of Mr. Thomas Ogram with William Sellers & Co., Inc., of Philadelphia. On July 23 Mr. Ogram completed a term of sixty years' service with the company which he has served as apprentice, journeyman-machinist, foreman, instructor, counsellor of apprentices, and in the doing of which he won the respect and regard of all with whom he came in contact. While not now in active service, he is still on the payroll of the company and is regarded as one of them.

The completion of the sixtieth year was fittingly celebrated by a reception at which the men in the shops and the officers of the company, some of whom had been in service with him for nearly fifty years, greeted Mr. Ogram. An engrossed album testimonial, signed by the officers and staff and the directors who were formerly officers and long associated with Mr. Ogram, was presented to him, after which a collation was served. The testimonial follows:

To our dear comrade, Thomas Ogram, greeting:

This twenty-third day of July, nineteen hundred and ten, brings to us the notable reminder that on the same day many years ago you entered the employ of this house as an apprentice, and have now completed an unbroken, faithful and honorable service of sixty years.

It is accorded few men to attain such an enviable record, and fewer employers to receive such loyal service.

In all of this long period as apprentice, journeyman-machinist, foreman, and trusty counsellor and instructor of other apprentices, your varied and responsible duties were performed cheerfully and with exceptional skill, while the impress of your high character and genial personality was left upon all with whom you came in contact.

Meanwhile the number of our employes grew from thirty-five to nearly six hundred, and the product of the particular department with which you were most directly identified—metal planing and metal planing machines—has acquired the highest reputation all over the world.

It therefore seems to us fitting that we should especially commemorate this day by presenting to you with appreciative and affectionate greeting, this inscribed testimonial as a permanent record of our high and lasting regard.

It is interesting to reflect on the changes in manufacturing conditions and in the industrial world generally that have come about in the span of Mr. Ogram's industrial career, beginning 1850, but of greater present interest is the consistent policy of a manufacturing concern that won and held the loyalty of an employe for sixty years. May there not be in this example of harmonious relation extending over an ordinary lifetime a suggestion for those who deplore the never-ending conflict between capital and labor?

* * *

LOW SALARIES OF ENGINEERS IN GERMANY

An interesting article in *Teknisk Tidskrift* calls attention to the over-supply of technically educated men in the German industries and the resulting low wages paid to well-educated men filling the positions in the designing room and laboratory. A young man, after having finished a four or five years' college course, often finds himself forced to accept a position with no pay at all for four or six months, with the promise that after that time his services will be compensated, providing he proves satisfactory. Others receive from $10 up a month, and a young graduate who receives 100 marks ($25) per month considers himself fortunate. It is by no means only for the first few years that the technical graduate finds himself so poorly compensated. There is a large class of these men whose salary never exceeds 200 marks ($50) per month. The same scale of compensation applies also to the great number of doctors of philosophy who have entered in industrial work as chemists. A monthly pay of 175 marks ($45) per month for a middle-aged doctor working in the laboratories of the large industrial companies is not unusual. These conditions are due to the enormous number of men who have, during the last few years, entered into industrial work. During the fifteen years from 1891 to 1906 the number of students at the higher engineering schools in Germany increased over 200 per cent, and is still increasing, while at the same time the number of students at the regular universities who devoted themselves to sciences and of which the majority later on entered the industrial field, increased by 160 per cent. The number of students at the lower technical colleges during the same period increased by 130 up to 300 per cent. The conditions have become so acute that the Bavarian Government has issued a warning to young men against selecting the engineering profession on account of the over-supply of men in this branch.

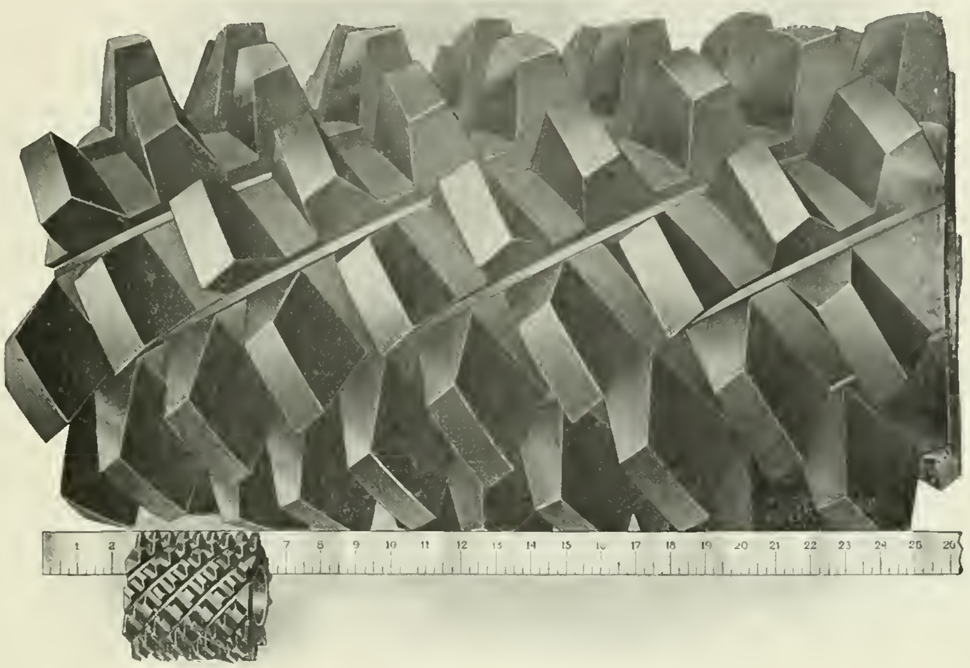
These abnormal conditions have also created a system of industrial despotism unknown in America. It is not unusual that the young graduate in order to obtain a position is required to sign a contract in which he agrees that he will not enter into the employ of a competing firm during a period of from two to four years, or, in extreme cases, up to ten years, after the time of leaving the employer with whom this contract is made. The older employes are largely tied to their position by the pension system of the employers. Another abnormal condition which may be mentioned is that an employe has no right to patent anything that has been conceived in connection with his employment, and the inventions which he makes are the property of his employer. His name, in fact, does not even appear in the patent application. In many cases access to the works is entirely denied any employe not directly working in the shops, and sometimes one will hear persons expressing their wish to see the works where for a period of five years they may have been working in the drafting-room or laboratory.

* * *

COBALT-CHROMIUM ALLOY TO REPLACE STEEL IN MAKING CUTLERY

A new alloy, discovered by Elwood Haynes, an automobile manufacturer of Kokomo, Ind., is proposed as a substitute for steel in the manufacture of small cutlery. It is more lasting than steel and so slightly higher in cost that it will be a practical metal for that purpose. Mr. Haynes has erected a factory in Kokomo for the manufacture of cutlery in the new alloy, which is a compound of cobalt and chromium. When a mixture of cobalt and chromium is heated to whiteness in a crucible the cobalt fuses first and immediately combines

When you buy a hob that is accurately cut, properly hardened and correctly ground, you can feel sure of accurately cut worm wheels.



HOB MANUFACTURE

Because of our long experience, coupled with the aid of special hobbing machinery, we are able to fulfill all of the above conditions and to quickly fill all orders for Worm Hobs, either large or small.

The main characteristics of these hobs are their accuracy, ability to stand up under heavy service and the fact that they cut as freely and may be sharpened in the same manner as formed cutters.

The illustration shows the comparison between a small hob and a large one 25⅜″ in length, 15.4″ in diameter, 28″ lead, 7 threads and 4″ circular pitch.

The hobs are made with straight or taper holes, right or left hand threads and with or without shanks.

We will gladly estimate and submit prices on hobs if you will submit blue prints of the work you wish to do.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

with the chromium; if the metals are mixed in the proportion of about three parts, by weight, of cobalt to one part of chromium, a eutectic is formed, that is, an alloy having a lower melting point than cobalt or chromium. The color of the alloy lies between that of steel and silver and is especially pleasing in a bright light. It is readily polished, but requires special treatment in order to develop its highest luster. The most valuable property of this combination, however, is its resistance to corrosion. It is equalled in this respect only by gold and metals of the platinum group. It is attacked slowly by cold hydrochloric acid, and somewhat vigorously by the strong acid when heated. Momentary exposure, however, to either dilute or strong hydrochloric acid has practically no effect upon the metal. Fruit acids which quickly dim the luster of ordinary cutlery do not tarnish the cobalt-chromium alloy.

* * *

PERSONALS

T. Evans, for many years purchasing agent of the Cananea Copper Co., has been appointed local manager of the Mine & Smelters Supply Co.'s branch office at Denver.

C. M. Hamersly, formerly engineer with the Link Belt Co., Philadelphia, is now in charge of the Philadelphia office of the Vandyck Churchill Co., 654 Bourse Building, Philadelphia, Pa.

George Gilmore, head of the safety department of the Travelers' Insurance Co., New York, has been sent to Europe by the New York State sub-committee on industrial accidents to study the causes of industrial accidents in England, Germany, France and Switzerland.

G. A. Thompson, for a number of years special traveling representative of the Lodge & Shipley Machine Tool Co., has entered the employ of that firm's Pittsburg agent, the Brown & Zortman Machinery Co., as a general machine tool salesman in the Pittsburg district.

Walter Cantelo has resigned his position as superintendent of the Herreshoff Motor Co., of Detroit, Mich., in order to enter into the employ of the American & British Mfg. Co. of Bridgeport, Conn., as assistant general superintendent. Mr. Cantelo was connected with this company before going to Detroit nearly two years ago.

Frank Koester, of New York, in a paper presented before the recent convention of the Society for the Promotion of Engineering Education, held at Madison, Wis., discussed in detail the educational system of the German Technical Universities. He also analyzed the conditions and standing of the German engineers as compared with our own.

M. A. Beck, who was chief engineer of the Pawling & Harnischfeger Co. for a number of years and who has been closely connected with the design and manufacture of cranes, machine tools, etc., for years, has allied himself with the Toledo-Massillon Bridge Co., Toledo, Ohio, in the capacity of consulting engineer and representative in the Milwaukee district.

William J. A. Bailey, 32 Broadway, New York City, who recently returned from a successful trip around the world, representing a number of American manufacturers, is now preparing for another business tour, and expects to leave this country early in the Fall. He expects to be gone about a year, visiting the leading commercial centers of the world, and his trip will no doubt be of interest to manufacturers seeking foreign trade.

Dr. William H. Tolman, director of the American Museum of Safety and chairman of the American Executive Committee of the International Committee of Social Insurance, has been designated by the State Department at Washington as a delegate on the part of the United States to the International Congress on Workmen's Insurance to be held at the Hague, September 6-9. Among the questions to be discussed are: the extension of social insurance to include other than workmen, that is, small trades-people, shop keepers, and farmers; provisions for widows and orphans by insurance; and insurance against unemployment.

Prof. George I. Alden, treasurer of the Norton Co., Worcester, Mass., returned, on July 29, from a short business trip to England and Germany. The Norton Co. has established at Wesserling, Germany, a plant for making abrasive wheels, and Prof. Alden visited the new plant in the interests of the firm with which he is officially connected. He was accompanied on his return voyage by Mr. Clayton O. Smith, chief of the purchasing department for the Norton Grinding Co. Mr. Smith was returning from a trip of about seven weeks' duration to the Continent and to England, during which he had visited the cities of London, Berlin and Paris, as well as other cities in which are agencies and stores of the Norton Grinding Co.

OBITUARIES

Albert H. Wheeler, president of the Standard Machinery Co., Mystic, Conn., died August 4.

Charles W. Fisher, a member of the W. P. Davis Machine Co., Rochester, N. Y., died July 21 at his home in Rochester, aged fifty-one years.

David Ranken, Jr., founder of the School of Mechanical Trades in St. Louis, which bears his name, died at Atlantic City, N. J., August 18, aged seventy-four years.

Albert Spies, for several years editor of *Cassier's Magazine*, and later proprietor and editor of the *Foundry News* (recently founded), died at his home in Jersey City, N. J., August 16, aged forty-eight years.

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COMING EVENTS

September 6-9.—Fifteenth annual convention of the International Association of Municipal Electricians, Rochester, N. Y.

September 15-17.—Semi-annual meeting of the National Association of Cotton Manufacturers, Portsmouth, N. H., Hotel Wentworth, headquarters. C. J. H. Woodbury, secretary, 45 Milk St., Boston, Mass.

October 9-12.—Second International Congress of Refrigeration, Vienna, Austria. For further information address Mr. F. W. Pilsbury, 1660 Monadnock Building, Chicago, Ill.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. H. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

November 17-19.—Fourth annual convention of the National Society for the Promotion of Industrial Education, Boston, Mass. A feature of this convention will be a lecture on "Continuation Schools," by Dr. George Kerschensteiner, superintendent of schools, Munich, Germany.

SOCIETIES AND COLLEGES

Eighteenth Annual Catalogue, University of Idaho, Moscow, Idaho.

Year Book of the Michigan College of Mines, Houghton, Mich. Frances H. Scott, secretary.

Columbia University Bulletin of Information on Schools of Mines, Engineering and Chemistry, New York. Frank D. Fackenthal, secretary.

Bulletin of the University of Nebraska. 462 pages, 5¾ x 8½ inches. Published by the University of Nebraska, Lincoln, Neb.

This bulletin is the fortieth annual general catalogue of the university, and contains a complete record for the year 1909-1910 and announcements for 1910-1911. The courses of instruction are outlined and considerable general information regarding the university is given.

Bulletin of the University of Utah. 286 pages, 5 x 7½ inches. Published by the University of Utah, Salt Lake City, Utah.

This catalogue contains announcements for the year 1910-1911, together with a list of students for 1909-1910. It gives complete information regarding the university, its rules and regulations, courses, fees and expenses.

American Association for Labor Legislation, Metropolitan Tower, 1 Madison Ave., New York City. Papers read at the First National Conference on Industrial Diseases, Chicago, June 10, 1910. This pamphlet of 52 pages, 6 x 9 inches, contains several important papers relating to diseases prevalent among industrial workers due to their occupation.

American Association of Commerce and Trade, Equitable Building, Friedrichstrasse 59-60, Berlin, Germany, founded seven years ago by Americans, for the purpose of promoting American trade with Germany and German trade with the United States, calls the attention of American business men, intending to do business in Germany, to the facilities of the association. Information is given regarding business conditions in Germany, and firms are actively assisted in finding agents and establishing branches in Germany.

NEW BOOKS AND PAMPHLETS

The Forests of Alaska. By R. S. Kellogg. 24 pages, 6 x 9 inches. Illustrated with maps and halftones. Published by the Department of Agriculture, Washington, D. C.

The New York Improvement and Tunnel Extension of the Pennsylvania Railroad. 31 pages, 5½ x 8 inches. Illustrated. Published by the Pennsylvania R. R. Co., Philadelphia, Pa.

Statistics of Railways in the United States for the Year Ending June 30, 1908. 989 pages, 6 x 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Bulletin of Revenues and Expenses of Steam Roads in the United States for the Month of April, 1910. 19 pages, 9½ x 11½ inches. Published by the Interstate Commerce Commission, Washington, D. C.

International Union of the American Republics. Report of the Director to the Fourth Pan-American Conference held at Buenos Aires, Argentine Republic, July, 1910. 120 pages, 6 x 9 inches. Published by the International Bureau of the American Republic, Washington, D. C.

Engineering Record Directory. 131 pages, 4 x 7 inches. Published by the *Engineering Record*, New York.

This is a directory of manufacturers of and dealers in engineers' and contractors' machinery and supplies. The directory is not intended to be a complete directory of the trade, the names listed being limited to those concerns and individuals whose advertisements appeared in the contractors' number of the *Engineering Record*, April 2, 1910.

Dimensions of Pipe Fittings and Valves. 89 pages, 6 x 9 inches. Published by the National Book Co., Collinwood, Ohio. Price $0.75.

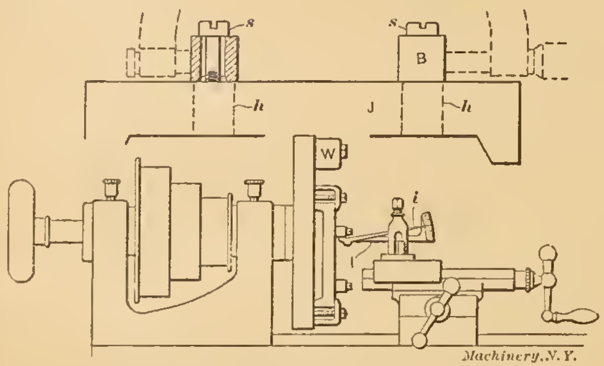
This book, which is now in its third edition, contains a collection of such dimensions and information as will enable the draftsman, engineer or architect, to plan installations including pipes, fittings and valves. Some of the tables have been taken wholly or in part from trade catalogues and engineering publications, proper credit having been given. A great many of the tables have been obtained by actual

Supplement to MACHINERY, October, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Locating Work by the Button Method"

SHOP OPERATION SHEET NO. 148

Franklin D. Jones MACHINERY, October, 1910



Locating Work by the Button Method

NOTE.—When it is necessary to bore holes with great accuracy as to location, the button method, which is the one commonly used on jig work, is employed. The method consists, briefly, in locating cylindrical bushings, or buttons B, exactly central with the holes to be bored and setting the work on the faceplate in the correct location for boring each hole, by the buttons. As the position of the bored holes is governed entirely by the buttons, the location of the latter is of great importance. As a simple illustration of this work, we shall assume that two holes h need to be bored in the jig-plate J, which has been previously finished on the top and sides.

1. First lay off the centers of all holes to be bored, approximately correct, by the usual method. Mark these centers with a prick-punch, and then drill and tap holes for the machine screws s which are used to clamp the buttons.

NOTE.—The buttons should be ground and lapped to the same size and the ends finished perfectly square. The outside diameter should preferably be such that the radius can easily be determined, and the hole should be about 1/8 inch larger than the screw so that the button may be shifted.

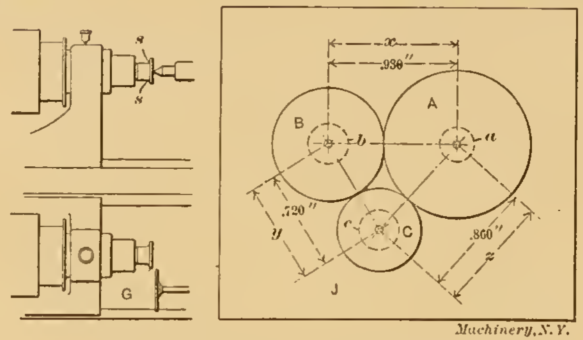
2. Clamp the buttons lightly and set them in correct relation with the sides of the jig. This can be done by placing first one and then the other of the finished sides from which the buttons are to be set, on a surface-plate and measuring with a Vernier height gage. The center-to-center distance can be verified by measuring with an outside micrometer, as indicated by the dotted lines. When the buttons are accurately set, clamp them tightly and then take a final measurement.

3. Clamp the work to a lathe faceplate (bench lathe is preferable for small work) and set one of the buttons true by using a test indicator I. When the inner end of the indicator is brought into contact with the revolving button, the vibration of the pointer i, shows which way the work should be shifted. When one button is set practically true, remove it and bore and ream the hole. In a similar manner finish the remaining hole.

NOTE.—When work being bored is set off center, as illustrated, the faceplate should be balanced by a counterweight W, as otherwise centrifugal action will tend to cause inaccuracy when the lathe is speeded up for boring.

SHOP OPERATION SHEET NO. 149

Franklin D. Jones MACHINERY, October, 1910



Locating Work by the Disk Method

NOTE.—Comparatively small precision work is sometimes located by the disk method, which is the same in principle as the one described on the preceding sheet, the chief difference being that disks are used instead of buttons. These disks are made to such diameters that when their peripheries are in contact, each disk center will coincide with the position of the hole to be bored; the centers are then used for locating the work. To illustrate this method, let us assume that the jig-plate J (see engraving) is to have three holes (a, b and c) bored in it to the center distances given.

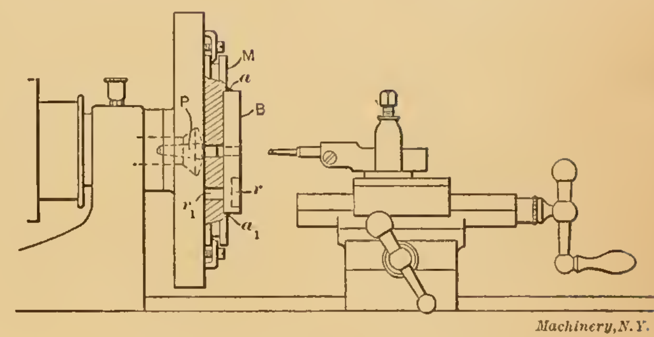
1. Before the disks can be made, it is first necessary to determine their diameters. If the center distances between all the holes were equal, the diameters would, of course, equal this dimension. When, however, the distances between the centers are unequal, the diameters may be found as follows: Subtract, say, dimension y from x, thus obtaining the difference between the radii of disks C and A; add this difference to dimension z, and the result will be the diameter of disk A. Dividing this diameter by 2 gives the radius, which, subtracted from center distance x equals the radius of B; similarly the radius of B subtracted from dimension y equals the radius of C. Having the radii, the diameters are, of course, easily obtained. For example, $0.930 - 0.720 = 0.210$ or the difference between the radii of disks C and A. Then the diameter of $A = 0.210 + 0.860 = 1.070$ inch, and the radius equals $1.070 \div 2 = 0.535$ inch. The radius of $B = 0.930 - 0.535 = 0.395$ inch and $0.395 \times 2 = 0.790$, or the diameter of B. The center distance $0.720 - 0.395 = 0.325$, which is the radius of C; $0.325 \times 2 = 0.650$ or the diameter of C.

2. After determining the diameters, the disks should be turned nearly to size and finished preferably in a bench lathe. First insert a solder chuck in the spindle, face it perfectly true, and attach the disk by a few drops of solder as at s, being careful to hold the work firmly against the chuck while soldering. Face the outer side and cut a sharp V-center in it; then grind the periphery, as at G, to the required diameter.

3. Fasten the finished disks on the jig-plate (in their correct location and with their peripheries in contact) by applying a mixture of melted beeswax and rosin (in about equal proportions) to the sides. When this has hardened, attach the work to the faceplate, and set it for boring each hole by using a center indicator in the disk centers.

SHOP OPERATION SHEET NO. 150

Franklin D. Jones MACHINERY, October, 1910



Locating Work by a Master-plate

NOTE.—When it is necessary to machine two or more plates so that they are duplicates, as to the location of holes, circular recesses, etc., what is known as a master-plate is often used for locating the work on the lathe faceplate. This master-plate M contains holes which correspond to those wanted in the work, and which accurately fit a central plug P in the lathe spindle, so that by engaging first one hole and then another with the plug, the work is accurately positioned for the various operations. Precision work of this kind is done when possible, in a bench lathe.

1. When making the master-plate, great care should be taken to have the sides parallel and the holes at right angles to the sides. The various holes may be located with considerable precision by the use of buttons or bushings as described on Sheet No. 148. Of course, it is necessary to have a hole in the master-plate for each different position in which the work will have to be placed on the faceplate; for example, if a circular recess r were required, a hole r_1 exactly concentric with it, would be needed in the master-plate. The method of holding the work and locating it with reference to the holes in the master-plate will depend largely on its shape. The cylindrical blank B illustrated, is positioned by a recess in the master-plate in which it fits, and it can be held by soldering at various points as at a and a_1. Clamps and dowel-pins or screws are, however, more often used.

2. The plug P which locates the master-plate, is first turned to fit the spindle or collet of the lathe and the outer or projecting end is rough turned for the holes in the master-plate; it is then inserted in the spindle and ground and lapped to a close fit for the holes in the master-plate. The latter, with the work attached to it, is then clamped to the faceplate by the straps shown, which engage a groove cut for the purpose.

3. The first hole is finished by drilling to within, say, 0.005 or 0.006 inch of the size, and then boring practically to size, a very small amount being left for reaming. The remaining holes can then be finished in the same way, the work being positively located in each case by loosening the master-plate and engaging the proper hole in it with the central plug. It is apparent that by the use of this same master-plate, a number of pieces B could be made which would be practically duplicates.

MACHINERY

October, 1910

DESIGN OF AUTOMOBILE TRANSMISSION GEARS—1

By M. TERRY*

STRICTLY speaking, clutch, speed-changing mechanism, universal joints, propeller shaft, differential, etc., have equal legitimate rights to the term "transmission"; however, the term, as used at present, applies only to the speed-changing device.

The first automobiles built lacked this important detail, and the driver controlled the speed of his car by varying the speed of its engine. To-day, transmission is an essential part of self-propelled vehicles. The sole object of transmission is to vary the relative speeds of the propeller and engine shafts. In general, this object is accomplished either by means of friction disks or by a set of gears of varying diameters. Of the two, the gears seem to have the lion's share of the field. The manner in which the gears are engaged to transmit power is the distinguishing feature of the various gear transmissions. We have planetary, sliding-progressive, sliding-selective, and non-sliding—each of them possessing advantages and disadvantages over other types. In the present article the author will attempt to discuss a few of the main principles common to all gear transmissions.

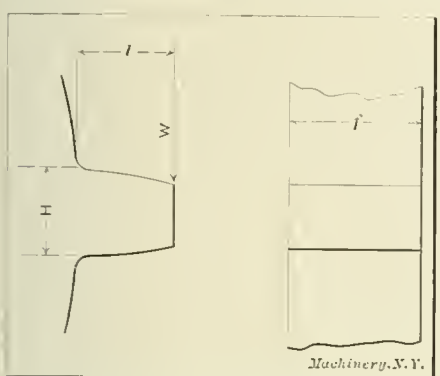


Fig. 1. Automobile Transmission Gear Stub-tooth as a Cantilever

With the data that a transmission designer is usually given, he first has to find the ratio of the various gears, their pitch and their face, and it usually takes a great deal of figuring and judgment to arrive at suitable proportions. As a matter of fact, judgment based on experience is of far greater importance than all the formulas in textbooks on machine design. The following incident may be of interest to those who are inclined to doubt this statement.

A certain firm was lately marketing an up-to-date car which sold largely on its mechanical merits. The car had a clutch of the disk type. A short time ago the firm decided to try out a cone clutch. Accordingly, one completely interchangeable with the disk clutch was built and installed in a test car. "Personal element" was practically eliminated; both clutches were designed by the same man, built in the same shops, and installed in like cars with like engines and transmissions.

In its first trial the cone clutch completely demolished the transmission which had never given any sign of trouble with the disk clutch. It is beyond the scope of this article to discuss the relative merits of the two clutches; the fact is merely stated to demonstrate the existence of one important element not subject to calculations—namely, shocks. A transmission suitable for a six-cylinder engine, may cause trouble on a four-cylinder and be a complete failure on a two-cylinder, the horsepower and the revolutions per minute of the three engines being precisely the same.

However good a designer's judgment may be, he must seek confirmation of his guess in figures. This becomes absolutely necessary when the horsepower of the car rises above 40, and in special racing cars where horsepower may vary anywhere from 80 to 225, the calculations are to be relied on in preference to the judgment.

The well-known and largely-used Lewis formula for gears

$$W = s\,p\,f\,y$$

cannot be applied to transmission gears, for the reason that automobile practice brought out a new type of gears called stub-tooth. Thus, an 8-10 pitch stub-tooth gear is one whose diametral pitch is 8 but whose addendum and dedendum are those of the regular 10-pitch gear. This combination gives a decidedly stronger tooth, for, considering each tooth as a cantilever, it is clear that for the same allowable stress the shorter tooth can transmit more power.

In the above formula

W = load transmitted by the teeth, in pounds,

s = safe working stress of the material,

p = circular pitch,

f = face, in inches,

y = a factor depending on the form and number of teeth.

The existing tables for different values of y cannot be applied to stub-teeth. In the absence of better formulas, the author prepared a table for the factor y, which in connection with the Lewis formula seems to give satisfactory results.

The derivation of this table is rather simple. Considering each tooth as a cantilever the following formula can be applied:

$$W\,l = \frac{s\,f\,H^2}{6}$$

where W, s and f have the same meaning as in the Lewis formula, and l and H are clear from Fig. 1.

By changing from the regular 20-degree involute tooth to the 20-degree involute stub the only values affected are those of W and l. (H is slightly affected, too, but it can be neglected.) Since W varies inversely as l, it is clear that the load-carrying capacity of a 6-8 pitch stub-tooth is to an ordinary 6-pitch tooth as 8:6. Likewise:

$$\frac{W \text{ of 5-7 pitch stub-tooth}}{W \text{ of 5 pitch tooth}} = \frac{7}{5}, \text{ etc.}$$

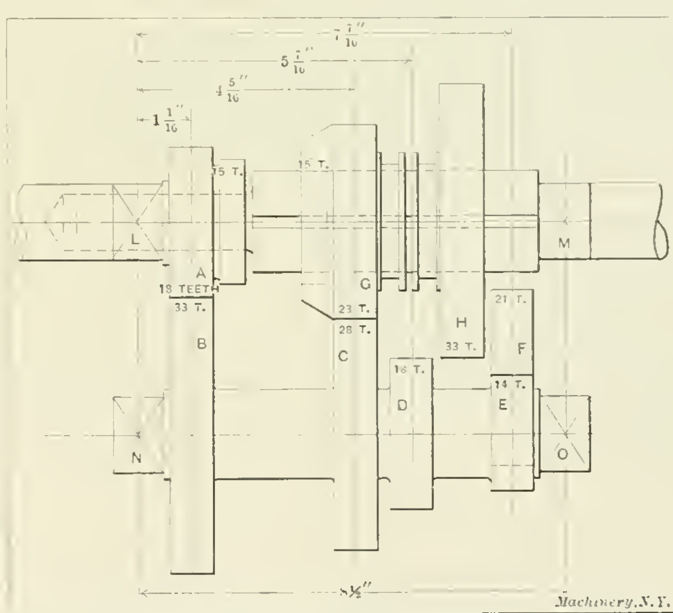


Fig. 2. Typical Automobile Transmission Gear of Sliding-selective Type

The following pitches are commonly used in automobile work: 4-5, 5-7, 6-8, 7-9 and 8-10—all 20-degree involute. Taking the values assigned by Lewis to y (Kent's Mechanical Engineers' Pocket-Book, p. 901 and MACHINERY's Data Sheet No. 22, July, 1903), and multiplying them by the ratio of the levers, we obtain the following table:

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TABLE I. VALUES OF y FOR STUB-TEETH

No. of Teeth	20 Involute Stub-tooth—Pitch				
	4–5	5–7	6–8	7–9	8–10
12	.097	.109	.104	.100	.097
13	.104	.116	.110	.106	.104
14	.110	.123	.117	.113	.110
15	.115	.129	.122	.118	.115
16	.117	.131	.125	.121	.117
17	.120	.134	.128	.123	.120
18	.122	.137	.130	.126	.122
19	.125	.140	.133	.128	.125
20	.127	.143	.136	.131	.127
21	.130	.145	.138	.134	.130
23	.132	.148	.141	.136	.132
25	.135	.151	.144	.139	.135
27	.139	.155	.148	.142	.139
30	.142	.159	.152	.146	.142
34	.147	.165	.157	.152	.147
38	.152	.171	.162	.157	.152
43	.157	.176	.168	.162	.157
50	.162	.182	.173	.167	.162
60	.167	.187	.178	.172	.167
75	.172	.193	.184	.177	.172
100	.177	.199	.189	.182	.177
150	.182	.204	.194	.188	.182
300	.187	.210	.200	.193	.187
Rack	.192	.216	.205	.198	.192

The value of W.—To obtain the value of W, the following formula is commonly used:

$$P\,R = 63{,}024\,\frac{\text{H. P.}}{\text{R. P. M.}} = T = \text{torque}$$

where P = tangential force, R = pitch radius of the gear.

In attempting to design gears that will stand up to the worst conditions of service, a designer invariably chooses the maximum horsepower and the corresponding revolutions per minute. While the error may not be great, the idea is erroneous, for the maximum torque does not occur at the maximum horsepower.

To obtain the maximum torque, an actual engine test is necessary. The data required are only those of horsepower and revolutions per minute, and from these a torque curve may be readily plotted. Having found the maximum torque, the value of P is obtained by dividing the torque by R.

$$P = \frac{T}{R}$$

As there are always two pairs of teeth in mesh, W is never equal to P.

$W = K\,P$, where K may vary from ½ to 1. In accurately cut automobile gears K may be safely assumed not to exceed 0.6.

Lack of knowledge of the value of s.—The material commonly used for transmission gears is 3 1/2 per cent nickel-steel alloy. As the horsepower of the car increases, chrome-nickel and chrome-vanadium steels are resorted to. These alloy steels possess high elastic limits, which are raised still higher by the special heat-treating methods to which all finished gears are subjected. The elastic limits of these heat-treated materials are well known, and by selecting the proper factor of safety, the value of s is readily obtained. This method, however, takes no account of the speed at which the gears are run. What is sadly needed at the present moment is a set of reliable tables of safe stresses for these alloy steels when run at speeds varying from 500 to 3000 feet per minute. The lack of information on this point is, however, made up as explained later.

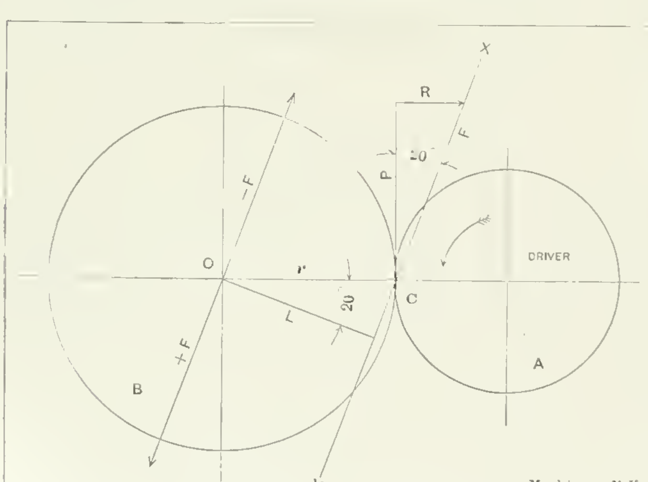


Fig. 3. Forces Acting in Gears

Solving for f.—All factors involved in the Lewis formula are now either known or assumed; it remains to solve for f—face of gears. For obvious reasons, designers concentrate their attention on the slow gear. Although the reverse gear is usually subjected to a somewhat greater stress than the slow gear, it can be neglected, for it is used but seldom, and then only for short periods of time.

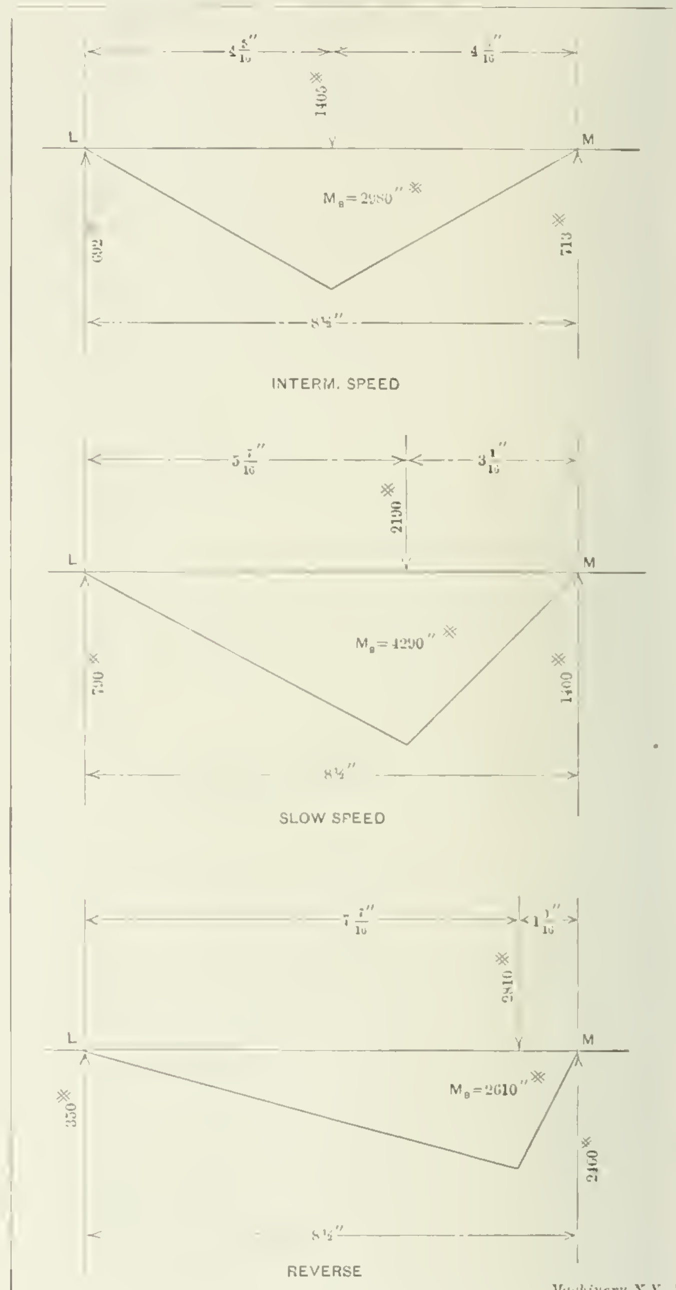


Fig. 4. Bending Moments in Transmission Shafts for Intermediate, Slow Speed and Reverse

The required width of the slow gear being found, the rest are made of the same width. At first glance this may seem to be inconsistent with principles of good design, but a little thought will show that there is a good reason back of it.

While the pressure on the teeth of the slow gear is considerably greater than that on other gears, its peripheral speed is smaller in the same proportion. The safe unit stress for a given material drops off very rapidly with increase of speed.

Thus the practice of making all gears of the same width seems to compensate for their great range of speed.

Factor of Safety

What is the proper factor of safety for transmission gears? The author is inclined to believe that a factor of 4, when used in connection with the Lewis formula, will give satisfactory results. He realizes that this factor is altogether too low, and from certain data at his disposal he is positive that the actual, existing factor of safety is much higher. The trouble lies with the Lewis formula. As stated before, it is used for want of a better one. Nevertheless, it can be successfully applied when proper values are assigned to various constants. When thousands of transmissions of various types give satisfactory service, and the rare cases of their breakdown and invariably due to the driver's carelessness in shifting gears and engaging the clutch, it may be assumed that they are reasonably safe. These gears when analyzed by means of the Lewis formula seem to have a stress equal to about one-fourth the elastic limit; hence, the conclusion regarding the factor of safety.

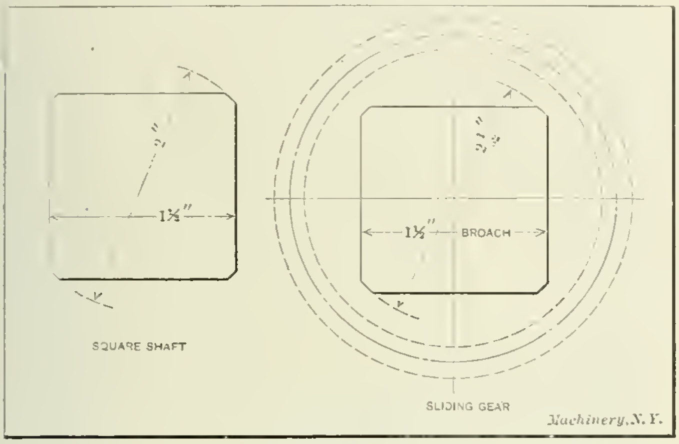


Fig. 5. Square Shaft and Sliding Gear used in Common Types of Transmissions

A problem taken from actual practice and completely worked out will serve to illustrate the principles involved in calculating gears, shafts, bearings, etc.

Specifications are as follows:

Maximum torque is developed at 1200 R. P. M.

Corresponding H. P. = 32.

Engine: 4-cylinder; 4½-inch bore; 5-inch stroke.

Clutch: Cone type.

Type of transmission: Sliding-selective.

Speeds required: Three forward and a reverse. High speed obtained by direct drive; intermediate speed = 65-70 per cent of the high speed; slow speed = about 30 per cent of the high speed.

Gears to be of 6-8 pitch, unless inconsistent with the requirements of strength.

Material for gears: 3 1/2 per cent nickel steel.

Gears

The first thing to do is to find suitable pitch diameters (or number of teeth) that will give the desirable speed ratios. By a cut-and-try method we obtain the number of teeth for each gear as indicated in Fig. 2.

$$\text{Intermediate speed} = \frac{18}{33} \times \frac{28}{23} = 66\tfrac{1}{2} \text{ per cent of high speed.}$$

$$\text{Slow speed} = \frac{18}{33} \times \frac{18}{33} = 29.8 \text{ per cent of high speed.}$$

$$\text{Torque on } A = 63{,}024 \times \frac{32}{1200} = 1680 \text{ inch-pounds.}$$

$$\text{Torque on } B \text{ (and consequently on } D) = 1680 \times \frac{33}{18} = 3080$$

inch-pounds $= T$.

Since the pressure on the pitch lines of gears D and H is the same, our calculations must be based on D since by virtue of having fewer teeth than H, it is the weaker of the two. (Consult Table 1.)

$$\text{The radius of } D = \tfrac{1}{2} \times \frac{18}{6} = 1\tfrac{1}{2} \text{ inch} = R$$

$$P = \frac{T}{R} = \frac{3080}{1.5} = 2050 \text{ pounds}$$

$$W = 0.6 \times 2050 = 1230 \text{ pounds.}$$

$$y = 0.130.$$

$$p = \frac{\pi}{6}$$

$$s = \frac{85{,}000}{4} = 21{,}250 \text{ pounds.}$$

The elastic limit of heat-treated 3 1/2 per cent nickel steel is in the neighborhood of 85,000 pounds; factor of safety = 4.

$$W = s\,p\,f\,y$$

Transposing

$$f = \frac{W}{s\,p\,y} = \frac{1230}{21{,}250 \times \pi/6 \times 13/100} = 0.85 \text{ inch.}$$

Therefore all gears are made ⅞-inch wide.

By making due allowances for clearances between the gears and the probable width of the ball bearings on which the shafts are to be mounted, the distance between the points of support is practically settled.

Both shafts are subject simultaneously to twisting and bending moments.

In Fig. 3, P stands for tangential pressure. The path of contact and direction of pressure are represented by the line XY which passes through the point of contact of the pitch circles and makes an angle of 20 degrees with P. The total pressure F along this line is the geometrical sum of tangential pressure P and radial pressure R. P and R being at right angles to each other. Their resultant F is the hypothenuse of a right-angle triangle. Expressed in terms of P

$$\frac{P}{F} = \cos 20 \text{ degrees}; \; F = \frac{P}{\cos 20 \text{ degrees.}}$$

By introducing at O (center of the gear B) two equal and opposite forces each equal to F and parallel to it, the balance of forces is not disturbed. But F at C and $-F$ at O form a couple or moment whose arm is L.

This moment produces rotation of the gear B against resistance offered at the other end of the shaft, thus tending to twist the shaft.

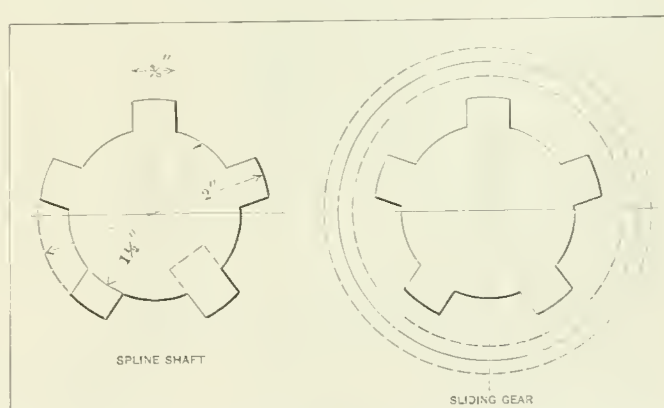


Fig. 6. Splined Shaft and Sliding Gear used in High-grade Transmission

The twisting moment $= M_T = F \times L$.

L is at right angles to XY, thus making 20 degrees with r; therefore,

$$L = r \cos 20 \text{ degrees.}$$

$$M_T = F \times L = \frac{P}{\cos 20 \text{ degrees}} \times r \cos 20 \text{ degrees} = Pr,$$

i. e., twisting moment on the shaft = torque on the gear. The force $+F$ at O produces a bending moment on the shaft and puts pressure on the bearings. The magnitude of this pressure as well as of the bending moment depends on the distance of the particular gear from the bearings.

Sliding Gear Shaft

High speed.—Since the high speed is obtained by a direct or through drive the shaft is subject only to a twisting moment numerically equal to that of the engine shaft or gear C.

Twisting moment $= M_T = 1680$ inch-pounds.

Bending moment $= M_B = 0$.

Pressure at L and $M = 0$.

Intermediate speed.—Twisting moment $= M_T = 1680 \times \frac{33}{18} \times \frac{23}{28} = 2530$ inch-pounds.

Radius of gear $G = \frac{1}{2} \times \frac{23}{6} = \frac{23}{12}$ inch.

Tangential pressure on pitch line $= 2530 \times \frac{12}{23} = 1320$ pounds.

Total pressure (combined tangential and radial) $= F = \frac{P}{\cos 20 \text{ degrees}} = \frac{1320}{0.93969} = 1405$ pounds.

Pressure at $M = 1405 \times \frac{4\ 5/16}{8\frac{1}{2}} = 713$ pounds.

Pressure at $L = 1405 - 713 = 692$ pounds.

Maximum bending moment $= M_B = 692 \times 4\ 5/16 = 2980$ inch-pounds. (See Fig. 4.)

The twisting and bending moments are combined according to the following formula:

$T_E = M_B + \sqrt{M_B{}^2 + M_T{}^2}$ (Unwin's Machine Design, Part I, p. 268) where T_E is the equivalent twisting moment. It is the theoretical twisting moment whose straining action is equivalent to that of the existing bending and twisting moments.

$T_E = 2980 + \sqrt{2980^2 + 2530^2} = 6980$ inch-pounds.

Slow Speed.—Twisting moment $= M_T = 1680 \times \frac{33}{18} \times \frac{33}{18} = 5650$ inch-pounds.

Radius of gear $H = \frac{1}{2} \times \frac{33}{6} = 2\ 3/4$ inches

Tangential pressure on pitch line $= 5650 \div 2\ 3/4 = 2055$ pounds.

Total pressure $\frac{2055}{0.93969} = 2190$ pounds.

Pressure at $M = 2190 \times \frac{5\ 7/16}{8\frac{1}{2}} = 1400$ pounds.

Pressure at $L = 2190 - 1400 = 790$ pounds.

Maximum bending moment $= 1400 \times 3\ 1/16 = 4290$ inch-pounds.

$T_E = 4290 + \sqrt{4290^2 + 5650^2} = 11{,}390$ inch-pounds.

Reverse.—Twisting moment $= M_T = 1680 \times \frac{33}{18} \times \frac{33}{14} = 7260$ inch-pounds.

Radius of gear $H = 2\ 3/4$ inch.

Tangential pressure $\frac{7260}{2.75} = 2640$ pounds.

Total pressure $= \frac{2640}{0.93969} = 2810$ pounds.

Pressure at $M = 2810 \times \frac{7\ 7/16}{8\frac{1}{2}} = 2460$ pounds.

Pressure at $L = 2810 - 2460 = 350$ pounds.

Maximum bending moment $= 2460 \times 1\ 1/16 = 2610$ inch-pounds.

$T_E = 2610 + \sqrt{2610^2 + 7260^2} = 10{,}325$ inch-pounds.

The results of all these calculations are tabulated in Table II for future reference.

TABLE II TWISTING AND BENDING MOMENTS AND TANGENTIAL PRESSURES IN TRANSMISSION

Speed	M_T in inch-pounds	M_B in inch-pounds	T_E in inch-pounds	Pressure at L, pounds	Pressure at M, pounds
High.......	1,680	0	1,680	0	0
Intermediate	2,530	2,980	6,980	692	713
Slow	5,650	4,290	11,390	790	1,400
Reverse.....	7,260	2,610	10,325	350	2,460

Square and Spline Shafts

Sliding gear shafts are made in two varieties: square and spline (Figs. 5 and 6). The latter is usually met with on higher grade cars. Being the more expensive of the two to produce, it constitutes an important "talking point" for the salesman. The buyer of a high-grade car, forever anxious to get his money's worth and fully alive to the costly feature of the spline shaft, invariably expects to find one on his car.

In what follows the author will attempt to present the case of both shafts from the designer's point of view.

Any automobile transmission is as compact a piece of mechanism as can be made consistent with requirements of strength. The amount of metal that can be removed from sliding gears to make room for the shaft is naturally limited. The question, then, is: Which shaft is the stronger for a given available space?

So far as space is concerned the square and spline shafts shown in Figs. 5 and 6 are alike.

The polar moment of inertia of the spline shaft $= 0.860$, approximately.

The polar moment of inertia of the square shaft $= 830$, approximately.

Of the two, then, the spline shaft seems to be the stronger. On the other hand, while the square shaft is subject to bending and twisting alone, the spline shaft is subject to an additional stress, namely, shear on the keys.

The spline shaft possesses a few other disadvantages which must be considered. It has sharp corners which are undesirable in the hardening process. It can be ground on the outside of the keys only. Since the flanks of the keys are merely machined and the keys are liable to warp in hardening, the fit of the spline shaft is by no means as good as the one that can be obtained with the square shaft whose broad faces can be ground to one-thousandth of an inch. Other things being equal, shocks are more injurious to parts having "play" rather than to those having a nice fit.

To overcome this objection, some makers resort to inserted keys (as shown dotted in Fig. 6), but this at once reduces the strength of the spline shaft below that of the square. It is rather hard to make a comparison of the two shafts. In the author's opinion it is a case of "six of one and half-a-dozen of the other."

* * *

DURALUMIN, NEW ALUMINUM ALLOY

Duralumin is a new alloy of aluminum discovered by H. B. Weeks, head chemist at Vicker's Sons and Maxim's Works, Barrow, England. The alloy is described as a little heavier than pure aluminum, but as strong as steel. The firm is building new works at Birmingham for the purpose of manufacturing the metal, which has been patented throughout the world. Mr. Weeks declares that his alloy can be rolled, drawn, stamped, extended or forged at suitable temperatures, and that it is much less easily corroded than other aluminum alloys, and possesses such valuable properties that the firm thinks there is bound to be a large demand for it. It is only one-third the weight of brass, and the purposes for which it can be used are, it is said, practically unlimited.

* * *

It is stated that the American Society of Swedish Engineers intends to raise a monument with inscription on the place where John Ericsson's house in New York was situated. It is intended to unveil the monument on November 23, the anniversary of John Ericsson's arrival in New York.

INTERCHANGEABLE INVOLUTE GEARING*

By WILFRED LEWIS

After a more or less unsatisfactory experience with cycloidal gearing, I investigated about twenty-five years ago the subject of involute gearing with the object of determining upon a system for the firm of Wm. Sellers & Co., Inc., with which I was then connected. The conditions imposed called for a system applicable to any number of teeth between a 12-toothed pinion and a rack, without change in the Sellers addendum which had always been made 0.3-pitch for the cycloidal teeth hitherto used almost exclusively by them.

I found that the involute forms then in vogue were confined to obliquities of $14\frac{1}{2}$ degrees and 15 degrees with an addendum equal to the modulus, or about 0.32-pitch. This long addendum with such small obliquities naturally gave rise to interference between racks and pinions of less than 30 teeth, and rather than modify the involute form I finally recommended the adoption of a pressure angle of 20 degrees. At the same time, I was well aware of the fact that even this obliquity was not sufficient to prevent interference between a 12-toothed pinion and a rack, but for such pinions and gears of 60 teeth or less, with which they are commonly engaged, I believed the interference would not be noticeable in practice. I was strongly tempted to go further and fix upon

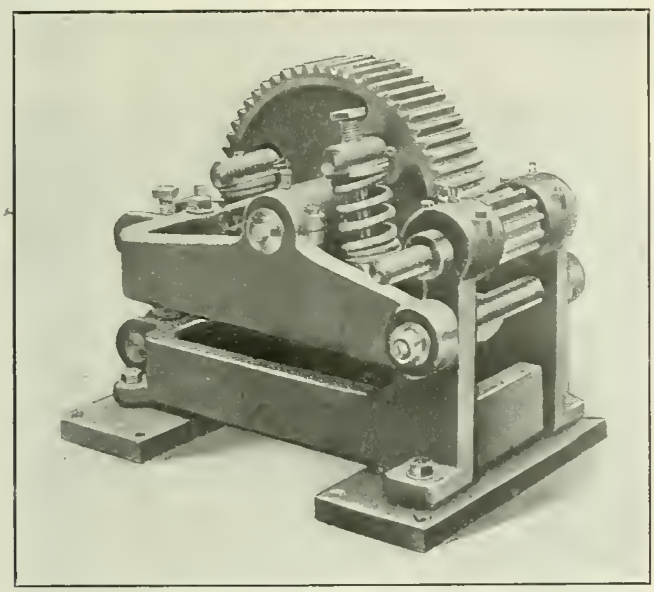


Fig. 1. Gear Testing Machine to be used for Testing for Noise and Durability

an obliquity of $22\frac{1}{2}$ degrees, but 20 degrees then appeared such a radical departure from common usage that the advantages of the greater angle were dismissed as being possibly more theoretical than real.

The 20-degree system with an addendum of 0.3-pitch has now been in use by Wm. Sellers & Co. for twenty-five years and has given satisfaction in a general way, although the interference referred to has been more or less noticeable on 12-toothed pinions. I reviewed this matter ten years ago in a paper read before the Engineers' Club of Philadelphia, advocating an obliquity of $22\frac{1}{2}$ degrees, and suggested as a much-needed reform in engineering practice the consideration of uniformity in interchangeable gearing. I then pointed to the action of the Franklin Institute more than thirty years earlier, which inaugurated a standard system of screw threads, and expressed the hope that by the interchange of opinions an agreement among engineers might be reached leading to the gradual disappearance of needless diversity in the forms of gear teeth.

Nothing in this direction had been done, however, when the subject of interchangeable involute gear-tooth systems was brought to the attention of the American Society of Mechanical Engineers in a paper by Mr. Ralph E. Flanders, presented in December, 1908.* A number of systems in general use were analyzed and their merits discussed from various points of view and the desire expressed that the council of the society be petitioned to appoint a committee to investigate the subject of interchangeable involute gearing and, if found desirable, to recommend a standard or standards.

In answer to this petition the council voted in January, 1909, that the president appoint a committee of five members† to formulate standards for involute gears and present the

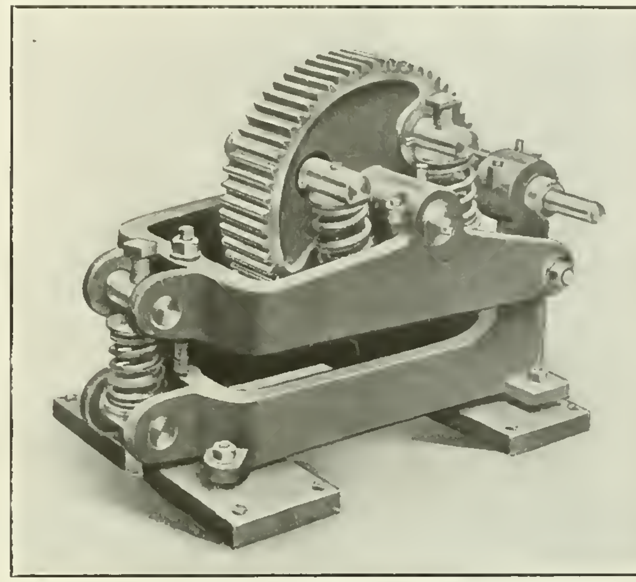


Fig. 2. View of Gear Testing Machine showing Pivoted Frame and Spring for Measuring Thrust

same to the council. Without anticipating in any way the conclusions of this committee yet to be formulated, if indeed an agreement be possible, I believe it will be helpful to give publicity to the line of investigation upon which we have embarked and thus obtain the benefit of such criticism or encouragement as it may provoke.

As pointed out in Mr. Flanders' paper and as mentioned

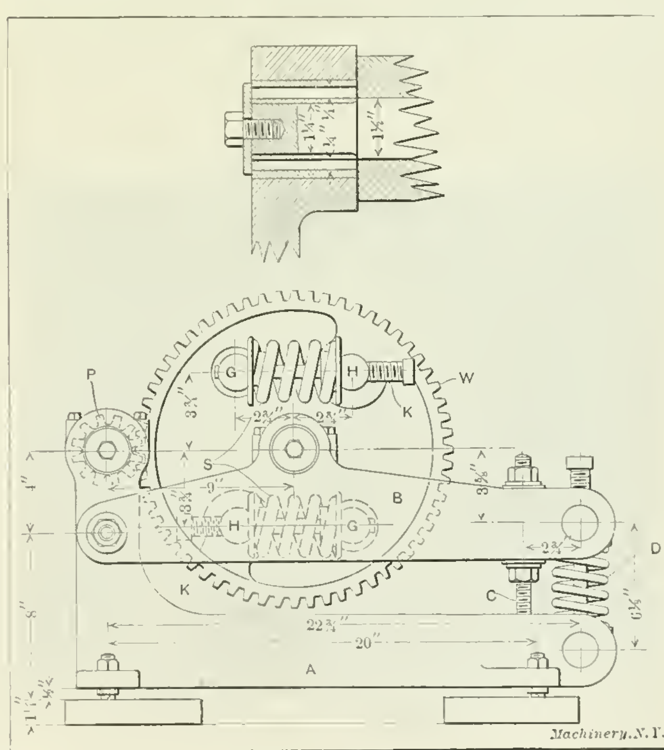


Fig. 3. Showing Construction of Spring Load Mechanism

repeatedly by our correspondents, the most desirable quality in gearing and the one by which it is almost universally

* Abstract of paper presented at joint meeting of American Society of Mechanical Engineers and Institution of Mechanical Engineers, July 26-29, 1910.

This paper was prepared at the request of the meetings committee of the A. S. M. E. as a contribution by Mr. Lewis, and is not to be considered as an expression of the opinions of the other members of the committee.—EDITOR.

* See MACHINERY, January, 1909.

† Wilfred Lewis, Philadelphia; Hugo Bilgram, Philadelphia; E. R. Fellows, Springfield, Vt.; C. R. Gabriel, Brooklyn; Gaetano Lanza, Boston.

judged, is quietness and smoothness of running. Next to this comes strength, durability and permanence of form, and upon the last, of course, depend continued quietness and smoothness of action. Friction and journal pressure are of less importance, but still worth considering, and before reaching any conclusions from theoretical considerations alone, we propose to determine if possible, in a practical way, the relative advantages of some of the systems in common use and, with these, other systems to which we are disposed to give favorable consideration.

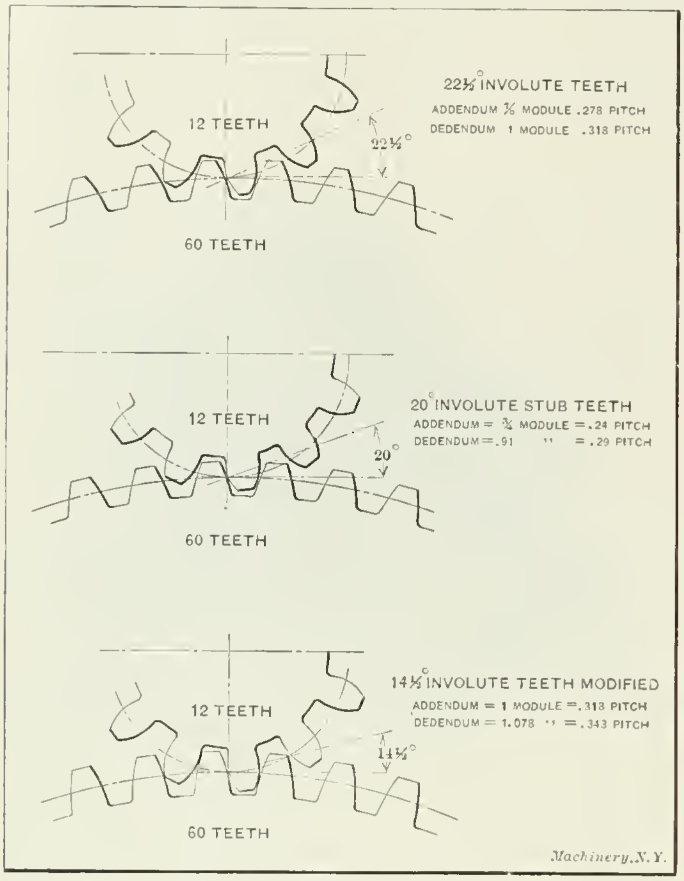


Fig. 4. Gear Types to be tested

Prof. Webb, of Stevens Institute of Technology, has suggested the possibility of so dividing one of the pair of spur gears to be tested as to make the load on the teeth self-contained. The apparatus which we have designed embodies this idea, thus making it possible to run gears under heavy loads at high speeds with a very small consumption of power. We have also provided in our apparatus for an adjustment of center distance and means to measure the thrust between centers while the gears are running. Of course, the thrust between centers can be estimated very closely for involute gears from the pressure angle on the teeth, but we anticipate results somewhat in excess of this on account of the excess in friction of approach over that of recess, and, if any but involute gears are tested, it will also be interesting to compute from experimental data the effective obliquities of other systems.

Fig 5. Bilgram System: Pinion with Undercut Teeth

We propose to determine the friction loss under various speeds and pressures for wheels and pinions cut to the Brown & Sharpe 14½-degree standard, the 20-degree stub tooth and a 22½-degree tooth with addendum of ⅞ module or about 0.278 pitch. These gears will be tested at normal center distance, and also at distances about 1 per cent or 2 per cent of the pitch greater or less than this, and an effort will be made to record graphically the noise produced under these different conditions.

We believe that accuracy and permanence of form can thus be given their proper influence on the reduction of noise. It may take some time to determine the effect of wear, but from the method of loading the teeth and the small amount of power consumed, some indication of the tendency of wear can be obtained. All gears tend to wear out of shape, and involute gears more so than cycloidal, but we recognize as a possibility that this tendency may be checked by the deformation itself and also that the loss in friction at different parts of a gear tooth is practically incalculable on account of the variations in friction for different velocities of sliding. The experiments we propose should therefore give information unobtainable in any other way and throw a flood of light on the problem in hand.

The apparatus to be used by Messrs. Green and Doble, of the Massachusetts Institute of Technology, in making these experiments is shown by the half-tones, Fig. 1 and Fig. 2, and the line drawing, Fig. 3, which gives some of the principal dimensions and shows the knife-edges on which the machine rests. The machine consists of a frame A designed to carry a pinion shaft in roller bearings at one end, and a frame B pivoted to it and designed to carry the gear wheels W engaging with a wide-faced pinion P on the pinion shaft. The frame B is held to the frame A at its outer end by an adjustable clamping bolt C, and provision is made to measure the thrust on centers by means of the spring D acting between the frame A and an adjustable abutment on the frame B. The gear wheels to be tested consist of a central gear with a wide face and two side gears with narrow faces. The central gear carries two heavy cross pins G, which pass through clearance holes in the side gears, and the side gears carry two heavy pins H, which pass through clearance holes in the central gear. Between the projecting ends of these pins G and H, heavy helical springs S are inserted, upon which pressure can be applied by means of the set-screws K.

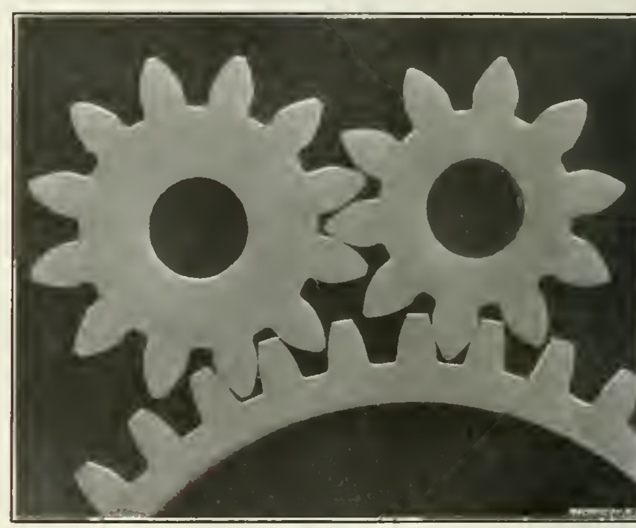


Fig. 6. Bilgram System: Pinions with Increased Addenda in Mesh with Gear

The pressure of these four springs S is resisted by the gear teeth, the middle gear pressing against one side of the pinion teeth and the side gears pressing against the other side. The pinion thus becomes simultaneously a driver and a driven gear and the power required to turn it when loaded in this

way is only that required to overcome the friction of the teeth and whatever resistance there may be in the gear journals. The latter presumably is very small indeed, but provision has been made to measure it by substituting plain cylinders without teeth for the gears and pinion, and running these under the same journal pressures. By deducting the resistance due to journals from the total resistance with running gears, the friction of the teeth alone can be determined.

In operation this machine is driven by an extension to the pinion shaft, carried to bearings several feet distant to permit of ample flexibility. The knife-edge directly beneath the pinion rests upon a permanent support, and the other knife-edge is carried upon the platform of a small platform scales. The driving moment in the pinion shaft will therefore be measured by the scale reading at the end of an arm 20 inches long, and by reversing the direction of motion given to the pinion shaft the effect of any initial lateral strain in the driving shaft can be eliminated.

Fig. 4 illustrates three types of gearing to be tested, and, with these, other types may be included later on.

Figs. 5, 6 and 7 illustrate a group of involute gears designed by Mr. Bilgram to engage a rack of 15-degree obliquity, and to demonstrate the possibility of using pinions of ten or even nine teeth with such a rack, provided the addendum can be varied. Without wishing to advocate the use of a variable addendum in interchangeable gearing, it is interesting to note the possibility of making a tentative solution of the problem in this way. A set of these gears has kindly been furnished

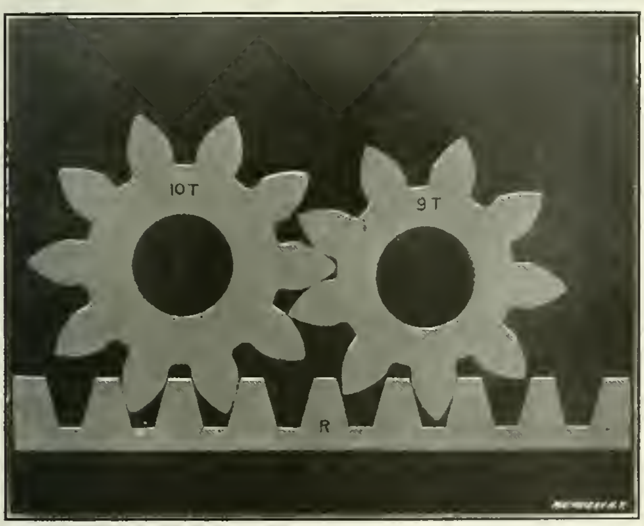


Fig. 7. Bilgram System: Pinions with Increased Addenda in Mesh with Rack

by Mr. Bilgram for making a comparative test. He has also made a set of models from which the figures have been photographed, and, referring to them, he gives the following explanation:

"While the involute system of gearing has decided advantages over any other, it has the one disadvantage that the faces of the teeth of wheels come into interference with the flanks of pinions, if the latter have a comparatively small number of teeth. Unless the flanks of the latter are undercut, the teeth will interlock or at least mesh improperly.

"In making a single pair of wheels, a remedy can readily be applied. There are two ways in which interference can be avoided, namely, either by increasing the angle of pressure or by shortening the addendum of the wheel. If the latter method is chosen and it is desired not to reduce the working depth of the teeth, it is necessary to add to the addendum of the pinion the amount taken from the addendum of the wheel.

"This latter method is out of the question when the problem is given to make an interchangeable set of spur wheels from a rack down to a 12-tooth pinion. This problem may be solved by a combination of both remedies alluded to."

The method consists of making racks and larger wheels with normal addendum, but increasing the addendum of pinions just enough to prevent the rack tooth from interfering with the flank. The samples presented (Figs. 5 to 7) consist of a 36-toothed wheel *W* or a rack *R* with angle of pressure of 15 degrees and addendum equal to the modulus. The 12-tooth pinion *A*, generated by a rack corresponding to rack *R*, shows the undercutting thereby produced. Obviously this pinion will not work, as so much of the involute is cut away that the path of contact is materially less than one pitch. But there are also shown pinions of twelve, ten and nine teeth, made with increased addenda. These were generated by a rack like *R*, but with a somewhat greater addendum than that used in generating the wheel *W* and a somewhat greater cutting depth. If these pinions are then mated with wheels of a large number of teeth, they will not enter as far as with pinions of an equal number of teeth, thus having a slightly less working depth.

On this plan may be based a system of involute gearing with a working depth of twice the modulus, and with a moderate pressure angle, 15 degrees in the samples submitted. Pinions of a small number of teeth will have an increased addendum, but a theoretically correct action is maintained. The pinion teeth have a wide base and are strong. One disadvantage in those cases in which pinions with less than about 24 teeth are embraced, is that the center distance is greater than that computed by the usual rule from the modulus and the number of teeth of the meshing wheels. Moreover, pinions will not have the full working depth when meshing with large wheels or with racks, but even in the case of a 10-tooth pinion meshing with a rack, the path of contact exceeds one pitch so that at least for a portion of the action two teeth will be in contact simultaneously.

The plan proposed by Mr. Fellows is to use an involute with an angle of pressure of 20 degrees and to reduce the addendum to 3/4 of the modulus. Such teeth are known as "stub teeth." By this method interference in case of a rack gearing with a 12-tooth pinion is just avoided and in the case of two 12-tooth pinions meshing with each other the path of contact is equal to about 1 1/8 of the pitch. Mr. Gabriel prefers the 14 1/2-degree standard of the Brown & Sharpe Mfg. Co. The system which I propose is that of a pressure angle of 22 1/2 degrees and an addendum of 7/8 of the modulus.

I believe that an interchangeable system of involute gearing, to be of the greatest value, should extend from a 12-tooth pinion to a rack, and in the selection of gears to be tested we have chosen a 12-tooth pinion engaging a 60-tooth wheel. The maximum reduction with the maximum strength in a limited space is the problem in gearing that generally confronts the engineer and a ratio of five to one is very often as much as he can realize without sacrificing too much strength. I recognize, of course, that the adoption of a larger number of teeth in the smallest allowable pinion overcomes some difficulties, and that this may be a debatable point, but I do not think any system of interchangeable gearing will be satisfactory which does not include pinions of twelve teeth.

* * *

VOLUME OF SALES IN THE ELECTRICAL INDUSTRY

The *Wall Street Journal* estimates the gross sales of the five largest electrical companies for 1910, as follows:

General Electric	$70,000,000
Western Electric	61,000,000
Allgemeine Elektricitäts Gesellschaft	55,000,000
Siemens & Halske	50,000,000
Westinghouse	30,000,000

The following table, which gives the gross sales of the three largest American companies for the last five years, brings out their relative positions in the electrical industry:

	General Electric	Western Electric	Westinghouse
1909	$52,000,000	$46,000,000	$29,000,000
1908	44,000,000	32,000,000	21,000,000
1907	71,000,000	53,000,000	22,000,000
1906	60,000,000	69,000,000	33,000,000
1905	43,000,000	44,000,000	24,000,000
Total	$270,000,000	$244,000,000	$129,000,000

* * *

It is stated that the Western Electric Co., Hawthorne, Ill., uses, in a single year, about one ton of platinum in the manufacture of telephone apparatus. Platinum costs 30 per cent more than pure gold.

MAKING AUTOMOBILE RADIATORS

By ETHAN VIALL*

There are a great number of forms and types of radiators of the kind used for cooling the water in automobile and air-

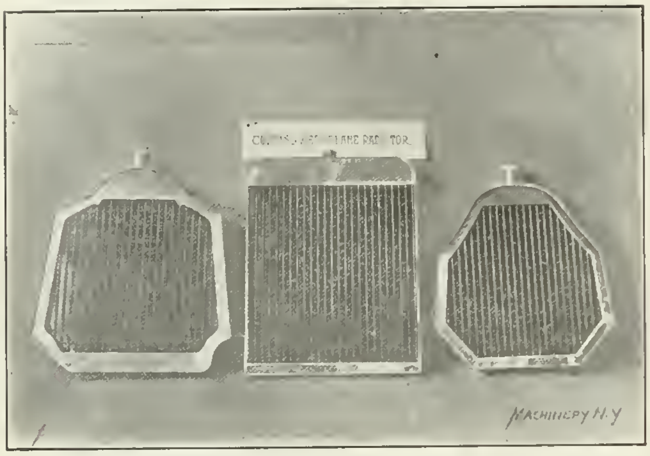


Fig. 1. Three Forms of Radiators of the Same Type. The Middle one is a Duplicate of the ones used on the Curtiss Aeroplanes

ship engines, and while this article will give in detail the manufacturing steps necessary in the building of radiators of

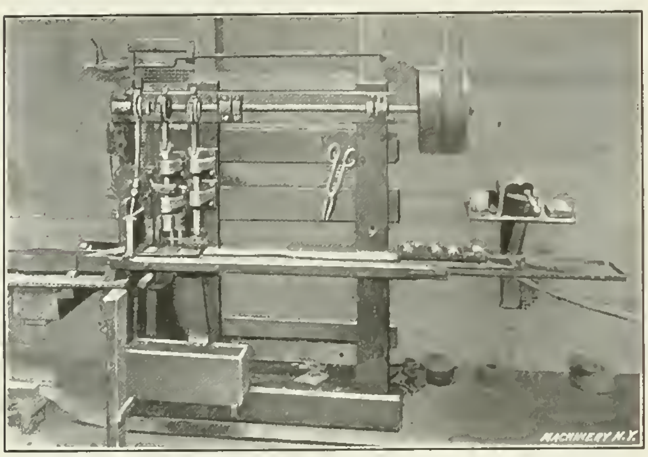


Fig. 3. Special Automatic Machine for Edging, Punching and Shearing off the Fins

the perforated fin-and-tube type, reference will merely be made to the various shapes and forms of this type.

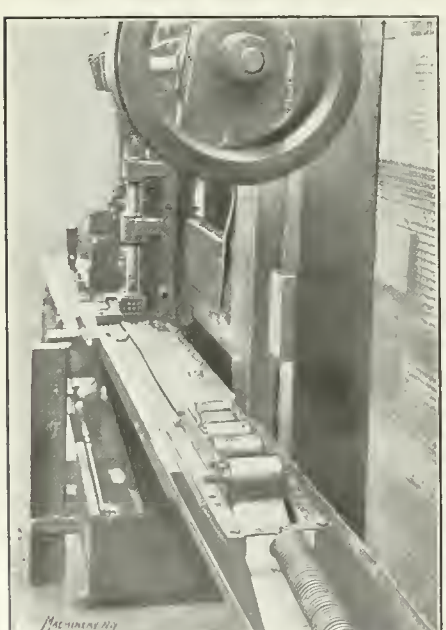


Fig. 5. Edge Turning Rolls used on the Automatic Machine for Edging the Fin Strips

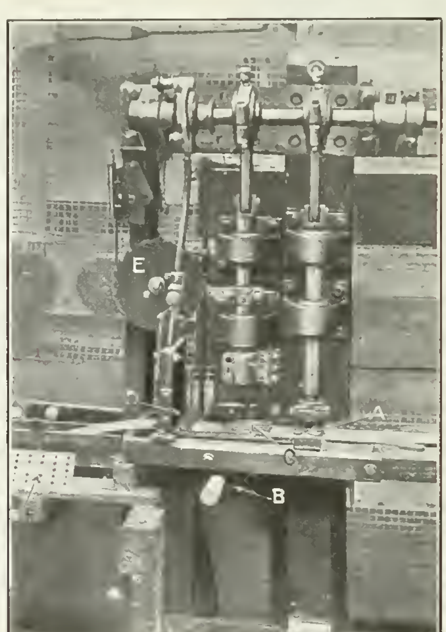


Fig. 6. The Perforating, Feeding and Shearing Mechanism of the Automatic Machine

In order that the reader may have a clear idea of the type of radiator that is under discussion, three forms are shown in Fig. 1. These radiators are manufactured by the Detroit Radiator Co., Detroit, Michigan, which has a capacity of 200 radiators a day, and it is through the courtesy of Mr. C. F. Patterson and Mr. R. L. Frost, and the personal assistance of Mr. Beardsley, that the accompanying photographs were ob-

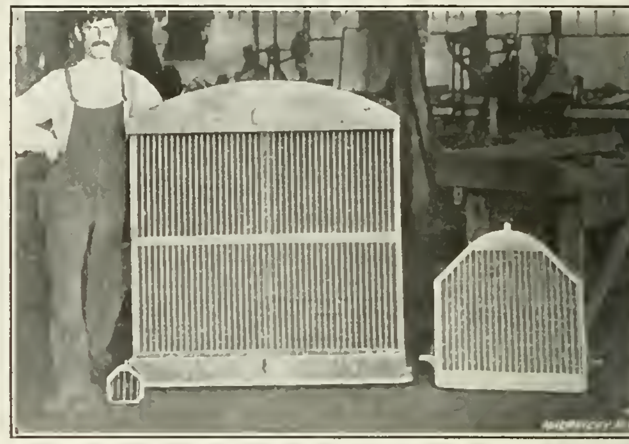


Fig. 2. Extremes in Radiator Sizes a Model, a Traction Engine Radiator and an Automobile Radiator

tained. Fig. 2 shows the range of sizes that are turned out, the radiator on the right being a regular automobile radiator,

Fig 4. Bundles of Tubing used in Radiator Construction

the middle one a special radiator for a traction motor, and the tiny one at the man's feet, a model.

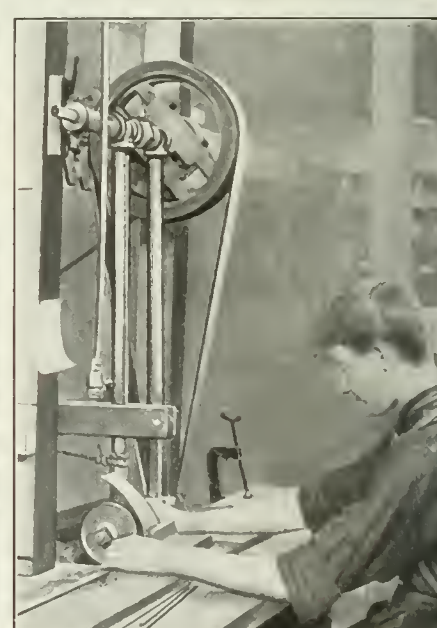


Fig. 7. Sawing the Tubing to Specified Lengths with a Small Saw

As can be seen from the half-tones just referred to, the cooling surface of the radiators consists of thin perforated strips of copper or brass through which are thrust small tubes carrying

* Associate Editor of MACHINERY.

Fig. 8. Beveling the Ends of the Tubes

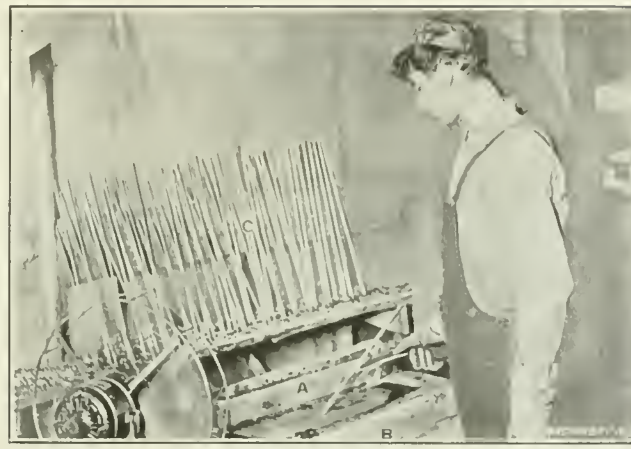


Fig. 9. Tinning the Tubes

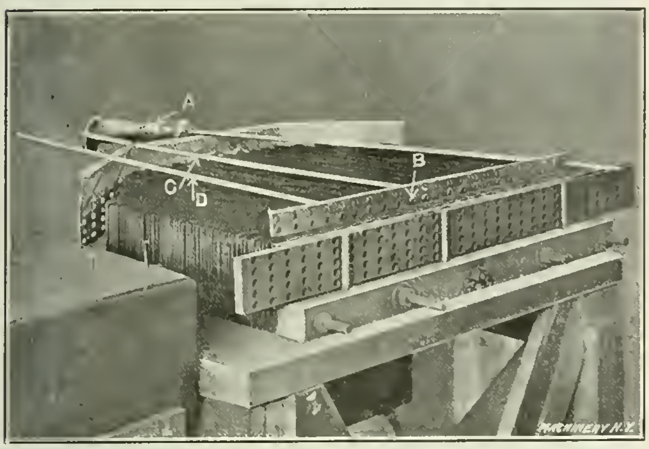


Fig. 10 The "Nests" used while putting the Tubes into the Fins

Fig. 11. Soldering on the Ends

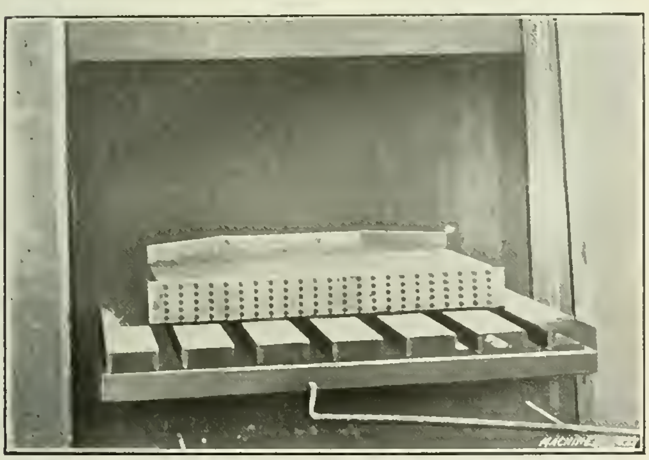


Fig. 12. Fusing the Solder-covered Tubes with the Fins

Fig. 13. Fitting and Soldering on the Water Tanks

Fig. 14. Testing, and Soldering the Leaks

Fig. 15. Straightening the Fins

the water, these tubes being connected to tanks at both ends.

Edging, Punching and Shearing the Fins

The cooling strips, or fins, as they are called, are made by running a band of brass through a specially built automatic machine which doubles over each edge of the band, punches the holes for the water tubes, and cuts the strips into the required lengths. A general view of the machine is given in Fig. 3, and in Fig. 5 the mechanism used to double over the edges is shown. As the engraving shows, the turning device consists of a box or forming die into which is set a series of rolls, the first roll being straight. The second roll has ends beveled to 45 degrees, and presses the strip down into the die channel, bending the edges of the strip to correspond to the bevel on the ends of the roll. The third roll is straight, but short enough to bring the edges of the strip up square. The fourth roll is like a common thread spool, with beveled flanges on each end which roll the edges inward 45 degrees, while the last roll flattens them down onto the body of the strip. The perforating, feeding and cutting-off mechanism is shown in Fig. 6. After the strip passes under the battery of punches A, it is drawn along by the feed wheel B which has pins in its periphery to engage the holes punched in the strip, the strip being held to the rim of the feed-wheel by the spring-fingers C. As the required length is fed out, it is cut off by the shear D, which is tripped by the action of the ratchet wheel E. Various lengths may be sheared off by using different sized ratchet wheels. A section of one of the punched fins is shown at F.


Fig. 16. Lining up the Fins by Melting the Solder with a Gas Blow-torch

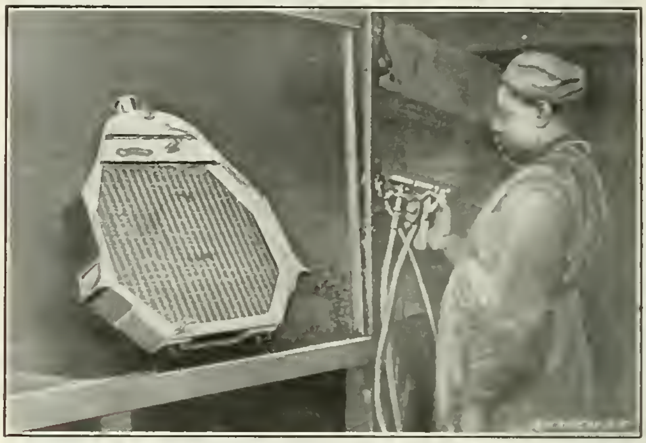


Fig 17. Spraying the Paint over the Fins and Tubes


Fig. 18. Wiping the Surplus Paint off the Frame


Fig. 19. Packing and Shipping

Preparing the Tubes

Both seamless and hard soldered brass or copper tubing is used in the radiators, the tubing coming in long bundles as shown in Fig. 4. Whether copper or brass, seamless or soldered tubing is used depends on the specifications and price of the order. The tubing is cut to the specified length by using a small saw as shown in Fig. 7. Tubing cut to standard lengths for regular orders is kept in stock racks.


Fig. 20. Making the Bottom Water Tanks out of Sheet Brass


Fig. 21. Scraping the Soldered Joints of a Made-up Frame

After being sawed into lengths, the ends of the tubes are slightly beveled on an emery wheel, Fig. 8, and they are then taken to the tinning room and coated with "half and half" solder. The tinning process, which is illustrated in Fig. 9, consists of grasping the tube with a pair of Y-nosed pliers, dipping it into the acid bath *A* and then into the bath of molten solder *B*, after which it is placed on end to cool as at *C*. Care is taken to dip the tubes into both baths by placing one end in first and then slowly immersing, so that the liquid flows entirely through the tube, driving the air out ahead of it; otherwise the tinning solution would be apt to spatter dangerously as the imprisoned air or surplus acid suddenly expanded.

Fig. 22. Filing Frame Parts that have been cut out by Hand from a Templet

Assembling the Fins and Tubes

The fins and tubes are assembled in "nests," Fig. 10, which are made up of heavy combs of iron solidly bolted together and so spaced that the fins may be placed between them, the holes in the fins coinciding with the spaces between the teeth of the combs. A tube is placed on the rod *A*, provided with a handle and forced in between the comb teeth, through the holes in the set of fins. In the engraving, *B* is a fin which has been dropped about half way down between a set of teeth. A number of nests are in use for the various sizes and shapes of radiators; these are so shaped that a top and bottom piece may be properly placed in relation to the fins. After the tubes are all in, the radiator is removed from the nest and the top and bottom soldered on by hand, as in Fig. 11, after which it is dipped in acid and placed in an oven, Fig. 12, and heated just enough to cause the solder on the tubes to run and fuse onto the fins, making the radiator practically one solid mass. Next, the top and bottom water tanks are fitted and soldered on, Fig. 13, and the side strips put into place, the radiators being then tested by air pressure in a tank of water. Fig. 14 shows the testers at the water tanks, soldering up leaks with a blow torch.


Fig. 23. Beaded and Bent Frame Parts

The fins are now straightened and lined up as shown in Fig. 15, and if they are much out of line they are corrected by melting the solder with a torch and straightening, as shown in Fig. 16. The radiators are again tested for leaks and the tanks and frame polished, after which they are ready to be painted, which is done by spraying the fins and tubes with a special air drying enamel, Fig. 17. Then the surplus paint is wiped off the polished surfaces as shown in Fig. 18, and the completed radiator is ready to be packed and shipped, the method of crating or packing being shown in Fig. 19.

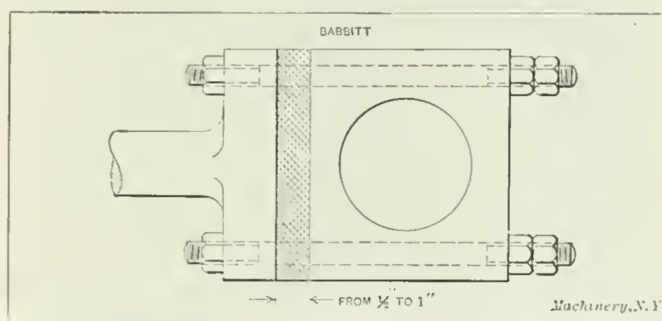
The work on the tanks and frames of the radiators is essentially tinshop work, as many of the radiators are made to order and then, too, the size and shape of most of the parts preclude the use of press work unless when required in quantities. However, a few of the parts are made in a punch press, including the top water tank shell, though the bottom tank is sheared out by hand from an outline scribed from a templet, and then bent to shape as shown in Fig. 20. Irregular frames are made up of a number of parts soldered together and scraped smooth at the joints as shown in Fig. 21. Fig. 22 shows a man smoothing up, with a file, sheet brass frame parts, which have been cut out by hand from a templet, while in Fig. 23 are shown a number of beaded strips, some of which have been bent to shape over a form.

* * *

METHODS OF INCREASING EFFICIENCY OF GASOLINE ENGINES AT HIGH ALTITUDES

By STANLEY GOULD*

Any one familiar with gasoline engines knows that an engine which runs well at sea level seems to lose its efficiency when it is operated at a high altitude, say, of from 6000 to 7000 feet above sea level. When an engine is taken to this altitude, it is noticed that the sharp ring in the cylinder which occurs at the time of ignition is not present, or is not nearly so prominent as it is at a lower level. The explosion is weak and the engine lacks power. The reason for this is that the air is so rarified that the mixture is not compressed enough before ignition. This effect is often overcome by fastening a plate slightly smaller than the bore of the cylinder on the top end of the piston. This, as can be seen, reduces the compression space and thereby gives a higher compression. There is one objection to this method, however, which is due to the fact that the plate gets hot and there is apt to be premature ignition.



Method of increasing Length of Connecting-rod to decrease Compression Space, and thus increase Efficiency of Gasoline Engines at High Altitudes

The same results may be obtained with less trouble and expense and also with greater efficiency, by separating the crank-pin brasses from the connecting-rod the desired amount to increase the compression, and filling the space with babbitt, as shown in the accompanying illustration. The babbitt is generally made from 1/2 inch to 1 inch in thickness, depending on the design of the engine, altitude, etc. A little experimenting is usually necessary to determine exactly the amount required, and longer connecting-rod bolts may also have to be made. Care should be taken that the rings on the piston do not pass beyond the counterbore in the cylinder. This method may be easily accomplished, and it will generally be found a means for getting considerably more power. However, it cannot be expected that an engine will give as much power in a high altitude as it will at sea level, as the power depends on the amount of air and fuel taken into the cylinder. The main point is to get the proper compression for the mixture, which should be as high as possible without causing pounding or premature ignition.

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THE OPERATION AND MANUFACTURE OF MAGNETOS—1

By HAROLD WHITING SLAUSON

Ever since the first internal combustion motor puffed and snorted and backfired, the ignition problem has been one of the most serious with which the designers have had to contend. In the early days the "hot tube" served as the source of heat by which the charge was "exploded," but this was adaptable only for low-speed, heavy-duty, inefficient, stationary engines, and was no more suited for automobile or motor boat practice than is flint and steel for a modern rapid-fire gun. The electric current has gradually been developed as the source of heat for ignition purposes, until now it may be said to be used on practically every internal combustion engine in existence. Its points of advantage over any of the other systems formerly in use lie in the fact that it furnishes a point or area of intense heat at the instant desired, and that the time during the stroke of the piston at which the ignition shall occur can be regulated by the operator. This makes it the only ignition source possible for use on high-speed motors.

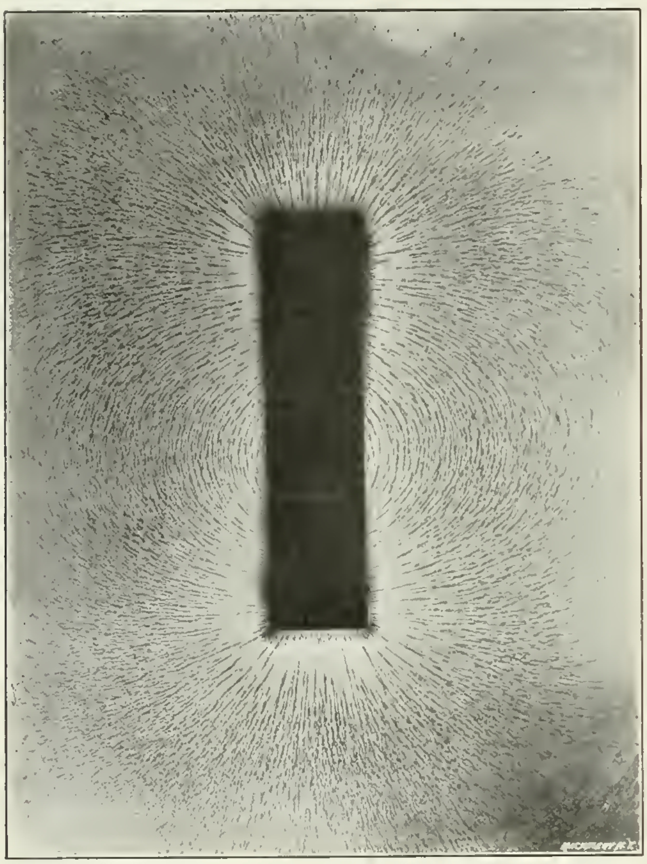

Fig. 1. Iron Filings showing the Lines of Force around a Bar Magnet

Dry Batteries vs. Magneto Generator

It is only recently, however, that the electrical system of ignition has been brought to its present high efficiency, for the source of current has not always been as reliable as could be wished. Dry batteries depend upon a chemical action for the production of current, and they will deteriorate whether used or not. This renders continual testing necessary to make certain that the batteries are sufficiently strong for the day's run, and at best they are more or less capricious and liable to fail without previous warning. A storage battery will continue to give current until it has "run out," but it must be charged occasionally and its ingredients and plates must be attended to carefully, especially during freezing weather, so that it will not deteriorate rapidly or be utterly ruined. Consequently, although dry batteries or storage batteries form reliable sources of current while they last, the care, attention and renewals that they require if used frequently, make them more suitable as auxiliaries than as generators or storehouses of the main ignition supply.

Universal Application of Magneto Generator on Automobiles

During the last few years, the increase in the reliability of the automobile motor has been astonishing. From a machine which, a decade ago, could only be driven by an expert, to a car that can be handled by a woman or child, that will start on the first crank, and that will continue to run indefinitely, day and night, as long as it is fed with gasoline and oil, is a striking advance, but it would not be exaggerating to say that much of this change has been brought about by the almost universal application of the magneto on the modern automobile. The magneto generates current independent of storage capacity or chemical renewals, and consequently furnishes a source of ignition supply as long as power can be obtained with which to drive it. It is really a converter, or transformer of mechanical force into electrical energy, and as the small amount of power necessary to operate it is obtained from the motor to which it is furnishing current, it will generate the ignition supply without deterioration as long as required.

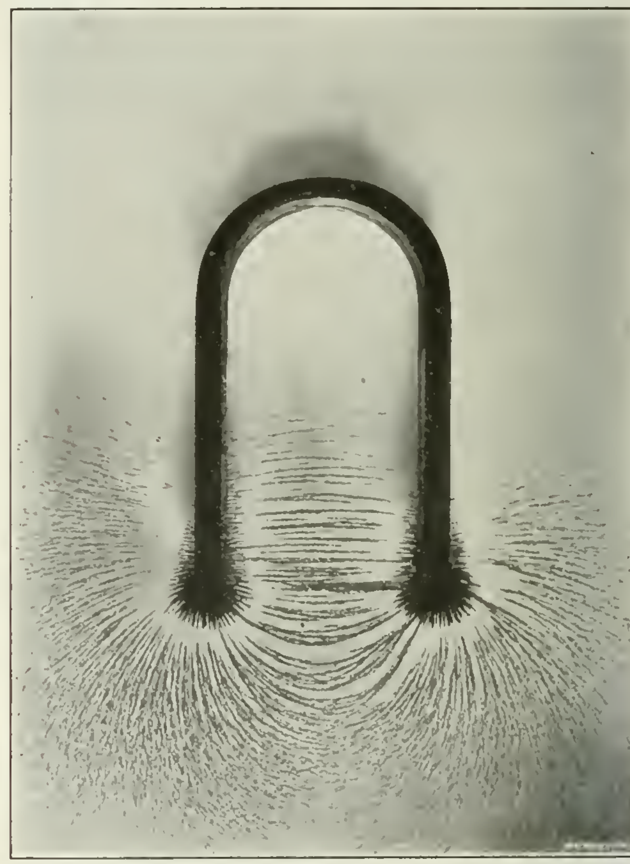

Fig 2. Showing Lines of Force around the Poles of a U-shaped Magnet

The Principle of the Magneto Generator

Although the appearance of the magneto is familiar to everyone who has ever driven a car or who has been interested in internal combustion motors in general, probably but a small percentage of these persons really understand the theory of the action and operation of the machine. It is in reality nothing but a small and compact form of dynamo with a few changes and refinements made necessary by the nature of its location and the work that it is called upon to perform. Around every magnet there are what are known as "lines of force" emanating from all portions, and concentrated chiefly at the extreme ends, or north and south poles of the magnet. The basic principle of the magneto, dynamo or generator, lies in the fact that if these lines of force are cut by a wire passing near the magnet at either the north or south poles, an electromotive force, or difference in pressure of an electric current, will be set up in this moving wire. In other words, a current of electricity is generated in this wire cutting the lines of force, and if the ends of this wire are connected, a flow of the electric "fluid" will continue as long as the

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Figs. 1 to 5 inclusive from *Motor*. Copyrighted by the New Publication Co., New York.

motion through the lines of force is kept up. If the magnet is bent U-shape, a moving wire, or series of wires, may cut the lines of force emanating from both poles without moving out of a position of rotation midway between the two poles. The magnet is known as the field of the machine, and the wire cutting the lines of force forms the armature—the two composing the principal parts of any electric generator or motor.

The armature generally consists of an iron spindle, notched out in several portions of its periphery, and rotating on a horizontal axis placed midway between the two poles of the

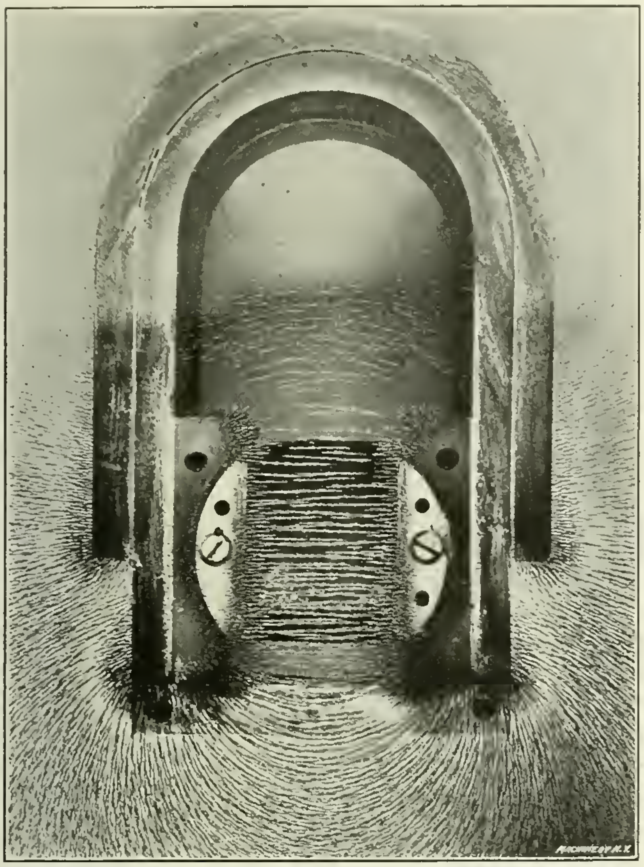


Fig. 3. Compound U-shaped Magnet with Pole Pieces and Armature showing Action of Lines of Force

magnet, or field. Through these notches in the armature and parallel to the axis, are wound several layers of insulated wire. This great number of wires cutting the lines of force of the field, serve to generate a greater current than would be the case were but one wire used, and consequently if the armature is driven at a high speed, and the magnetic fields are strong enough, electric power sufficient to light several lamps may be obtained from even the smallest machine. In the ordinary power-house generator, the fields are wound with insulated wire in order to form a separately-excited electromagnet. It is in this respect that the magneto differs chiefly from the dynamo, for the former has no *electro-magnet*, but uses instead, a permanent magnet. This consists of the U-shaped bar of iron, specially treated so that it will retain its magnetism for an indefinite period of time after it has once been magnetized.

Although the lines of force are, of course, invisible, their position and the effect made upon them by a rotating armature or series of wires cutting them transversely are well shown by the accompanying illustrations, Figs. 1 to 5, inclusive, which show iron filings in the field of a magneto. These illustrations were taken when the armature was placed in different positions, and show unusually well how the lines of force are collected or swept up, by the revolving bundle of wires, and unite to form the electric current.

Lines of force from the north pole of a magnet cut by a wire or revolving armature will induce a current in one direction through the circuit, while the current flows in the opposite direction if the lines of force from the south pole are cut. This means, then, that in the simplest form of magneto or dynamo in which the two ends of the armature wire are led to "collector rings," the current will flow first in one direction, and then in the other, as alternate poles of the field are cut by the revolving armature. This forms the alternating current, familiar to most people. Practically all magnetos that are geared to the motor are of the type producing alternating current.

Principle of the Direct-current Magneto

In equipping old automobile motors and marine and stationary engines with magnetos, however, it is sometimes impracticable to install a set of gears, and in this event the use of a direct-current magneto is advisable. The direct-current machine is the opposite of the alternating type in that any point in the circuit always has a north and south pole. In other words, the direction of the flow of current is constant, and not changeable, as it is in the alternating type. In order to keep the current flowing in the same direction, a slightly different type of armature must be used in the direct-current type than is found in the alternating machine. Such an armature generally has several slots cut in its periphery, parallel to the axis of rotation, and in each pair of these slots, on opposite sides of the armature, are wound a few turns of insulated wire. A copper commutator or drum, is placed on the armature shaft near the terminals of these turns of wire. This commutator has as many segments on its surface as there are slots in the periphery of the armature, and each bundle of wires is soldered to its own segment, which is thoroughly insulated from all the rest. Two copper or carbon brushes are placed 180 degrees apart in contact with the armature, and continually wipe against it as the armature revolves. As each bundle of wires passes by one pole of the field it induces a current which flows in one direction, and this is collected by the brush on that side and sent out into the circuit. By the time this same section of the armature reaches the

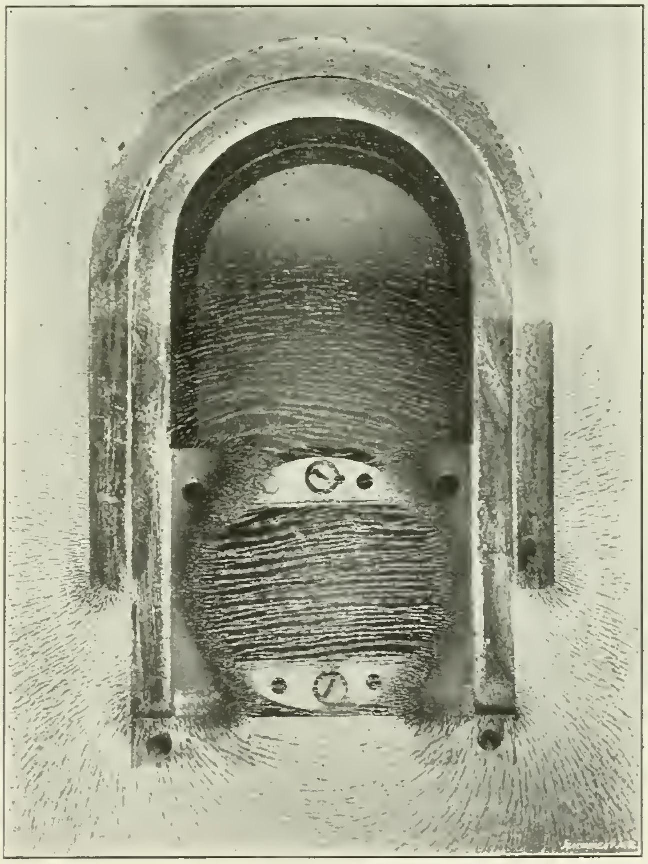


Fig. 4. Same as Fig. 3, Armature rotated One-fourth Turn. Note Change in Lines of Force

other pole of the field and is excited with a current in the reverse direction, its segment of the commutator wipes against the opposite brush and the electricity thus collected flows through the circuit. In other words, one brush collects all the current when the windings of the armature are positively excited by reason of proximity to one pole, and the opposite brush collects all the negative current from the armature when it is cutting the lines of force of the other end of the magnet.

The Function of the Distributor

Although the field and armature are the primary parts of an electric generator, there are several other attachments to a magneto which are vitally necessary for the successful application of the machine to an automobile ignition system. One of these is the distributor, which is the hard rubber box, generally located on top of the magneto, from which the wires that lead to the separate cylinders of the car emerge. By means of a hard rubber disk, in the periphery of which is a copper segment connected with the source of current supply, connection is made with the spark plugs of the various cylinders in the proper order. This distributor enables a single-

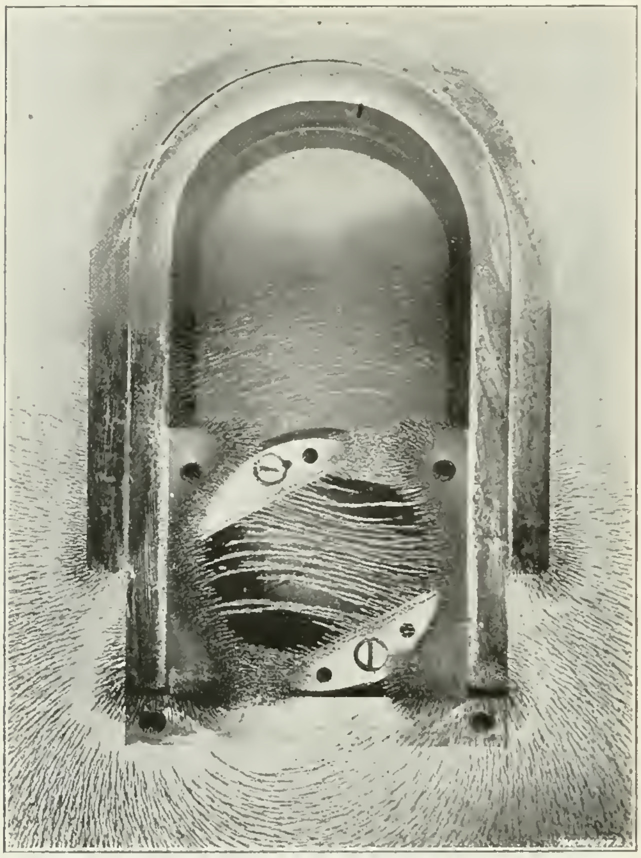


Fig. 5. Showing Lines of Force with Armature in Position Midway between those of Figs. 3. and 4

unit coil to take the place of the four coils usually found on the dash of all cars using a battery ignition system. In some systems, to be considered later, no coil whatsoever is used, the current being led directly from the magneto to the spark plugs of the cylinders.

Various Systems of Ignition in Gas Engines

There are two systems of gas engine ignition, for either of which a magneto may be used advantageously. These are known as the make-and-break and the jump-spark systems. The spark, or flash, rather, in the former is obtained by sending a comparatively low-voltage current through a mechanism passing through the cylinder walls. At the proper time, two portions of this mechanism break or snap off, and the result of this break in the circuit is a hot flash, which serves to ignite the charge in the cylinder. The same result will be obtained in the open air if the two terminals of a set of batteries are taken in the hand, connected, and then separated with a "wiping" motion. A bright flash will be seen, which corresponds to the igniting spark of the make-and-break system.

The Jump-spark System of Ignition

The jump-spark system is in more common use than the make-and-break, and is especially well-adapted for magneto service. This system is so well known that it is useless to describe it in detail, and suffice it to say that when the connection is made, the current jumps across a small gap between two points of the spark plug screwed into the cylinder, and in so jumping, a hot spark is formed. Although this space is scarcely ever more than 1/32 inch wide, it is well known that a high voltage is required to cause a current to jump even an infinitesimal gap, and as the hot gases and compression in the cylinder increase the resistance, it is necessary to furnish a sufficiently high electromotive force to the current to enable the spark to jump at least half an inch in the open air. This requires a pressure of from 10,000 to 20,000 volts, and because of the high voltage used, this is known as the "high-tension" system. The make-and-break type of ignition, by virtue of its lower voltage, is known as the "low-tension" system.

Principles of the High-tension Magneto

Batteries, of course, cannot furnish this tremendous voltage required for the jump spark, and it is the duty of the coils to "step up" the current to the final fifteen or twenty thousand volts. A "step up" transformer consists of two coils, one within the other, known as the primary and secondary. The current from the source of supply is led through the coarser, or primary winding, and this "induces" a very high voltage current in the many turns of fine wire of the secondary winding. The amperage is reduced, however, in the proportion in which the voltage is raised. In order to induce this high voltage in the secondary winding, there must be an intermittent surging, or "piling up," of the original current. This is accomplished by means of a vibrator, or interrupter, through which the primary current passes, and by the alternate making and breaking of the contact through the medium of a magnet and spring the desired intermittent action is obtained.

A direct-current magneto can be introduced into the above-mentioned system of ignition, the vibrating coils being used in connection with this mechanical source of current in the same manner as with the batteries. In this case the magneto may be driven by either a belt or a friction pulley, and the necessity for any gears in this connection is eliminated.

The ordinary alternating-current magneto furnishing current for a high-tension ignition system, however, operates on a slightly different principle. In this case a non-vibrating coil is used, of the same general design as the step-up transformer previously described, but without the current-interrupting mechanism. Consequently the magneto itself is equipped with an interrupter in the form of a cam revolving in intermittent contact with one or more rocker arms, on the end of each of which is a platinum contact point through which the current passes when the cam forces that end of the rocker arm against another platinum point, and thus completes the circuit. This cam is generally attached to the end of the armature shaft, and is so timed that the circuit is closed whenever the armature is in such a position that it will deliver a maximum amount of current. This interrupter, or circuit-breaker, is used as the timer, the spark being advanced or retarded in the cylinders as the case containing the contact points is revolved forward or backward on the armature shaft. Because the current from the magneto is not absolutely constant, it is necessary that the machine be geared positively to the crankshaft of the motor in the proper relation so that connection will be made with the spark plugs through the timer only when the armature is receiving its maximum amount of current. In the ordinary four-cylinder motor magneto there are generally two high-voltage impulses, or contacts of the cam, for each revolution of the armature.

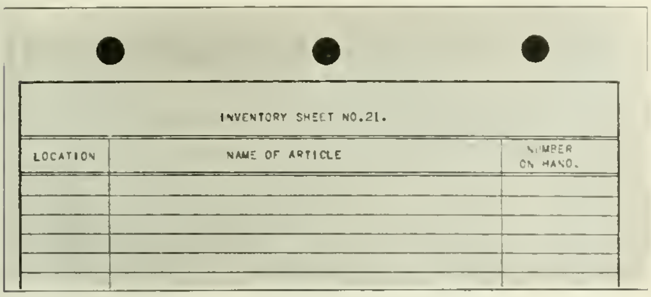
Some magnetos are made which will furnish a high-tension current without the necessity of a step-up coil, or transformer. Such a machine has two windings on the armature, the primary and secondary, so that in reality the transformer is combined with the armature, instead of being located in a separate box on the dash. A machine of this type is a *bona-fide* high-tension magneto, because the current is generated at the same high voltage as that at which it will be used in the plugs. The other type of magnetos, however, is sometimes erroneously called "high-tension" when used for jump-spark work, even though the current is actually generated at a low voltage in the machine, but it will be seen that these are actually of the low-tension type with a separate step-up coil to obtain the desired electromotive force. There should be some method of distinguishing between the two types, but because both systems are used for jump-spark service, the majority of persons seem to think that the same name will serve for each of these two entirely different forms of ignition supply.

TEMPORARY FORMS AND THE USE OF THE TYPEWRITER IN THE DRAWING-ROOM

By DESIGNER

In the May number of MACHINERY there is an article describing a method of making up temporary forms at small expense. Now this method, while producing the desired results, strikes me as being in the final analysis more expensive than the well-known and approved method of making positive blue-line prints; *i. e.*, the use of a Van Dyke or brown process negative, made from the original tracing.

In our shop we have often been obliged to produce a small



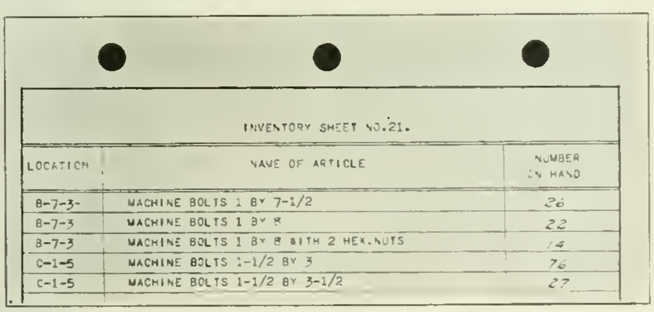
INVENTORY SHEET NO.21.

LOCATION	NAME OF ARTICLE	NUMBER ON HAND.

Fig. 1. Heading of Stock Sheet Blank

number of temporary forms at a time for special statements, inventory sheets, etc., when it would not pay to have forms printed. Our method is to make a tracing, properly ruled and headed, from which we make a Van Dyke negative, and from the latter, as many blue-line prints as desired, or if desirable, positive brown-line prints. The brown-line prints are by far more attractive and permanent, the lines showing a great deal more strongly than the blue lines.

The paper used as a base for sensitized brown print paper is a thin and very tough parchment, admits of much handling without damage, and is so transparent that after having made skeleton prints of the forms desired, properly headed and



INVENTORY SHEET NO.21.

LOCATION	NAME OF ARTICLE	NUMBER ON HAND
8-7-3-	MACHINE BOLTS 1 BY 7-1/2	26
8-7-3	MACHINE BOLTS 1 BY 8	22
8-7-3	MACHINE BOLTS 1 BY 8 WITH 2 HEX.NUTS	14
C-1-5	MACHINE BOLTS 1-1/2 BY 3	76
C-1-5	MACHINE BOLTS 1-1/2 BY 3-1/2	27

Fig. 2. Reproduction of Part of Stock Sheet made by filling in Positive Print on Typewriter

ruled, if it is desired to reproduce the information after the form has been filled out, blue prints can be made directly from it.

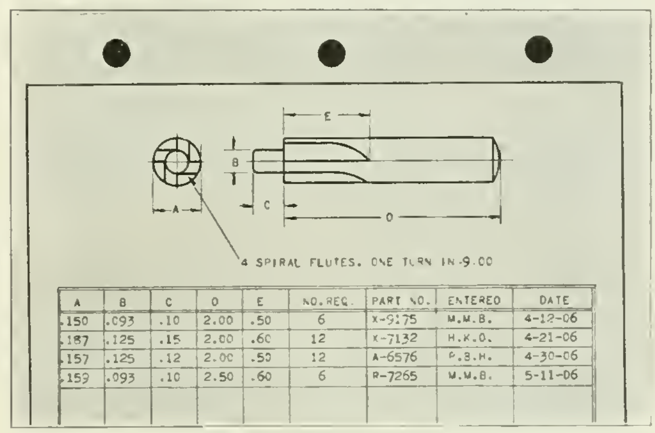
Considering the fact that the extra cost of the small amount of brown print paper required for such work is so trifling, I think it will be agreed that this method is superior to the one described in the May number, as an ordinary tracing and a negative for reproduction can surely be made in much less time than it takes to scratch out the lines and letters on the shellaced tracing cloth. Besides, it is possible to do much neater work directly on the cloth with ruling and lettering pen than by scratching with a sharp wire.

We have occasion once every year at inventory time to use about twenty-five stock sheets like the one the heading of which is shown in Fig. 1. The heading and ruling of this form are laid out on tracing cloth, from which a Van Dyke negative is made, as described above. From the latter, twenty-five or thirty positive prints are made, which are filled out on the typewriter with the names of the articles in the stock department, of which it is desired to obtain an inventory, and are used by the stock keeper as tally sheets. The quantities on hand of the different items are filled in the proper columns in India ink by hand. After the inventory is completed, a complete set of blueprints of the inventory sheets is made and a copy sent to the foreman of each department of the works. A reproduction of one of the finished sheets is shown in Fig. 2.

Previous to the adoption of this method the inventory sheets were manifolded on the typewriter, using as many carbon sheets as necessary to produce the requisite number of copies, and the work produced was not, by far, so neat as now, as the bottom carbon copy sheets were more or less blurred.

Having mentioned the use of the typewriter, I think some points regarding the use of this machine in the drawing-room will prove of interest to many readers, as I do not think that most engineers appreciate fully the utility and economy of this adjunct of the drawing-room. The following illustrations show some of its economical applications.

Fig. 3 shows a sheet of standard counterbores. These counterbores are alike in general plan, but being used for different pieces, the dimensions vary to suit requirements. The counterbore itself and the ruled columns headed with letters denoting the different dimensions, are drawn and inked in on white bond paper, and from time to time the columns are filled in on the typewriter with the dimensions of the counterbores required. As these counterbores are so nearly alike, it is not necessary to make separate drawings for each

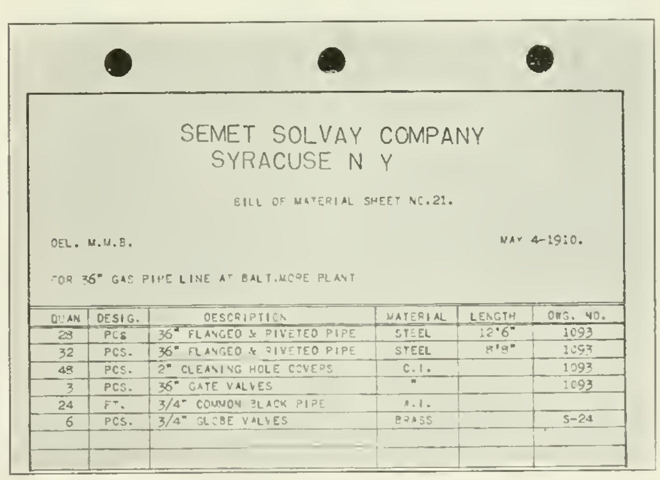


A	B	C	D	E	NO. REQ.	PART NO.	ENTERED	DATE
.150	.093	.10	2.00	.50	6	X-9175	M.M.B.	4-12-06
.187	.125	.15	2.00	.60	12	X-7132	H.K.O.	4-21-06
.157	.125	.12	2.00	.50	12	A-6576	P.B.H.	4-30-06
.159	.093	.10	2.50	.60	6	R-7265	M.M.B.	5-11-06

Fig. 3. Sheet containing Dimensions of Standard Counterbores which are filled in on the Typewriter

one, and this scheme saves time and keeps the dimensions together on one sheet for quick reference. Of course the columns could be filled in by hand, but, as many different draftsmen have occasion to make additions to this list, they are filled in on the typewriter in order to keep the figures uniform, and this feature aids in making a neat and attractive drawing.

Fig. 4 is a reproduction of a bill of material sheet. Blue-



SEMET SOLVAY COMPANY
SYRACUSE N Y

BILL OF MATERIAL SHEET NO.21.

DEL. M.M.B. MAY 4-1910.

FOR 36" GAS PIPE LINE AT BALTIMORE PLANT

QUAN	DESIG.	DESCRIPTION	MATERIAL	LENGTH	DWG. NO.
28	PCS	36" FLANGED & RIVETED PIPE	STEEL	12'6"	1093
32	PCS.	36" FLANGED & RIVETED PIPE	STEEL	8'8"	1093
48	PCS.	2" CLEANING HOLE COVERS	C.I.		1093
3	PCS.	36" GATE VALVES	"		1093
24	FT.	3/4" COMMON BLACK PIPE	W.I.		
6	PCS.	3/4" GLOBE VALVES	BRASS		S-24

Fig. 4. Illustration showing Use of Typewriter for filling in Bill of Material Sheet

prints of this form usually accompany the drawings for a machine or building or whatever the case may be, on which a firm wishes to get bids from outside firms for furnishing or building same. It is a summary of certain parts shown on a drawing, on which estimates are desired. Some firms, as for instance, the Semet Solvay Co., Syracuse, N. Y., issue several hundred of these bills of material a month, and the cost of preparing these tracings reaches a large amount in a few weeks' time.

The blank forms were formerly furnished printed with the heading and ruling, and the lettering was done by hand. The

blanks furnished now are of thin tough parchment paper, printed and ruled as formerly, but the items are filled in on the typewriter, with greater neatness and general satisfaction, and an enormous saving in time and money. In fact, it is thought that the lettering can be done with the typewriter in one-sixth of the time formerly required by hand.

The machine for work of this kind should be equipped with what is known as the Pica Gothic style of type, all capitals. This is the style illustrated on the different forms reproduced herewith. These letters are square and vertical, and give a sharper outline than the style with which a typewriter is usually equipped.

Some firms who make blueprints from typewritten originals, use a piece of carbon paper, laid face up on the back of the sheet, to aid in making a heavy impression of the type, but I do not think that this is necessary, as ribbons with special inking which print very dense and black can be procured for this purpose. The carbon paper on the back is undesirable also, because it smears all over the back of the drawing.

In conclusion, I would like to state that many economies might result if different shop managers would give this subject their attention, and that new and economical uses for the typewriter may be found in almost every drawing-room and shop.

* * *

EMERGENCY BRAKE MOUNTINGS FOR AUTOMOBILE TRUCKS

By HERMANN HILL*

The subject of resisting the torsional strains caused by applying the emergency brake is one that seems to have been overlooked by the majority of designers of automobile trucks. The writer had occasion to design several trucks and found that this particular point received very little original thought by the truck builder, and that the majority of them were simply following the ideas of some one who was guilty of designing a faulty construction, such as is shown in Fig. 1. Let us

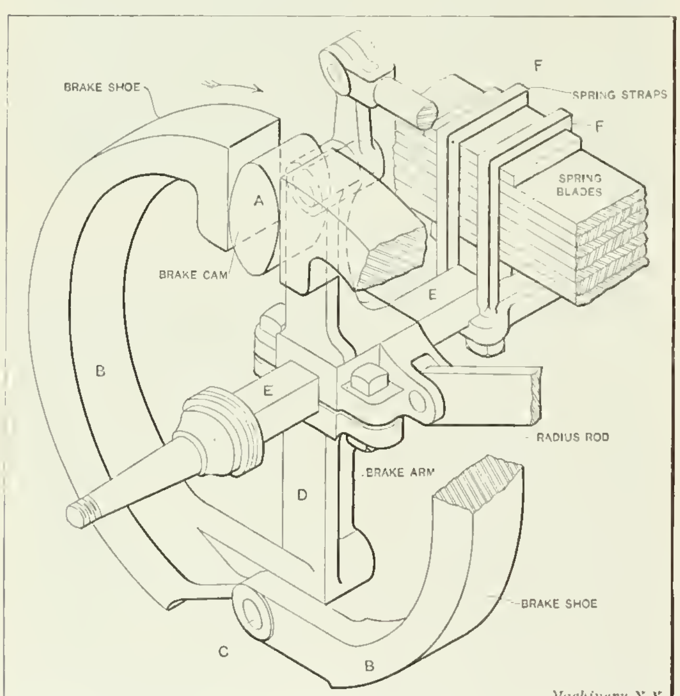


Fig. 1. A Weak and Inefficient Method of Mounting Expanding Band Brakes

for an instant imagine a heavy motor truck loaded with a weight of 7 or 8 tons, traveling at 15 miles per hour. When it is necessary to stop suddenly, the emergency brakes are applied. This, as can be seen, would act through the small brake cam *A*, expanding the shoes *B*. The friction between the brake drum and the brake shoes sets up a torsional strain, tending to turn the axle and the mounting on it. This torque has to be resisted first by the arm carrying the cam *A*, and the stud *C*, then through the brake-arm *D*, which is connected, as shown, to the axle *E*, and finally to the ¾-inch square straps *F*, which clamp the springs to the axle. It is, therefore, evident that the latter fastening is the last and weakest part to resist the enormous torque and it is also plain that this fastening was never intended to do such heavy duty. This axle and spring fastening is a remnant of the wheelwright's art, and as nothing better was suggested it was universally adopted by the makers of modern trucks. As it was originally applied to a wagon or carriage, it served this purpose admirably, but it certainly is not fitted to do the additional duty which would be necessary to stop a 50-horsepower motor truck.

What the writer considers to be a far better method of

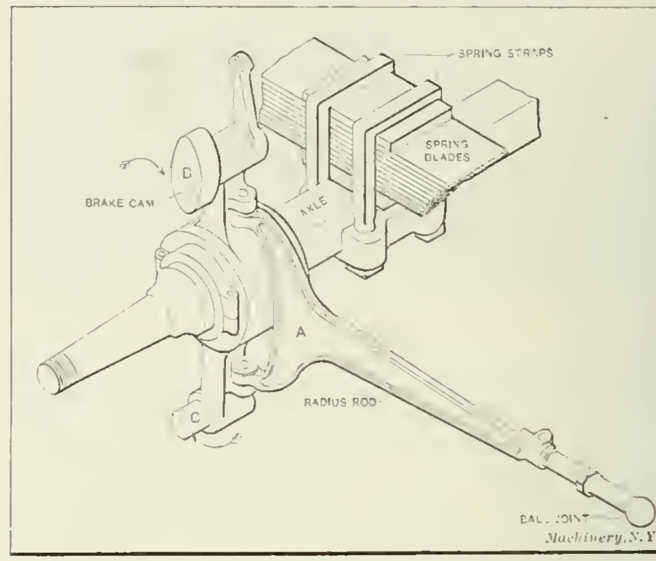


Fig. 2. Improved Method of Mounting Expanding Band Brakes

mounting an expanding brake is shown in Fig. 2. This mounting, as shown, is more rigidly constructed than that shown in Fig. 1, and has the additional advantage of the long radius rod, which is secured to the frame or chassis with its ball joint. This connection resists the torsional strain set up by the application of the brake and relieves the strain on the spring straps. The radius rod *A*, which is connected to the brake arm carrying the points *B* and *C* is, of course, mounted so that the brake arm can rotate upon the axle to permit a vertical movement of the latter, the other end of the radius rod being ball-socketed in some part of the frame or jack-shaft bearing. It is, therefore, evident from a study of this construction, that it relieves the axle and spring fastening entirely of any twisting action, leaving them as they were intended to be since their conception. To fasten the radius rod in this manner serves another purpose; namely, it gives the axle perfect freedom and will not strain the rod or its fastenings in going over rough roads where the axle is continually thrown out of alignment with the frame. It is, therefore, obvious that the ordinary radius rod shown in Fig. 1, which is simply strapped to the axle or fastened with clevices on either end and movable only in a vertical plane, does not permit any disalignment of the axle, but as this will always happen, the rod and its fastenings will have to suffer. The purpose of the radius rod is, as its name implies, to maintain the center distance between the axle and the jack-shaft, by permitting vertical motion of the axle in a fixed radius, and in doing this the rod is only under tensile or compressive strain. If not directly connected, it would in addition be subject to bending and twisting strains which would ultimately cause breaking of the rod or its fastenings.

* * *

Is it good practice to mount the motor and speed boxes on the housings of planers? It is a very convenient location; the motor and speed box are in view and accessible in case anything goes wrong. It is claimed, however, that the vibration and jar due to lack of balance of armature and poorly fitted gears will show on finished work. The inaccuracy resulting is negligible, but the appearance cannot be tolerated on work which is finished when it leaves the planer.

* Address: 799 Cherokee St., Pittsburg, Pa.

AUTOMOBILE FACTORY PRACTICE*

HABERER & CO.'S WORKS, CINCINNATI, O.

By ETHAN VIALL†

The jigs and fixtures used in the shops of Haberer & Co., Cincinnati, Ohio, makers of the Cino motor cars, are unusually complete, well designed and well made, owing principally to the liberal, up-to-date policy of the management, and the practical experience and mechanical knowledge of the designer and shop foreman, O. L. Snyder. Specially designed machinery is not used, as the term is generally understood, but American radial drills, Fosdick horizontal boring mills, Beaman & Smith cylinder boring machines, Brown & Sharpe cylinder grinders and other on-the-market machines make up the excellent shop equipment.

Cylinder Jigs

The shop operations on the double cylinders used do not differ materially from those in other shops doing a similar class of work. The ends and side bosses are first surfaced off on a milling machine, then the cylinders are placed in the jig, Fig. 1, and the six end holes drilled. These holes are used as locating holes for the subsequent operations as well

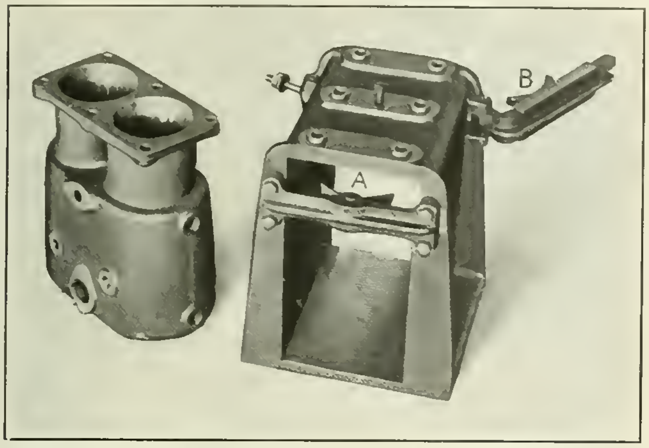


Fig. 1. Jig for Drilling the Six Holes in the Flanges of the Cylinders which are used as Locating Holes in the Subsequent Operations

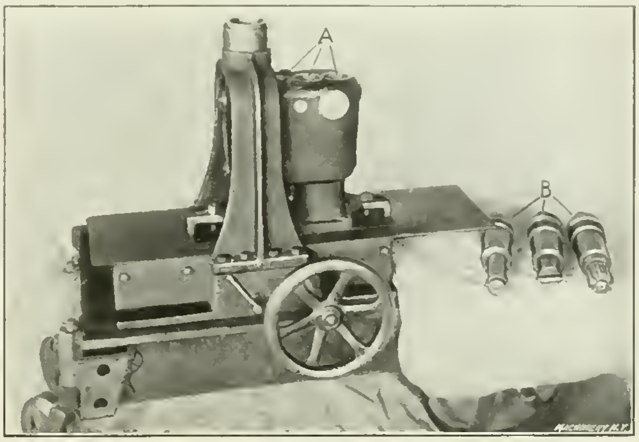


Fig. 2. Indexing Jig for Boring and Reaming the Four Valve Cage Holes

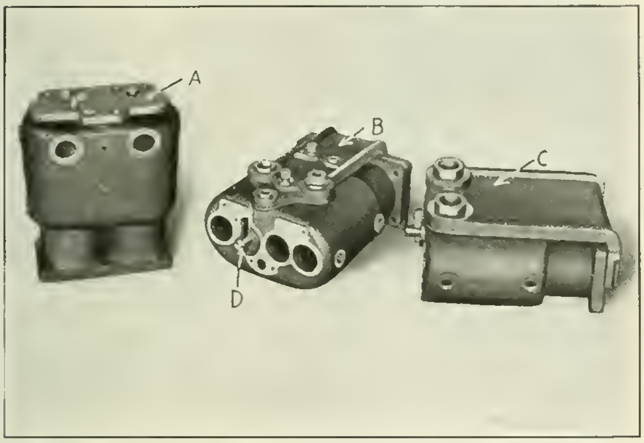


Fig. 3. Jigs for Drilling the Various Small Holes in the Cylinder Castings

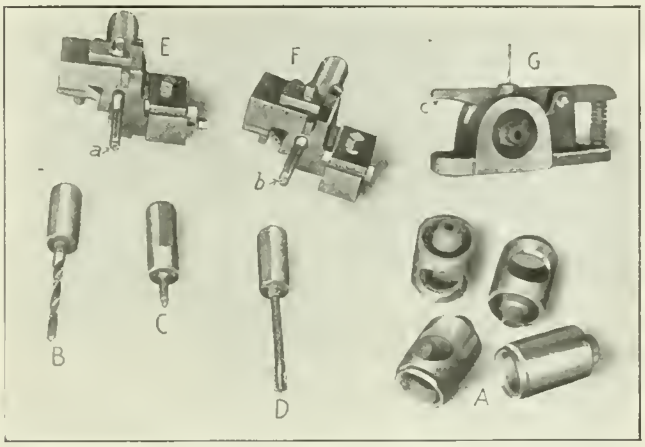


Fig. 4. Tools used in Making the Valve Cages

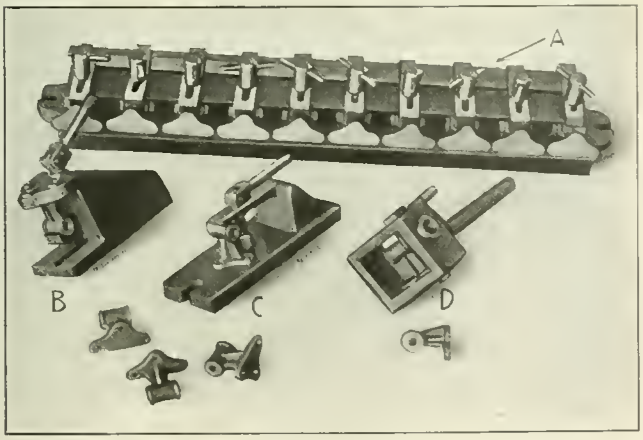


Fig. 5. Tools used in making the Rocker Arm Brackets

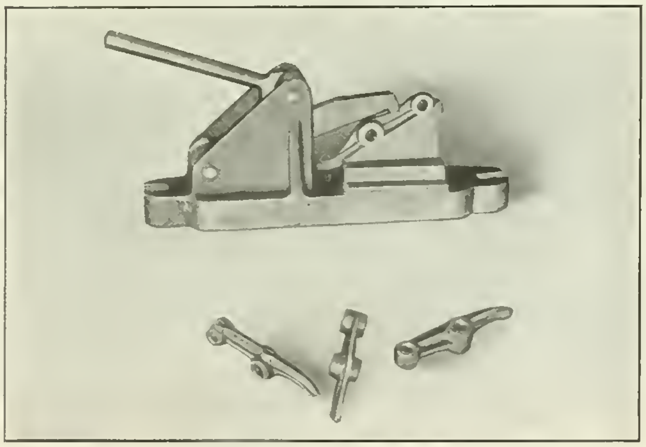


Fig 6. Jig for Milling the Rocker Arm

* For additional information on automobile factory practice and kindred subjects, see: "Automobile Factory Practice in the Olds Motor Works, Lansing, Mich.," July, 1910; "Making an Automobile Steering Wheel," July, 1910; "Laying Out Steering Gears for Automobiles," May, 1910, engineering edition; "Milling Fixtures for Automobile Parts," March, 1910; "Automobile Factory Practice in the Nordyke & Marmon Co.'s Shops," January, 1910, engineering edition; "Design of Automobile Springs," January, 1909, engineering edition; "Machining Cylinders and Pistons for Automobile Engines," January, 1909, engineering edition; "Tools for Drawing Seamless Automobile Lamp Hoods," February, 1909; "Organization and Equipment of an Automobile Factory," March, 1909, engineering edition; "Special Tools and Devices for Automobile Factories," April, 1909, engineering edition; "Broaching Automobile Parts," April, 1909; "Special Automobile Factory Tools and Devices," May, 1909; "Machines and Tools for Automobile Manufacturing," June, 1909; "Treatment of Gears for Automobile Transmissions," October, 1909, engineering edition; "Automobile Factory Practice in the Dayton Motor Car Co.'s Shops," October, 1909; "The Design and Manufacture of a High-Grade Motor Car," October, 1909, engineering edition; "Manufacturing Methods in the Stevens-Duryea Co.'s Works," October, 1909, engineering edition; "Efficient System for the Rapid Assembly of Motor Cars," October, 1909, engineering edition; "Manufacturing Automobile Equalizing Gears," December, 1909; "Drop Forge Work in an Automobile Shop," September, 1908; "Automobile Engine Building in a Steam Engine Plant," April, 1907. See also MACHINERY'S Reference Series pamphlet No. 59, "Machines, Tools and Methods of Automobile Manufacture," and No. 60, "Construction and Manufacture of Automobiles."

† Associate Editor of MACHINERY.

as for bolting the cylinders to the crank case. It will be noted that the cylinders are located in this jig by being held between the swiveled V's *A* and *B*, which grip the cylinder castings between the waterjackets and the flanges, the milled bosses and lower end of the casting locating the cylinder in the desired relation to the finished sides of the jig box. After leaving this jig the cylinders are bored on a Beaman & Smith upright boring mill and then placed in the indexing jig Fig. 2, where the valve cage holes *A* are bored and reamed with the tools shown at *B*. The moving table of this jig is operated by the hand wheel, which turns a pinion meshing in a rack. The table is located for the four holes by the latch lever shown to the left of the hand wheel. The various side and end holes not already finished are drilled by means of the jigs shown in Fig. 3. *A* is the jig for drilling the small top holes, and is located by plugs which fit the valve cage holes. *B* is the jig for drilling the holes for the spark plug and water-pipe; and *C* is the jig for drilling the holes for the exhaust pipe and bracket. The jigs *B* and *C* are both located properly by dowel pins which enter the holes in the cylinder flanges, and are clamped by a rod which passes through one of the cylinders and out through a valve cage hole, where the rod is locked by a washer and tapered wedge as shown at *D*.

Machining the Valve Cages

The valve cages, *A* Fig. 4, which fit the holes that are bored in the jig shown in Fig. 2, are first caught in a three-jawed universal chuck on the open end, and are roughed out to within 1/32 inch of size of the other end; then they are placed in the universal chuck of a turret lathe, where the center hole is drilled with the drill *B*, and the drilled hole is then bored for about 1/4 inch deep with the boring tool *C*, for the purpose of facilitating the starting of the reamer *D*, which is next run through. This reamed hole is used as a guide for the pilots *a* and *b* of the roughing and finishing box tools *E* and *F*, and finally the cages are placed on a mandrel and ground. The jig *G* is used to hold the valve cages while drilling the small holes, into which the locating pins are driven. The spring lever *c* is worth noting, as it serves to both clamp and locate the cage.

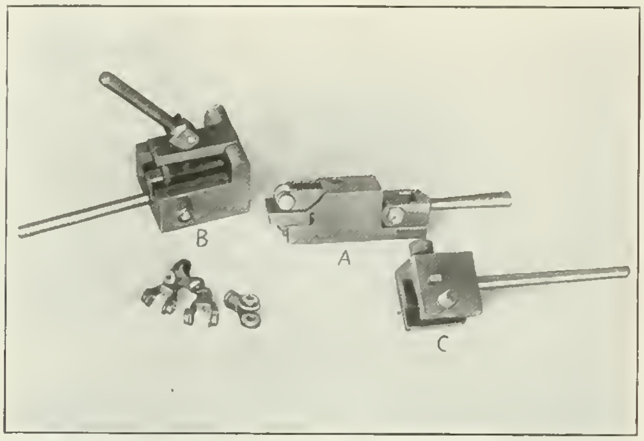


Fig. 7. Jigs for Drilling and Milling the Rocker Arm Clevis

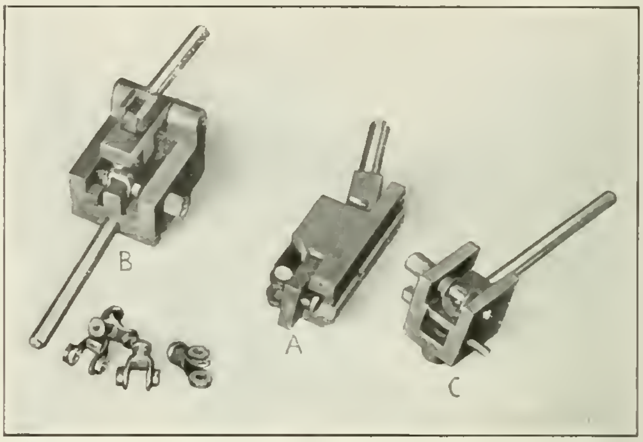


Fig. 8. Use of the Rocker Arm Clevis Milling and Drilling Jigs

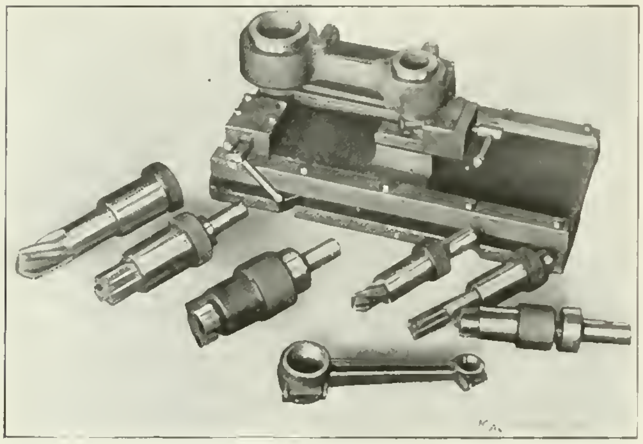


Fig. 9. Drilling, Reaming and Facing Jig and the Tools used for Machining the Connecting-rods

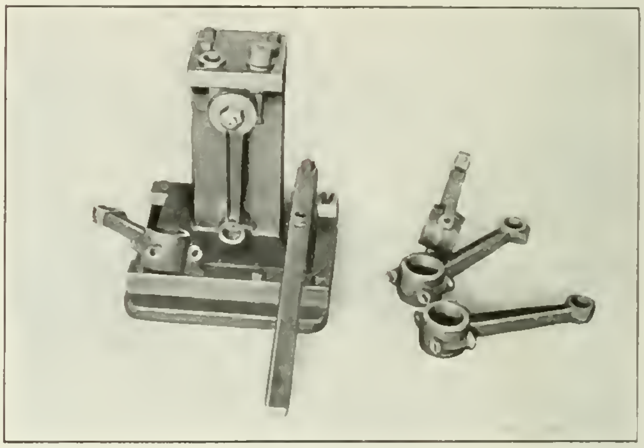


Fig. 10. Jig for Drilling the Holes in the Connecting-rod Caps

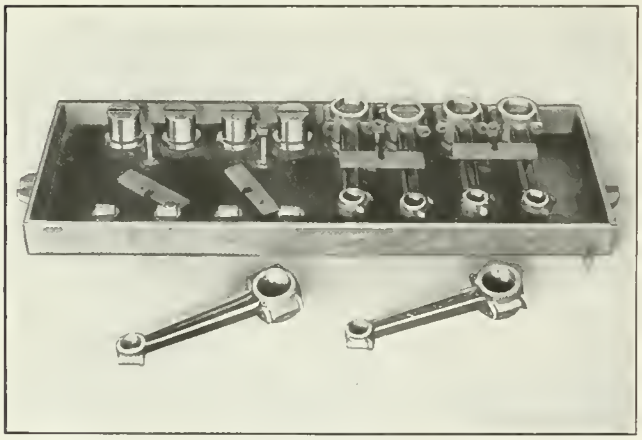


Fig. 11. Milling Jig used in Splitting the Connecting-rod Case into Two Pieces

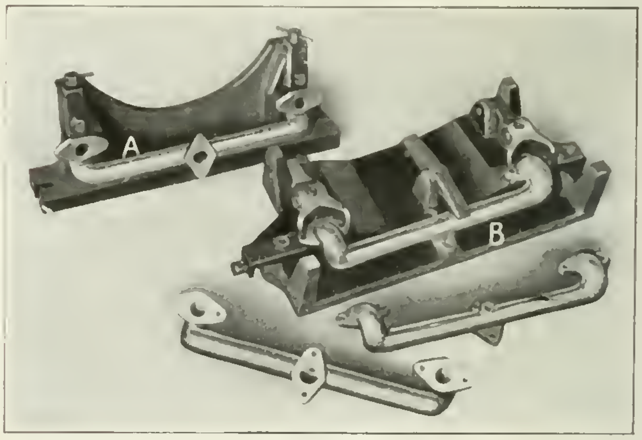


Fig. 12. Milling and Drilling Jigs for the Inlet Water Pipes

Rocker Arm Brackets

The rocker arm bracket bottoms are milled off in the jig *A* shown in Fig. 5. This operation is practically continuous, as the pieces are replaced at one end, when the milling cutter is working at the other. For milling operations, where a quick-acting clamp may be necessary, those shown on the jig *A* are commendable, as the jar of the cutters has a tendency to loosen almost anything but a screw clamping device. For ordinary drilling the eccentric clamps shown on the jigs *B*, *C* and *D* are both quick and effective. Taking these jigs up in the order in which they are shown, *B* is used to drill the three holes in the base of the bracket, the piece being pressed up against the bottom of the member in which the drill bushings are set, by a clamp operated by the eccentric lever on top. The jig *C* holds the bracket while the ends of the bearings are surfaced off with a straddle mill, the piece being located by dowel pins over which the base holes fit, and is clamped as shown. The jig *D* holds the bracket while drilling out the bearing hole, the piece being located by dowel pins in the same manner as in the jig *C*. The rocker arms are straddle milled in the jig shown in Fig. 6, which is a model of simplicity, and easy to operate, an eccentric locking lever being used, as was the case in those just described. The holes in these levers are punch marked and then drilled, as the distance between the holes may vary somewhat.

The rocker arm clevises are centered and straddle milled in jig *A*, Fig. 7. The fork holes are drilled in the jig *B*, and the end hole drilled in the jig *C*. The construction of these jigs is more fully shown in Fig. 8.

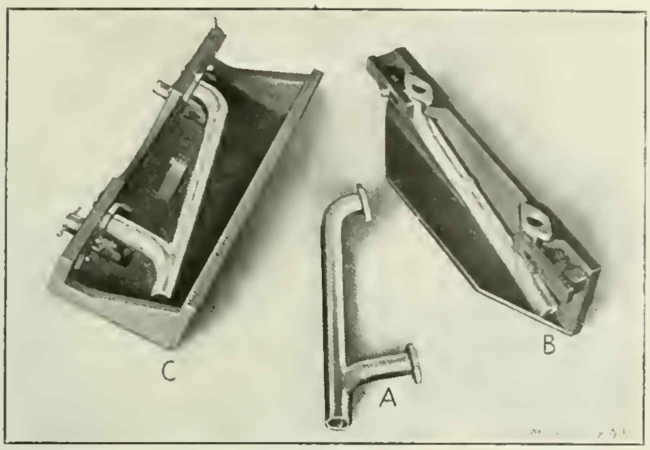


Fig. 13. Milling and Drilling Jigs for the Outlet Water Pipes

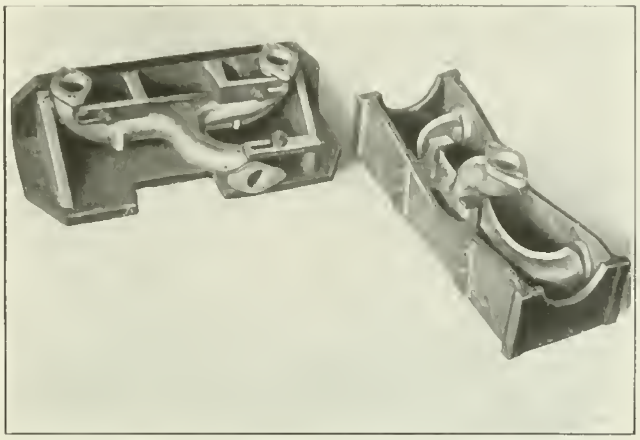


Fig. 14. Milling and Drilling Jigs for the Intake Pipee

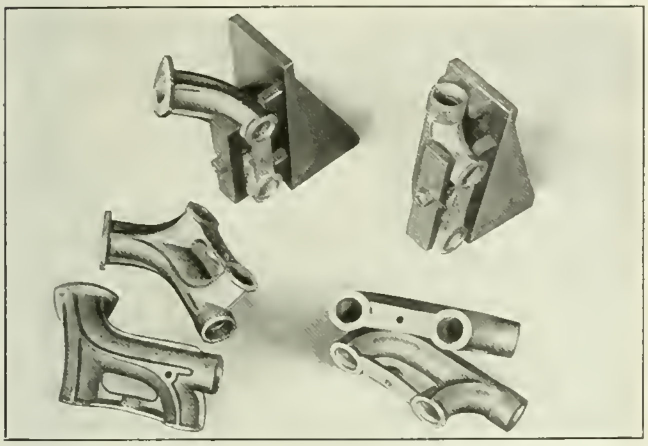


Fig. 15. Milling Jigs for Two Different Shapes of Exhaust Manifolds

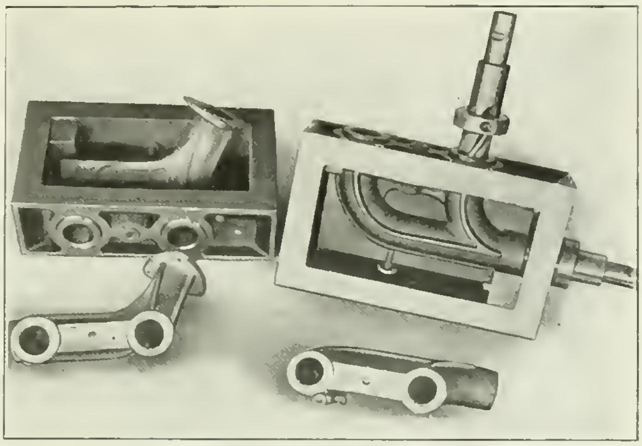


Fig. 16. Drilling Jigs for Two Different Shapes of Exhaust Manifolds

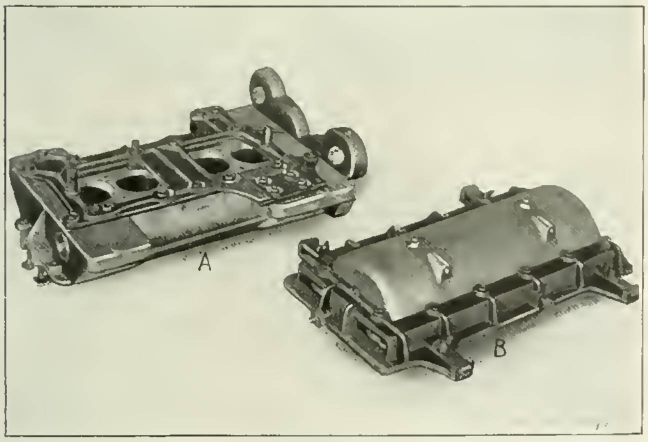


Fig. 17. Drilling Jigs for Upper and Lower Crank Case

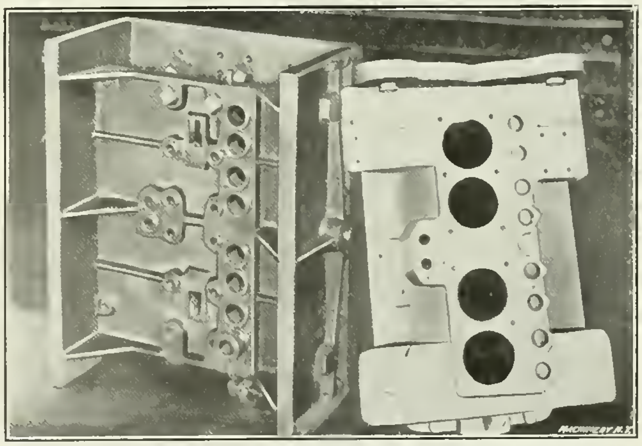


Fig. 18. Drilling and Reaming Jig for Upper Crank Case, also showing Model Drilling and Reamer Rack in the Background

Connecting-rod Jigs

The first operation on connecting-rods is to drill, ream and face the end holes in the jig shown in Fig. 9, which is made to be used on a single spindle drill press, the upper part of the jig being made to slide in the bed. The connecting-rods are locked by two screws, operating V-clamps, and the various tools used have guide bushings fastened on the shanks, which have been ground and lapped to fit the bushings of the jig.

The cap-screw holes of the connecting-rods are drilled in the jig shown in Fig. 10, which is made to slide on the same

principle as the one just described, though a small hand lever is used to operate it in this case. A point to note in all of these jigs is that where more than one operation is necessary for any particular hole, the jig bushing is made extra large, and then bushings for the different tools are carefully fitted into it, and where possible these bushings are fastened to the shank of the tool used, avoiding the annoyance of misplaced bushings. After being drilled, as shown, the caps are split in two pieces in the milling jig shown in Fig. 11.

Pipe Milling and Drilling Jigs

The various pipe connections used on a gas engine for an automobile are generally awkward things to handle, so the set of jigs used for the pipes on the Cino engine are here shown, though little explanation is needed. *A*, Fig. 12, is the flange milling, and *B* the flange drilling jig for the inlet water pipes, the latter jig being shown upside down. *A* in Fig. 13 is the outlet water pipe, and jig *B* is the milling, and *C* the drilling jig. Fig. 14 shows jigs for drilling and milling the intake pipes, and Figs. 15 and 16 show respectively the jigs for milling and drilling the exhaust pipes. *A* and *B*, Fig. 17, are the jigs used for drilling the top and bottom crank cases, while another top crank case jig is shown in Fig. 18. The jig shown in Fig. 19 is used for holding the gear-case covers while surface milling the contact edges.

Gear Marking and Keyseater Jigs

The crank, cam shaft and magneto gears all bear certain definite relations to the gear with which they mesh, so in order to avoid the usual "cut-and-try" method these gears are marked before being taken from the keyseater. This is accomplished by using the keyseating and marking jigs shown in Fig. 20, *A* being a magneto gear jig; *B* a jig for the cam shaft gear, and *C* a jig for the crank gear. As can be easily seen, the swinging punches when tapped with a hammer, will mark the gear in relation to the position of the keyway. These jigs are used on a Baker keyseater as is shown in Fig. 21. Fig. 22 shows a Fosdick horizontal mill at work, boring out the crank bearing cam shaft and other holes in the crank case, an enlarged view being shown in Fig. 23.

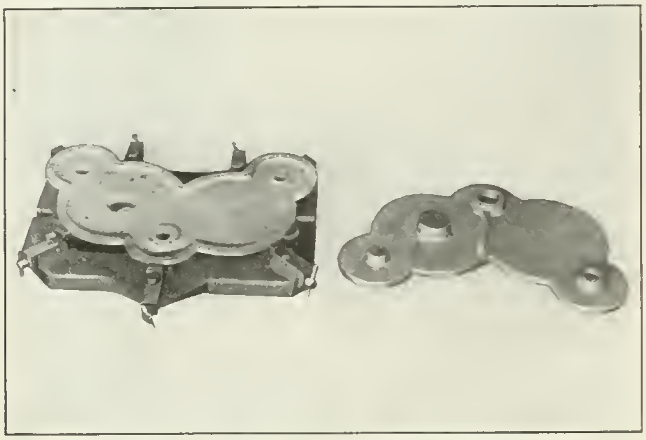


Fig. 19. Milling Fixture for the Gear Case Covering

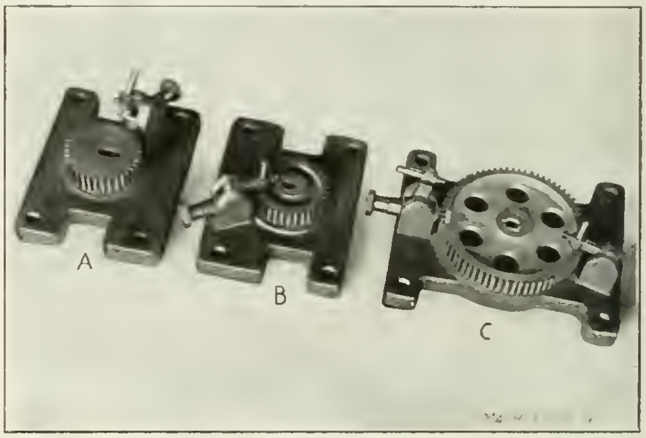


Fig. 20. Keyseating Fixture used for Holding and Marking the Gears

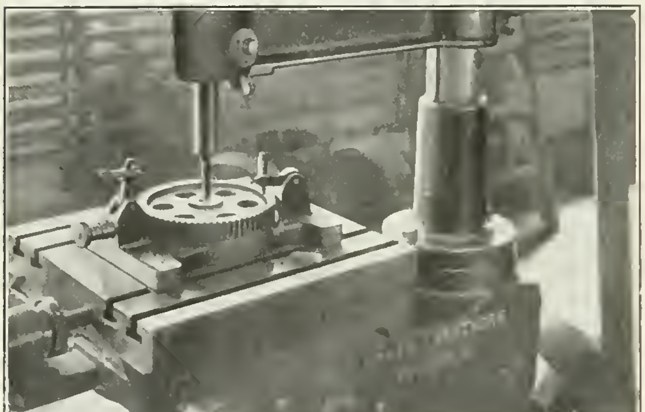


Fig. 21. Showing Method in which Jig is used on the Keyseater for Marking the Gears

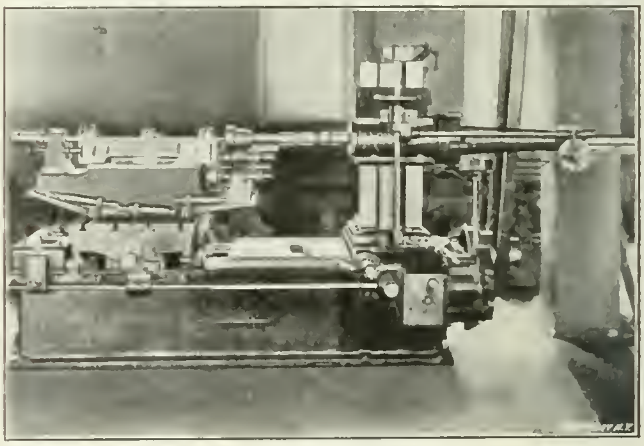


Fig. 22. Fosdick Boring Mill at work on a Crank Case

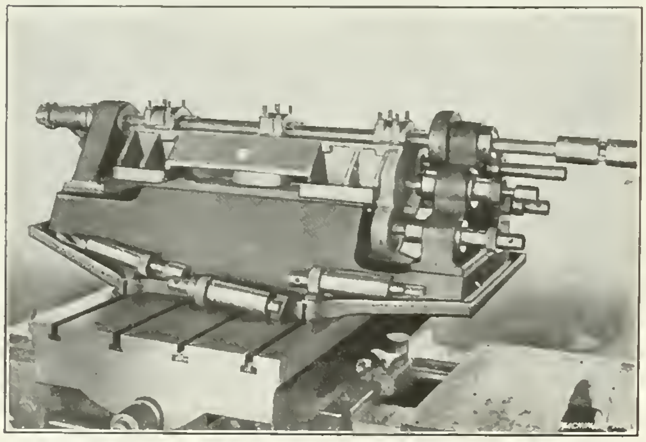


Fig. 23. Fixture and Tools used for Machining the Crank Case

Fig. 24. View of the Hardening Furnace

A model hardening room is shown in Fig. 24, *A* and *B* being the hardening furnaces and *C* a cyanide bath. On top of the cyanide heating crucible is a shovel-like holder for hardening valve stems, which consists simply of a piece of flat iron with a nandle on it, the flat part having twelve holes in it through which are put the valve stems. The shovel is placed over the bath allowing the stems of the valves to hang in the cyanide, but protecting the heads.

Thanks are due to Mr. W. F. Meyer for courtesies extended to us while obtaining the material given.

* * *

AUTOMOBILE MOTOR-TESTING PLANT

By F. B. HAYS*

The accompanying illustrations show a universal motor-testing plant for testing automobile motors. This plant was designed to overcome the difficulties arising from the lack of facilities for giving motors of various sizes and construction a block test without building special blocks for each size of motor. At first sight this would be considered a very difficult matter, as every make and size of motor varies. However, after some consideration of the subject a general idea for making the plant was conceived and general details worked out accordingly. The chief difficulty lay in the necessity of holding four separate motors or a three-point suspension motor on the same block.

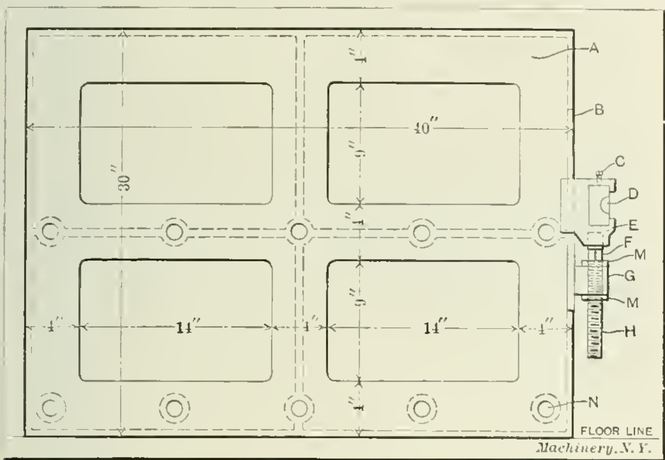


Fig. 1. Side Elevation of an Assembled Testing Block

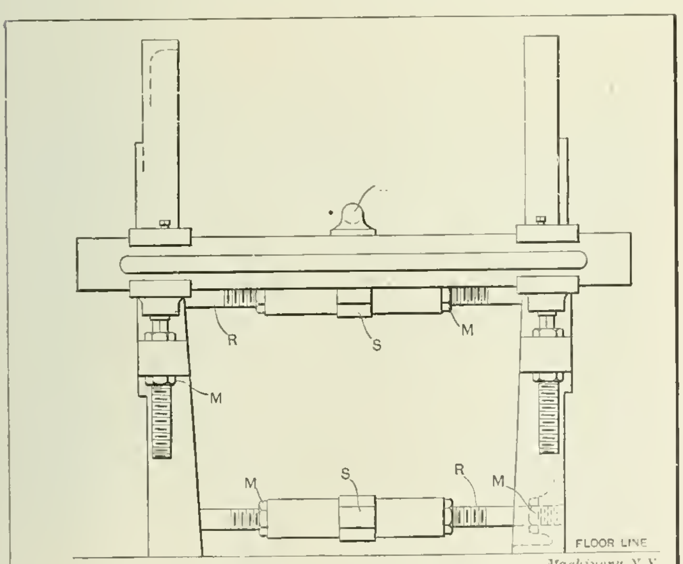


Fig. 2. End Elevation of Assembled Testing Block

Fig. 1 shows a side elevation of an assembled testing block which was devised and proved satisfactory. For a four-support motor the supporting plates *B* are bolted to the face or the top side of blocks *A*. For a three-point suspension motor, the side-supporting plates are bolted to the face and the bearing is fixed to the beam *D* by means of trunnions or by other means as required by the construction of the motor. The proper alignment of the motor is obtained by raising or lowering the beam *D* by means of adjusting screw *H* which is operated by the square portion *F*, beam *D* being supported by the yoke *E* which travels on the guide *B*. The width between the yokes *E* is maintained by set-screws *C*. The locking nuts *M* hold the adjusting screws *H* in the required position. Fig. 2 shows an end view of this assembled testing arrangement, the distance between the side blocks being maintained by turn-buckles *S*, this required distance being governed by the size of the motor to be tested. All the locking nuts should be held rigid by means of lock-washers so that once the testing arrangement is set it will not require further attention. The rods *R* are used for regulating the width between the sides of blocks *A*; W is the trunnion for operating the front bearing of the three-point suspension motor.

* Designer and Engineer, Cole Motor Car Co., Indianapolis, Ind.

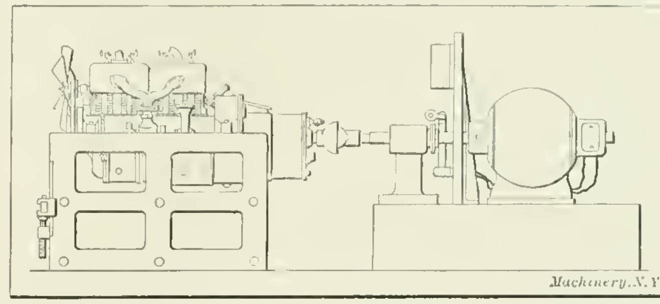


Fig. 3. Unit Power Plant for Testing Motors by means of an Electric Dynamometer

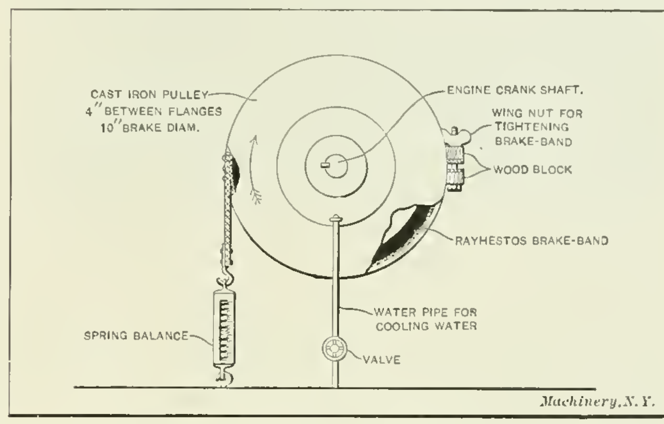


Fig. 4. Friction Brake for Testing Motors

Fig. 3 shows a unit power plant for testing motors which are connected to an electric dynamometer. The motor may be connected with a friction dynamometer type of prony brake with equal facility and the horsepower obtained with little difficulty. Where it is not desirable to maintain an expensive outfit, the friction brake of the type shown in Fig. 4 will be found very convenient for general work. This brake is clearly illustrated and it will not be necessary to describe it further. The accompanying table gives the various horsepowers for different speeds and brake loads as determined by the dynamometer tests.

DYNAMOMETER POWER CHART—DIAMETER OF PULLEY = 10".
Without Brake Arm 360° Contact
Formula: Brake Load × R. P. M. × 0.00008 = H. P.

Brake Load	Revolutions per Minute								
	500	800	1000	1200	1400	1500	1600	1700	1800
	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
100	4.0	6.4	8.0	9.6	11.2	12.0	12.8	13.6	14.4
125	5.0	8.0	10.0	12.0	14.0	15.0	16.0	17.0	18.0
150	6.0	9.6	12.0	14.4	16.8	18.0	19.2	20.4	21.6
175	7.0	11.2	14.0	16.8	19.6	21.0	22.4	23.8	25.2
200	8.0	12.8	16.0	19.2	22.4	24.0	25.6	27.2	28.8
225	9.0	14.4	18.0	21.6	25.2	27.0	28.8	30.6	32.4
250	10.0	16.0	20.0	24.0	28.0	30.0	32.0	34.0	36.0
275	11.0	17.6	22.0	26.4	30.8	33.0	35.2	37.4	39.6
300	12.0	19.2	24.0	28.8	33.6	36.0	38.4	40.8	42.2
325	13.0	20.8	26.0	31.2	36.3	39.0	41.6	44.2	46.8

BENDING DIES FOR THE RIBBON FORKS OF THE ELLIS ADDING TYPEWRITER*

By RALPH E. FLANDERS†

If the reader will cast his eye upon Fig. 1 and note the very complicated twists which have been given to the punchings there shown, he will doubtless be surprised when he is told that practically all of the bending in the first sample, and absolutely all of it in the second sample, was done at one stroke of the press in a single die. If he is not surprised he ought to be. The operation of bending the blanks for these pieces comes pretty close to being the most complicated presswork job ever undertaken. The designer of the dies, however, Mr. Burchett, of the Ellis Adding Typewriter Co., Newark, N. J., modestly asserts that tools of this kind are not uncommon. But they certainly are not so common as to be well-known, so it is fitting that an achievement of this kind should be signalized by detailed illustration and description.

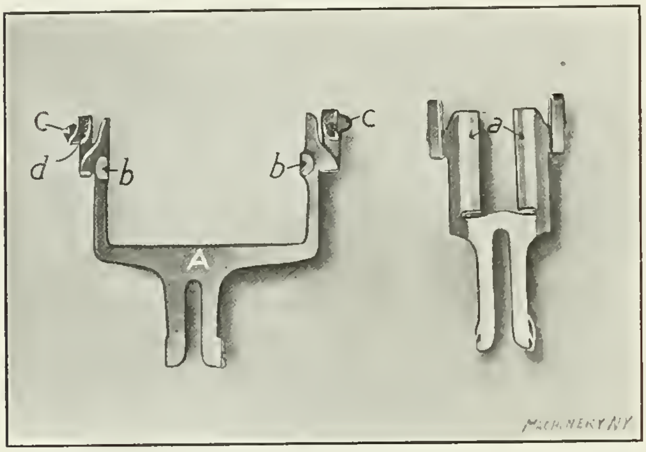


Fig. 1. The Ribbon Forks of the Ellis Adding Typewriter

The operation of making the large ribbon fork, *A*, consists simply in blanking in one die and bending in a second. The simpler of the pieces shown at the left of Fig. 1 has a third operation performed; this is merely the bending of the two inner blades as shown at *a*, and the only reason for making a separate and third operation of this is that, if performed in the main bending die, it would not permit the removal of the work.

The Blanking Dies

The blanking dies for these two parts are shown in Figs. 2 and 3. Their chief interest lies in the fact that two operations in a single die are required in one case, and three in the other, for cutting out the complex blank. These operations are so distributed that there is no danger of drawing or distorting the slender blank in the process; at the same time, no dangerously slender parts are required in the punch, this being, in fact, the main purpose of the sub-division of the blanking operations.

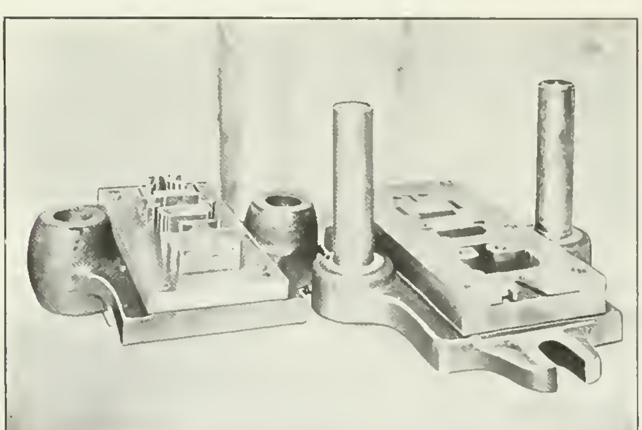


Fig. 3. Punch and Die for Blanking out the Adding Machine Ribbon Fork

* This is the third of a series of articles on the principles of action and tools used in the manufacture of a special typewriter. The practice, while typical of the class of manufacturing represented, is novel in many respects.—EDITOR.

† Address: Springfield, Vt.

The die for cutting out the narrow or typewriter-ribbon fork, is shown in Fig. 2. As may be seen, it is of the self-contained type, provided with two carefully fitted posts for guiding and aligning the punch. This construction gives all the advantages of the sub-press die so far as ease of changing and setting up in the punch-press is concerned. It has the merit, of course, of being much less expensive than the sub-press, and on all ordinary work the makers have found it to be eminently satisfactory.

The blanking dies for the large or adding-machine fork are shown in Fig. 3. The cutting out of this blank is a three-operation process, the arrangement of the punches of which is shown in Fig. 4. The first operation at *e* cuts out all the slots. The narrow blade-like punches work in the solid strip of metal, so there is no tendency for them to deflect one way or the other and be broken. In this operation, also, part of the stock is punched from the central blanked space. In the second step, shown at *f*, the corners of the arms are rounded and the blanking of the central space is completed. In the third step, *g*, the completed blank is outlined and punched out.

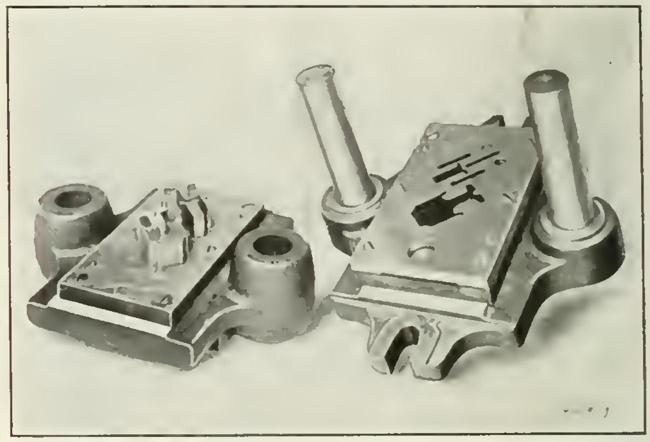


Fig. 2. Punch and Die for Blanking out the Typewriter Ribbon Fork

The condition of the strip of metal for each of the three steps of the blanking operation is shown in Fig. 5. It will be noted at *g* that the strip is entirely separated through the middle. To prevent the two sides of the strip from spreading or coming together, and thus giving a blank of incorrect shape, pilot holes h_1 h_1 are punched in the first step. In steps *f* and *g* pilots on the punch enter and fill these holes before the punching commences, as shown at h_2 h_2 and h_3 h_3, thus firmly and accurately locating the stock.

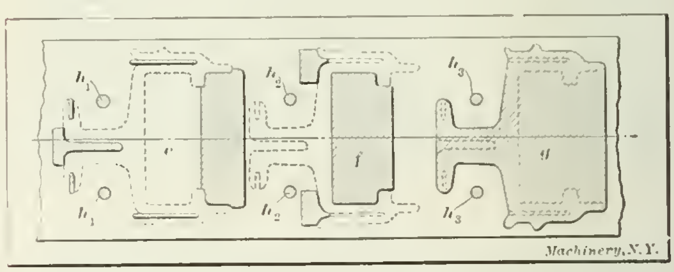


Fig. 4. Lay-out of Punches for the Die shown in Fig. 3

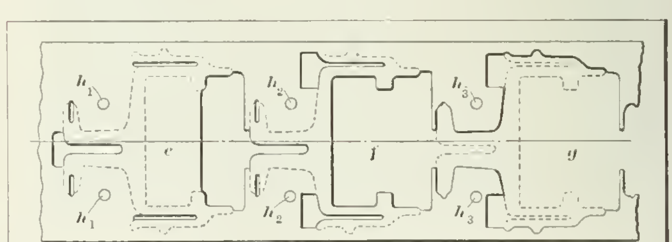


Fig. 5. Successive Operations on the Strip of Metal in the Die shown in Fig. 3

It is evident from a study of Figs. 4 and 5 that stock might have been economized by telescoping the head of one

blank in between the arms of the succeeding one. If the reader attempts to lay out a punch and die in this manner for this piece, however, he will find difficulty in getting proper support for the slender punch and die shapes required. The only practical alternative to the construction shown would be a costly sub-press die in which the blank is cut at one stroke, and the punch parts and the stock are supported by the strippers and shedders. But the success of such a scheme would be problematical.

Of the two bending dies, the construction of which is the main text of this sermon, that shown in Fig. 6 is for the narrow typewriter ribbon fork, while the one illustrated in Figs. 7 to 11 inclusive is for the wider fork shown at A in Fig. 1. The die shown in Fig. 6, while quite as complicated and ingenious

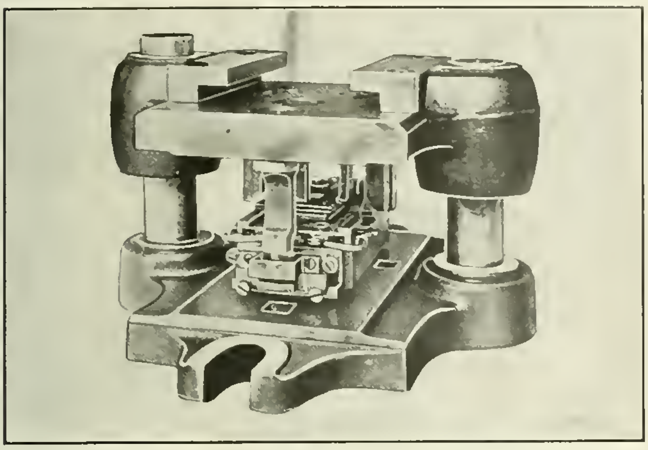


Fig. 6. Main Bending Die for the Typewriter Ribbon Fork

as the other, will not be described in detail. The die selected for description has one or two features of particular ingenuity, which should be capable of more extended application in bending operations in general.

Description of the Bending Die

Fig. 7 shows the bending die with the punch-plate removed, and the work A, in place as it appears at the conclusion of the operation, ready for removal. The same reference letters apply to all the engravings, Figs. 7 to 11. The punch holder shown in Fig. 8 is supplied with a number of projecting members, some of which operate directly on the work, but most of which act through their wedge-shaped faces to operate

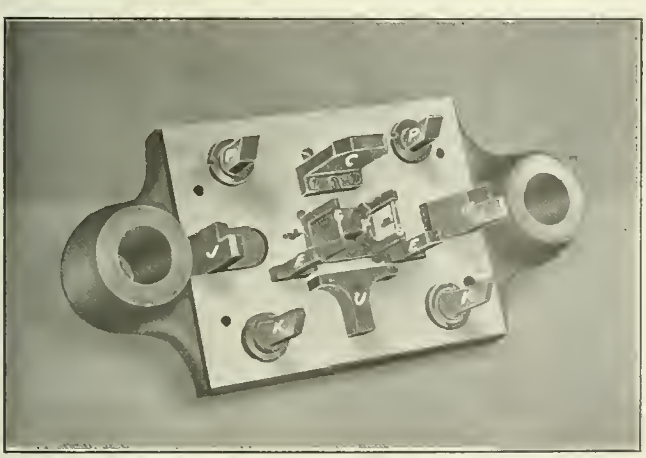


Fig. 8. Punch and Operating Parts for Die shown in Fig. 7

slides in the die, as shown more in detail in Figs. 9, 10 and 11.

The first thing that takes place (see Fig. 9 in particular) after the blank has been laid in position and the plunger starts to descend, is the throwing into place of matrix fingers B by the action of wedge C in the punch, which comes in between them and spreads them apart. These fingers, as shown by the dotted lines at B_1, are normally swung in together, permitting the placing or removal of the work, but when forced into the operating position they pass over the blank as shown, holding it down at the inner ends. The thin blade-like projections at the end of matrix levers B enter slots cut to receive them in the faces of blocks D. These blades are thus supported so as to prevent breakage under the pressure of subsequent bending operations.

As the ram of the press continues its downward movement, the next members on the punch holder to come into operation are the two wedges E, one of which is shown in detail in Fig. 10. These force together the inner ends of pivoted supporting levers F. One of these levers is shown in its outer or inactive position in the lower or sectional view Fig. 9, while the left-hand one is shown in its normal or working position in Fig. 10, where it has its working face flush with that of matrix lever B. Now as the plunger of the press continues its descent, the next member on the punch holder to be operated is the bending punch G, which, as shown in Fig. 10, bends downward the inner tab of the blank (see b,

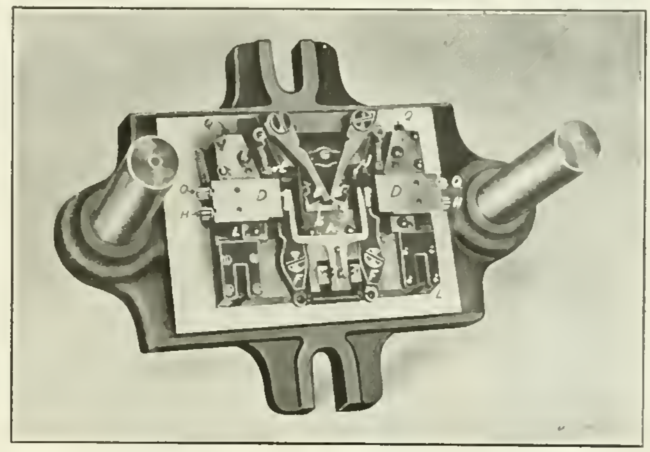


Fig. 7. The Die for the Complete Bending Operation on the Adding Machine Ribbon Fork

Fig. 1) over lever F, the blank meanwhile being supported between B and F.

The long tail of the blank has now to be wrapped clear around the blade of matrix lever B. The provision made for this wrapping operation is novel. As shown in Fig. 10, spring plungers H are provided which are capable of being moved

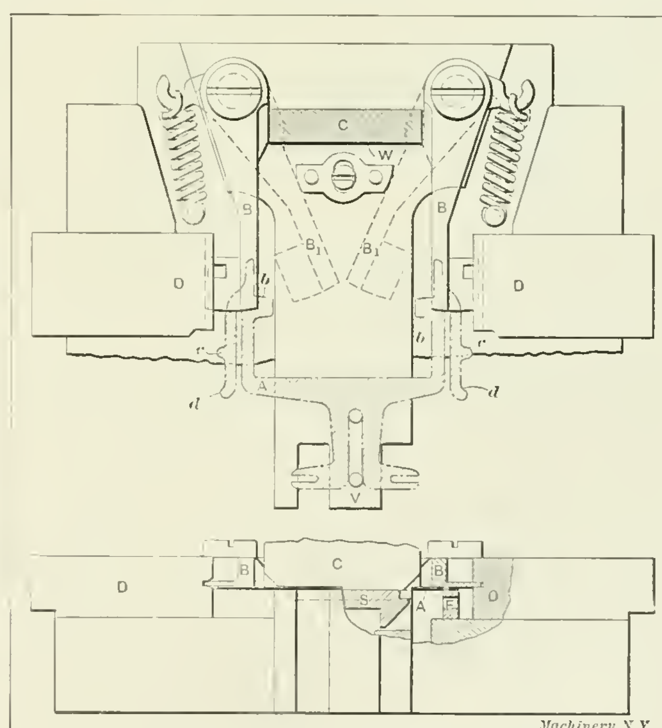


Fig. 9. Diagrammatic View of Die shown in Fig. 7, illustrating the Preliminary Movements

inward, and may also be rotated. In the first place, wedges J descend and force plungers H inward, against spring pressure as shown. The lip of plunger H supports the work up against the under side of the blade of B. After this has taken place wedges K descend, drawing slides L toward the front. These are slotted to engage pins M in rocking sectors N. The teeth in the periphery in these sectors engage gear

teeth cut in the shanks of plungers *H*. As *K* descends, therefore, plungers *H* are rocked in the direction shown by the arrow in the small detail at the lower right-hand corner of Fig. 10. By means of this rocking the tail of the blank is wrapped around blade *B* of the matrix lever. So much for the first bend.

As shown best in Fig. 7, there is also a second plunger, *O*, alongside of *H* in each of the two blocks *D*. As the ram continues to descend, a second inclined face on wedge *J* throws these plungers inward, over the tails of the blank. Then wedges *P* operate a second set of slides *Q*, through corresponding pins and rocking segments to rotate plungers *O*, wrapping the work a second and final one-half turn about blade *B*, as shown in the sketch at the lower right-hand in Fig. 11.

Now the extreme end of the tail of the work, which is thus being bent about *B*, has to be rounded up as shown at *d* in Fig. 1. This is done, as shown in Fig. 11, by interposing a projection *j* on supporting lever *F*, against which the extreme end of the tail strikes as it is bent round. This, combined with the shape of the bending finger on *O*, gives the proper curve to the end of the tail.

While all this has been going on, the central wedge *R* of the punch plate has been entering between two slides *S*, spreading

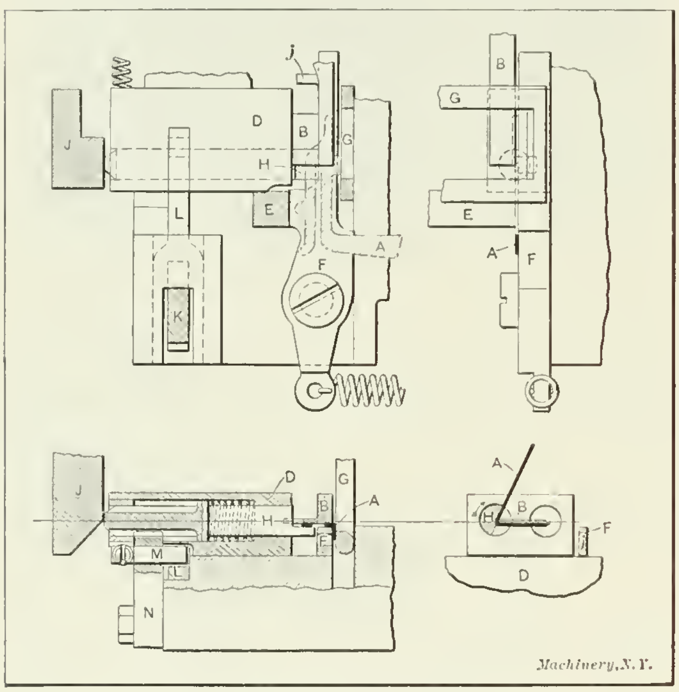


Fig. 10. Diagram showing the First Bending Operations for the Adding Machine Ribbon Fork

them apart. These slides, as shown, have projecting ends which bend the inner tab of the work (see *b*, Fig. 1) into a slot in supporting levers *F*, thus completing the double right-angle bend required at this point. The operation is shown best in Fig 11. There is a second pair of tabs on the work (*c* in Figs. 1 and 11), which has to be bent downward. This is done by punch members *T*, shown in Fig. 8, which have inclined faces pressing the tabs into bevel cuts provided to receive them in the blades of *B*.

When the operations just described are finished, punch *U* of Fig. 8 comes down solidly against the work as it lies on *V* of Fig. 9. At the same time a ledge on punch member *C* strikes solidly against the edge of the opening at *W*. Now the whole die mechanism, as so far described, is supported by a stiff rubber cushion, and when the punch holder thus solidly brings up against it, the continued movement of the ram of the press forces the whole die mechanism bodily downward against the resistance of this rubber spring. When this takes place, punch *U*, holding the work firmly against *V*, forces it down between stationary formers *Y* (see Fig. 7). This action bends up the two ears of the fork, by means of which connection is made with the operating mechanism for bringing the ribbon up in front of the type for printing. The fork is now completely formed.

On the return stroke the operations described are reversed. Wedge *R* returns as do also members *G*. The latter, it will be noted in Fig. 11, have beveled inner edges which strike corresponding wedge faces on the under sides of *S*, bringing them back to the central position shown in Fig. 9. Plungers *H* and *O* are rolled back to their normal positions and withdrawn. Supporting levers *F* are allowed to spring outward, leaving them free of tab *b*. The withdrawal of wedge *C* allows matrix fingers *B* to spring back to the central position. The work is now all bent to shape and all clear of its various supporting forms in the die and may thus be easily withdrawn.

There may be some doubt as to the advisability of making a complicated die like this one, when a number of simpler dies can be made to do the work in several operations. This matter was discussed at the time the tool was designed. It was concluded, however, that the several dies required would cost nearly as much as the complicated die, while there would

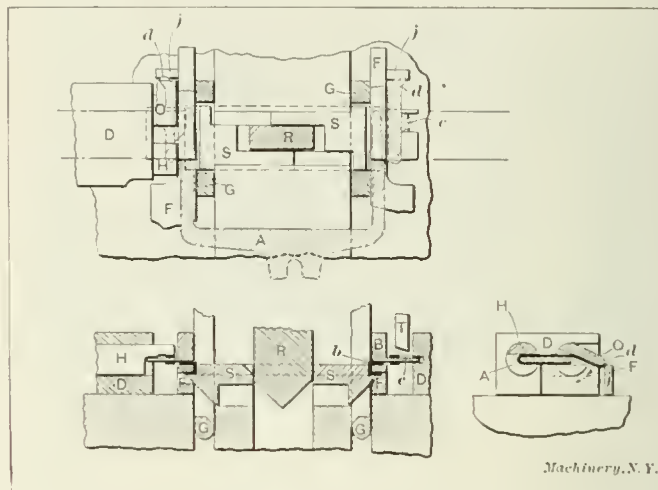


Fig. 11 Diagram showing the Completing Bending Operations for the Adding Machine Ribbon Fork

be a clear gain in the reduction of operations, consequently, of workmen's time and machine time. A tool of this kind, however, has the disadvantage of requiring careful handling. If anything should break, the whole of the bending operation is tied up instead of only part of it being disabled, as would be the case where multiple dies are used. It has never broken, however, and is turning out satisfactory work, so its expense appears to be justified by the service it is rendering.

* * *

DEATH IN UNGUARDED GEARS

Horrible accidents like this, in which limbs are mangled or lives crushed out—the direct result of unguarded gears—are of almost daily occurrence in this great country of ours where human life is held cheap—cheaper than the few pounds of cast iron that would have shielded the gears and prevented the gruesome tragedy.

Ground to Death in Gear Wheels

While Henri Koch, an engineer of a steam dredge of the R. C. Packard Co., which has been blasting and dredging in the east channel of Big Hell Gate at the foot of Ninetieth St., New York, was oiling a gear wheel near the winding drum of the dredge yesterday afternoon, his coat caught in one of the teeth and he was drawn between the largest two gear wheels. The wheels crushed through his body and then came to a stop. The engineer's screams brought half a dozen laborers employed on the dredge on the run. They saw him crushed to death between the wheels, with only his legs free of the long gear teeth. One of the laborers, Emil Hanson, tried to reverse the machinery, but the wheels would not move. After working several hours, the laborers, with the assistance of a squad of the harbor police under Lieut. Dwyer, extricated the body. It was removed to the morgue.

Must our manufacturers be brought up with a round turn by drastic laws, which awaken moral responsibility only by touching the "pocketbook nerve," before they will cease building and selling dangerous mantraps like this hoist? Some parts of machinery probably always will be dangerous of necessity, but what reason exists for leaving gears unguarded? The unguarded gear is a potential means of mutilation or death of some unfortunate, and must be abolished.

COMPRESSED AIR FOR STIFFENING BEAMS, STRUTS AND FLAT SURFACES

Prof. Perry, of the Royal College of Science, South Kensington, England, recently published a letter in which he called attention to the possibility of stiffening flexible materials by inflating them with compressed air, mentioning the bicycle tire and the long sausage-like india-rubber toy sold on the streets, as well-known examples. He suggested that the idea may be made very valuable in the design of metal structures, because with the proper internal pressure the compressive stresses can be reduced to zero. It is the compressive stresses that complicate structures and make bracing necessary that greatly increases weight. The idea, now of special interest in view of the development of the aeroplane, is treated in Perry's "Applied Mechanics" in part as follows:

"A tensile load applied to extend a beam may not only diminish the greatest compressive stress, but also the tensile stress. Again, there are many cases of beams or infinitely flat arches in which there is no tensile stress anywhere. In such cases, of course, the earth takes the necessary tensile load. When the pneumatic wheel tire was invented, Prof. Fitzgerald pointed out that columns to support loads, and military bridges easy to pack and unpack might be made of inflated tubes, the solid material being everywhere in tension . . . . . In a thin straight tube of circular section, if the greatest bending moment is M and R is the radius, t the small thickness of the material, the compressive stress anywhere due to bending is $\frac{M}{\pi R^3 t} y$, where y is the distance from the diameter which is the neutral line of the section on the compressive side. The greatest compressive stress is $M/\pi R^2 t$. Now imagine the tube to be subjected to internal fluid pressure P above that of the atmosphere; there is a tensile endlong stress $P \pi R^2 \div 2 \pi R t$ or $PR/2t$, and hence the greatest compressive stress is $M/\pi R^2 t - PR/2t$. This is just 0 when $P = 2M/\pi R^3$. The greatest tensile endlong stress is then, of course, PR/t; but this is equal to the lateral tensile stress which the mere internal pressure produces. When, therefore, the internal pressure is just sufficient to remove all compressive stress in the material, the tensile stress, where it is greatest, is the *same in all directions*, and is $2M/\pi R^2 t$. We see, therefore, that great loads may be carried by inflated tubes of thin material if they are only large enough in diameter, or by a bundle of small tubes. . . . . . One may go far in speculation on this idea—rigidity gained by using thin material and subjecting it to internal fluid pressure, so that there shall be no compressive stress. The great ships of the future may owe their stiffness and strength to the general use of fluid pressure in those parts of them where cargo is stored, and the same pressure which gives strength may serve to keep out the sea in case of a leak. It is the means by which the leaves of plants are made rigid. Similarly, large flat areas might be made of considerable size by fastening together two plane sheets by means of many connecting ties so that they may not balloon out, and then inflating them like an air cushion. Aeroplanes of sufficient size to support a man by Lilienthal's method can be made with comparatively small internal fluid pressures, and are not liable to make splinters when they fall to the ground, these splinters being a cause of considerable risk with aeroplanes made with sticks as stiffeners. Kites much larger than those suggested for military purposes might be made, in which the whole kite might be like an air cushion, or thin tubes with compressed air might take the place of the present bamboo framework. The inflation might be maintained automatically.

"Again a thin tube of radius R and thickness t has to act as a column carrying a load W, and this is the load which is carried when there is no axial tensile stress. The pressure of the fluid inside being P, we have $\pi R^2 P = W$. Also the lateral tensile stress produced in the material is PR/t or $\frac{W}{\pi R t}$, so that great loads may be supported by inflated tubes of thin material if they are large enough in diameter. Thus, for example, a tower of thin steel 1000 feet high would have in it a lateral tensile stress of only three tons to the square inch, due to its own weight and the necessary fluid pressure. Being all in tension there is no danger of instability such as exists in ordinary pillars. If large in diameter, the hemispherical top cap becomes of importance as a load. Any moderate diameter like 20 feet would bear many tons on the top in addition to the weight of the structure itself. Thus, a tower 1000 feet high and 20 feet in diameter and 0.01 foot thick would itself weigh about 125 tons. Its hemispherical cap would weigh 6.3 tons, and it would support 325 tons on its top. The internal pressure would be 23 pounds per square inch and the tensile stress 10 tons per square inch. There would be no compressive stress."

MACHINING A MOTOR FLY-WHEEL

By EDWARD J. BLANCHARD

Much has already been written about the machining of parts of various shapes and sizes on both hand and automatic turret machines. But the machining of motor fly-wheels as they are finished on a No. 3-A Potter & Johnston automatic, will no doubt be of interest to many, especially to manufacturers of gas engines. The manufacturer of to-day realizes more and more the need of automatic turret machines, if he is to meet competition. This is particularly so with the automobile manufacturer.

The tools illustrated in this article were designed and built by the Potter & Johnston Machine Co., of Pawtucket, R. I., for a well-known automobile concern in France. These tools were designed to take in two different sizes of fly-wheels which are shown in Fig. 1, and which the reader will note are very much alike. In fact, the clutch part and the hole, which are important, are the same on both sizes. The dimensions given are in millimeters, and are the finished sizes.

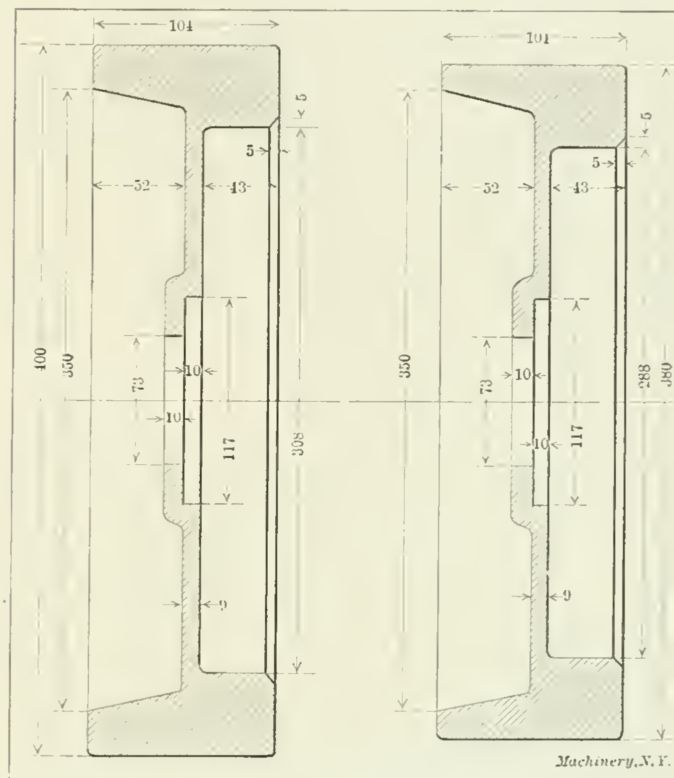


Fig. 1. Fly-wheels to be Machined

The fly-wheels are finished all over in two operations, and the time required for finishing both operations is 35 minutes. To this, however, must be added about 4 or 5 minutes for each operation, allowing time to remove the finished casting and to put in a rough one, making a total of 44 minutes in all.

First Operation

The fly-wheel is gripped under the rim by the hardened jaws A, Fig. 2, which are held in the standard chuck furnished with each machine. The chuck is of the three-jawed type and is shown at A in Fig. 3. One of the jaws is also visible at B. This chuck is operated by a socket wrench. Referring again to Fig. 2, the jaws are scored at B so as to prevent the work from slipping. It will also be noted that the flat part shown at B gives a very good bearing and proper gripping surface for the jaws. It may be necessary to call the reader's attention to the fact that this extra metal, as shown by the dotted line in the engraving, is added to the castings to facilitate handling, and is removed in the second operation. The pins C back up against the web and serve to locate the work. D is the pilot bushing which is fitted to the chuck, the tapered part E fitting into a similar taper in the chuck plate. F and G are forged tools which rough face both sides of the fly-wheel and are carried in the standard toolposts H and I on

* Address: 84 Warren Ave., Pawtucket, R. I.

the cross-slide block J, which is fastened to the cross-slide by means of the screw K. The forged tools L and M, which are similarly shaped to F and G, and are carried on the front cross-slide. They finish-face both sides of the fly-wheel, the cutting edge N rounding the corner. The hardened steel block O is fastened to the cast-iron block P by means of the screw Q, and the block P is fastened to the block R. The block O operates the swinging tool used for facing the web.

Fig. 3 shows the tools on the first turret face, which have just finished their work, and the turret has partly returned to the indexing point. As has been previously described, A is the chuck and B one of the jaws, C is a piloted boring-bar carrying the previous turret face and cutter K operates in the hole. As the practice was to use the same tools as far as possible in subsequent operations, this swing tool was designed to face the web in the next operation as well. The reader will see by referring to Figs. 1 and 2 that the fly-wheel has a raised part around the hole on the other side of the web. Therefore, it was necessary to have the extra slot L put in the swing tool. This swing tool consists of the swinging arm N held to the body M by means of stud O. This stud is fitted so as to allow the arm N to swing, and is fastened to body M by a nut and washer. Another one of these blocks is fastened to the swinging arm at Q. These blocks are also free to rotate. R is a

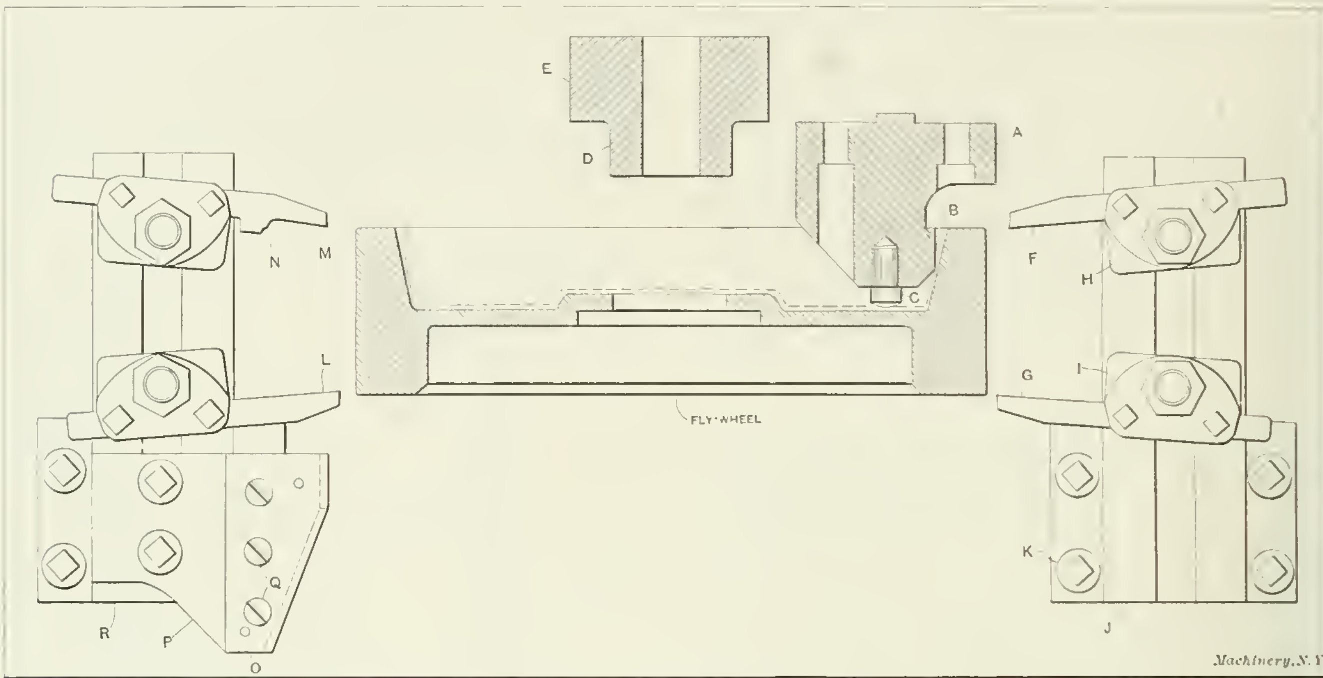


Fig. 2. Method of Chucking Fly-wheel in the First Operation and the Application of the Cross-slide Tools

two blades D and E which bore and counterbore the hole in the hub. F is a standard turning-tool holder carrying turning-blade G, which turns the periphery of the wheel. I is a tool which bores under the rim, and is held in the special boring-stem H. Another stem which cannot be seen in this photograph is used for turning a groove in the web. This groove is turned in the proper place so that tool J, shown spring between these two blocks, so that when the arm N is pushed forward the spring is compressed, and when the pressure is removed from the arm it is forced back to its starting position by this spring. S is a steel strap screwed on to the body. The cutters are held in place by clamps as shown at T, and have backing up screws which provide longitudinal adjustment. U is a stop-plate with an adjusting screw so as

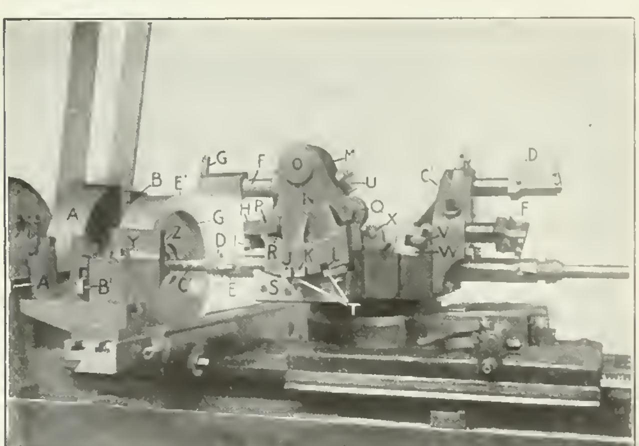


Fig. 3. Tools used in the Turret for the First Operation

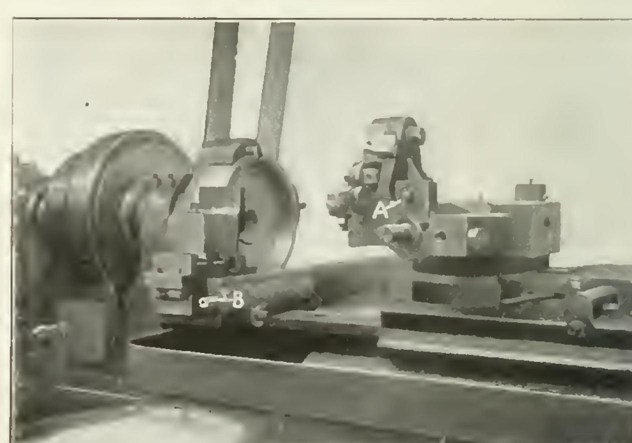


Fig. 4 Tools used in the Turret for the Second Operation

on the next turret face, can start cutting without having to break the scale. The standard turning-tool holder is shown clearly at C'. The rear cross-slide tools work simultaneously with the turret tools just described. The cross-slide is actuated by a separate cam on the same drum as the turret cams, and is so constructed as to permit adjusting so that the cross-slide can be fed in when desired. It will be noted that there are seven tools cutting at the same time, which is a feat that cannot be accomplished on a hand machine.

On the next turret face is shown a swing tool which faces the web. Cutter J starts in the groove made by the stem on to have the arm stop in the proper position. V is a roll held in the carrier W, which is pivoted at X, the holder for the roll being held on the turret face as shown. As has been previously explained, this swing tool is pushed by the hardened steel block Y, which has a groove Z machined in it. This groove engages roll V, and as the front cross-slide feeds forward to finish-face both sides of the fly-wheel and round the corner, it also pushes the swing tool. A' and B' are the forged tools which finish-face the fly-wheel and which are shown at L and M in Fig. 2.

The tools carried in holder C', on the third turret face, are

the same as those on the first turret face with the exception that the pin cutter D' is added, which rounds the corner E', and blade F', which chamfers the inside edge G'. On this turret face is omitted also the tool which turns the groove in the web. On the fourth turret face, which is directly in the rear of the swing tool and which is not visible in Fig. 3, is a bar similar to the boring-bars shown on the first and third turret faces, except that it has single point cutters instead of flat cutters. This bar sizes the hole in the hub and also the counterbored recess. This completes the first operation when the machine is stopped, and the operator replaces the finished piece by a rough one, when the machine is again ready to start. The time required to finish this operation, including the time necessary to replace the finished piece by a rough one is 30 minutes, or in other words, the output for this operation is 20 fly-wheels per day of 10 hours.

Second Operation

In the second operation the fly-wheel is centralized by the bushing *A* which is clearly shown in Fig 5 and is held in the fixture on the spindle nose *B* by means of screws *C*. This centralizing bushing *A* is hardened and ground and fits the counterbored hole in the fly-wheel which was finished in the first operation. The fly-wheel is held in place by means of

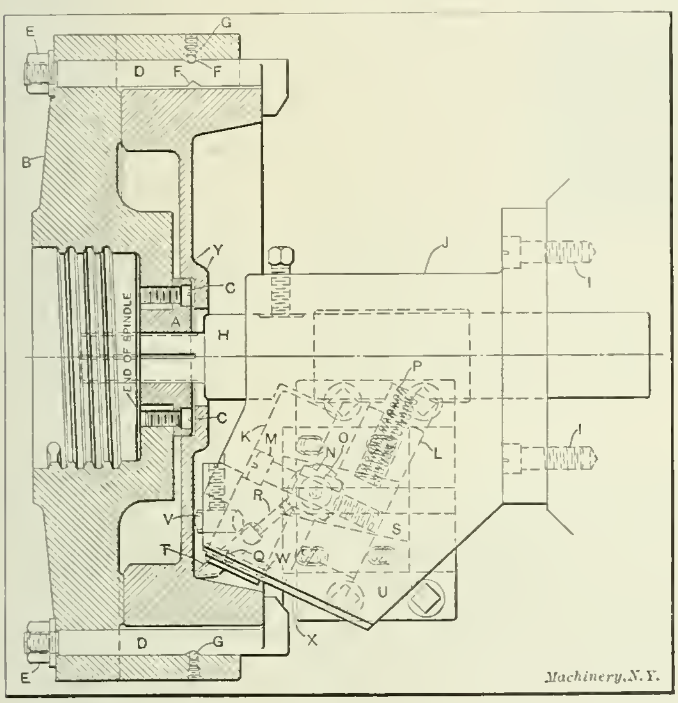


Fig. 5. Details of Chuck and Taper Boring-tool used in the Second Operation

the hook bolts *D* which clamp it against the fixture on the spindle nose as shown. There are four of these hook-bolts and they are clamped by means of the nuts *E*. Each bolt has two countersunk spots *F* diametrically opposite, as shown, so that when the operator changes the pieces the bolts are turned half way around, and the ball *G*, which has a spring at the back of it, drops into the opposite spot and keeps the hook part of the bolt out of the way. After the work is clamped in the fixture on the spindle nose the machine is started up and the taper boring-tool on the first turret face is brought into position and operates on the work. This taper boring-tool is clamped to the turret by screws *I* and is centralized by bar *H* which is also used as a pilot. The taper boring-tool consists of a cast-iron body *J* and carries two steel plungers *K* and *L*, which are hardened and ground. These plungers are clamped together by the screw *M*, and between these plungers, keeping them a certain distance apart, is a block *N*, one end of which is turned down so as to fit the roll *O*, held in place by a screw and washer. In the back of one of the plungers is a spring *P* which keeps the plungers out. One plunger would have been better and cheaper to make, but on account of the depth of the bore it was impossible to get the roll outside of the fly-wheel, when the end of the cut was reached, unless the plunger had been set at an angle which would necessarily have been too great. Plunger *K* carries a tool *T* which is held in place by screw *Q*. This tool has also a backing up screw *R* which makes it possible to get longitudinal adjustment. Roll *O* engages a slot in the hardened steel cam plate *S* which is screwed to the special cast-iron block *U* on the cross-slide. This slot is machined at an angle of 13 degrees and it can readily be seen that as the turret advances and the roll *O* engages this cam, the tool *T* will be forced to travel at the proper angle, at the same time that it is feeding in. *V* is a pin-tool set in the body of the taper boring-tool and turns a groove in the web to receive one of the cutters in the swing tool as described in the other operation. *W* is a felt washer held in place by plate *X* which also covers up the hole which was made for plunger *L*. This keeps the dust and chips from getting into the holes and eliminates a lot of trouble which is usually caused by the chips and dust getting between the sliding parts. A blade which can be seen at *A*, Fig. 4, is also carried in the body of this tool and forms the part *Y*, shown in Fig. 5. The taper boring-tool rough bores the clutch part. A tool similar to the pin-tool *V*, is carried on the third turret face and finish bores the clutch part. On the second turret face is the same swing tool which was used in the previous operation, but with the addition of an extra blade, which faces the web and raised part around the hole, the swing tool being operated in the same manner as it was in the first operation. The cam which is used on the turret face carrying the swing tool, is made so that when the turret has advanced the full amount it dwells long enough to allow the cross-slide to push the swing tool. When the tools on the first turret face begin to work the cross-slide is against the stop-screw *B* (Fig. 4) having been brought up previously by a special rear cross-slide cam. When the next turret face brings the swing tool in place the cross-slide starts to feed forward and pushes the swinging arm until the web is faced. Then the special rear cross-slide cam mentioned, which is a combination front return and rear dwell cam, brings the cross-slide back against the stop-screw and keeps it there until the clutch part is finished, thus assuring the correct taper. This operation consumed exactly 14 minutes, including the time necessary to take out the finished casting and to put in a rough one, or 43 fly-wheels per day of ten hours. The time given is the average time which the writer secured for his own benefit, and was made at the works of the concern for whom the tools were built, and it may be appropriate to mention at this time that the manufacturers stated that they were getting better work and more of it than they were able to get by their former method of machining. This is only one of an unlimited number of pieces which can be finished on these machines, and the reader will readily appreciate the advantage of this type of machine over the hand machine, as the only care necessary after the machines are once set up for a certain job, is to take out the finished work and to put in another piece. An operator can easily take care of from four to six machines, depending, of course, upon the length of time consumed in finishing the parts, and the manufacturer can also depend on each piece being a duplicate of the other.

* * *

UTILIZATION OF SCRAP

There is in Cleveland a concern that makes a business of blanking metal for other firms that do stamping. Now anybody who knows anything about the stamping business knows that there are hundreds of jobs a year which leave scrap from which many other stampings could be made—if the firm happened to get the order for the smaller pieces. But it may not get such an order for months and to store the scrap from the first job until the second comes, would cost more than buying new sheets for the second. But suppose somebody could make a business that did nothing but blank, suppose somebody could go to a lot of other stamping concerns and get their blanking work? The variety of pieces for which many concerns had orders would be such that the blanking concern could often use scrap twice or three times. The Cleveland man who started the blanking business got the idea by simply asking himself, "Why cannot better use be made of scrap steel than selling for scrap?"—*Silent Partner.*

EXAMPLES OF MODERN TURNING PRACTICE IN AUTOMOBILE CONSTRUCTION

A number of interesting examples of what can be accomplished with a modern turning lathe that has been specially designed for the rapid and accurate production of work, are shown by the illustrations accompanying this article. The operations on the different pieces illustrated are particularly noteworthy, partly because of the limited time in which the work is accomplished, and also because of the accuracy with which certain of the surfaces have to be finished.

The camshaft shown in the machine in Figs. 1 and 2 is a good example of that class of work in which rapidity and precision are combined, as seventy-five of these shafts are turned in ten hours, and the diameter *d* and the length of the bearing *l* must be kept within limits of 0.001 and 0.002 inch, respectively. This work, as well as the other operations which will be subsequently referred to in this article, is performed on the well-known Lo swing lathe, built by the Fitchburg Machine Works, of Fitchburg, Mass.

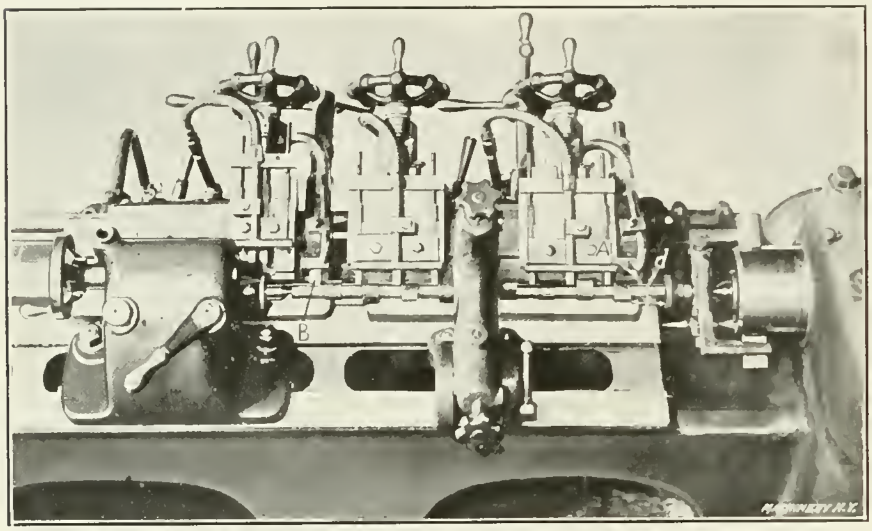


Fig. 1. Rear View of a Lo-swing Lathe arranged for Turning Camshafts—First Operation

These shafts are finished in two operations. The arrangement of the tools for the first operation is shown in Fig. 1, while Fig. 2 shows the machine set up for the second or final operation. Owing to the rapidity with which this work is turned out, a somewhat detailed account of the successive steps will be given. As it is necessary to support the shafts while they are being turned, they are first rough-ground on the central bearing for a steadyrest. The shaft is then placed in the lathe and the tool *A*, that is used for turning bearing *d*, is then used as an indicator for locating the automatic stop-rod.

As those familiar with the Lo-swing lathe know, this automatic stop-rod is located at the front of the machine and contains a number of adjustable stops which can be set to automatically disengage the feed at any predetermined point. The rod itself is also adjustable longitudinally so that the tools, which, for a given piece of work would have the same total travel, can be disengaged at a point nearer or farther from the headstock as may be required.

The method of using the tool for locating the stop-rod is as follows: After the stops on the rod have been set to give the required amount of tool travel and in the approximate location with reference to the work, the carriage is brought against the stop that is set for that side of the end cam which is next to bearing *d*. The stop-rod is then adjusted just far enough back to allow the tool to clean up the side of the cam. As soon as the cam is faced, the carriage is fed to the second stop and the inside of the collar for bearing *d* is finished. By the use of the stops, the distance between the cam and collar is kept within a limit of 0.002 inch. The tool is next returned to its first position, and, after being fed in until a zero mark on the micrometer collar of the feed screw is reached, it is again passed over the work, thus finishing the bearing within a limit of 0.001 inch. These close limits are necessary, as the jig used for drilling holes through the collar is clamped to and located by this finished bearing.

The two three-tool attachments which are both mounted on one carriage, as shown, are next employed for rough turning, simultaneously, the six spaces between the cams. The bearing on the tailstock end of the shaft is then rough turned by tool *B*, the stop for which is adjusted to face the cam the right length from the end of the shaft. This finishes the first operation which consumes five minutes.

After the entire lot is machined in this way, the tool is changed as shown in Fig. 2 for the second operation—except when two lathes are employed, in which case the work is, of course, passed from one to the other. On the second operation, the shaft is reversed, the dog being placed on the finished end. The stop-rod is first set for facing the collar to the correct width. This is done by running the carriage against a stop—set approximately correct—and adjusting the automatic stop-rod until the tool which faces this shoulder just touches the blade of a small combination square, set to project 1/4 inch (the thickness of the collar) beyond the base of the square, which is held against the finished face of the collar. When this adjustment has been made, the four sizes on this end, including the turning of the collar itself to the right diameter, are finished simultaneously by the special four-tool attachment shown. The tools in this holder are set the right distance apart for forming the shoulders, and any change of diameter is obtained by the screws shown back of each tool, which give an independent adjustment. All of the bearings are turned with an allowance for grinding, which operation is performed after the shafts are carbonized and hardened. The time required for the second operation is two minutes.

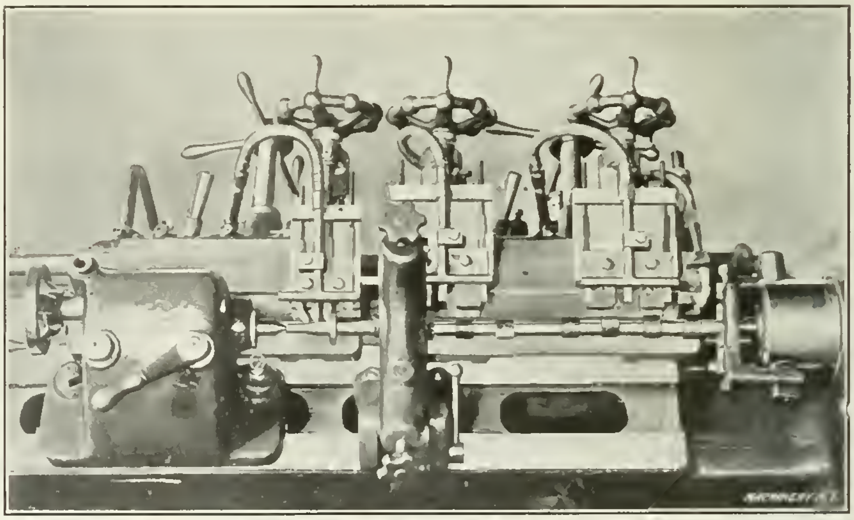


Fig. 2. Arrangement of Tools for the Second Operation on the Camshafts

It will be noted that provision is made for supplying a cooling compound to the cutting edges of all tools, each of the three tool-blocks having a T-headed pipe which distributes the lubricant. These pipes or nozzles are connected by the flexible metallic hose shown, to a cored passage in the carriage which is supplied from a geared pump inside the head of the machine. The speed of rotation, while turning, is 375 revolutions per minute, and the feed rate is equivalent to 1 inch of tool travel for every 75 revolutions per minute of the work. By means of a speed variator on the headstock, feed changes can be conveniently made. These shafts are being finished by the thousands in the time specified.

The part illustrated in Figs. 3 and 4 is an automobile transmission or propeller shaft. In this particular case, it is the nature of the work which makes the turning operation one of interest, as cylindrical, tapering, and spherical surfaces are finished almost as easily as a piece of uniform diameter. Fig. 3 shows, diagrammatically, the arrangement of the tools and work for the first operation. After the shaft is "spotted" at *A* for the steadyrest, the straight part *C* and the collar *B* are sized with tools *S* and *R*, which are mounted on the left-hand carriage. A concave groove is then cut in collar *B* by tool *R*,

The method of driving this shaft is worthy of note as it is both simple and ingenious. A dog having two driving arms is used, each of which bears against a pin *N* that passes through a hole in the spindle. As the ends of this pin, against which the dog bears, are beveled in opposite directions, the pin turns in its hole when the dog makes contact with it and automatically adjusts itself against the two driving members of the dog. The advantage of driving by a two-tailed dog, as most mechanics know, is in equalizing the tendency to spring slender parts while they are being turned.

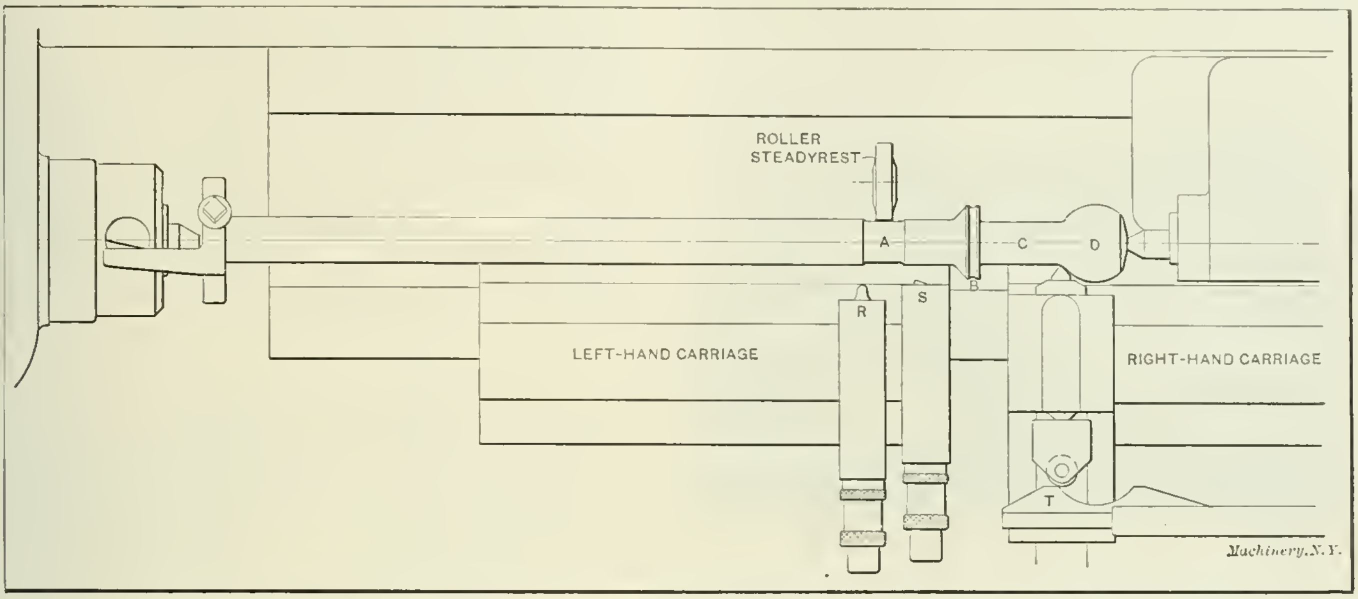


Fig. 3. Diagrammatical View showing Tools and Spherical Turning Attachment used in Machining Automobile Propeller Shafts

after which spherical end *D* is formed by a special attachment mounted on the right-hand carriage. This attachment is the same in principle as the regular taper turning attachment, the substitution of a circular templet *T* for the straight kind used on taper work, being the only practical difference. It

It should be added that the equalizing driver referred to is the one regularly employed on the Lo-swing lathe.

An excellent example of fast but accurate work is shown set up in the machine in Fig. 5. This part is an automobile steering knuckle, the shape of which is more clearly shown

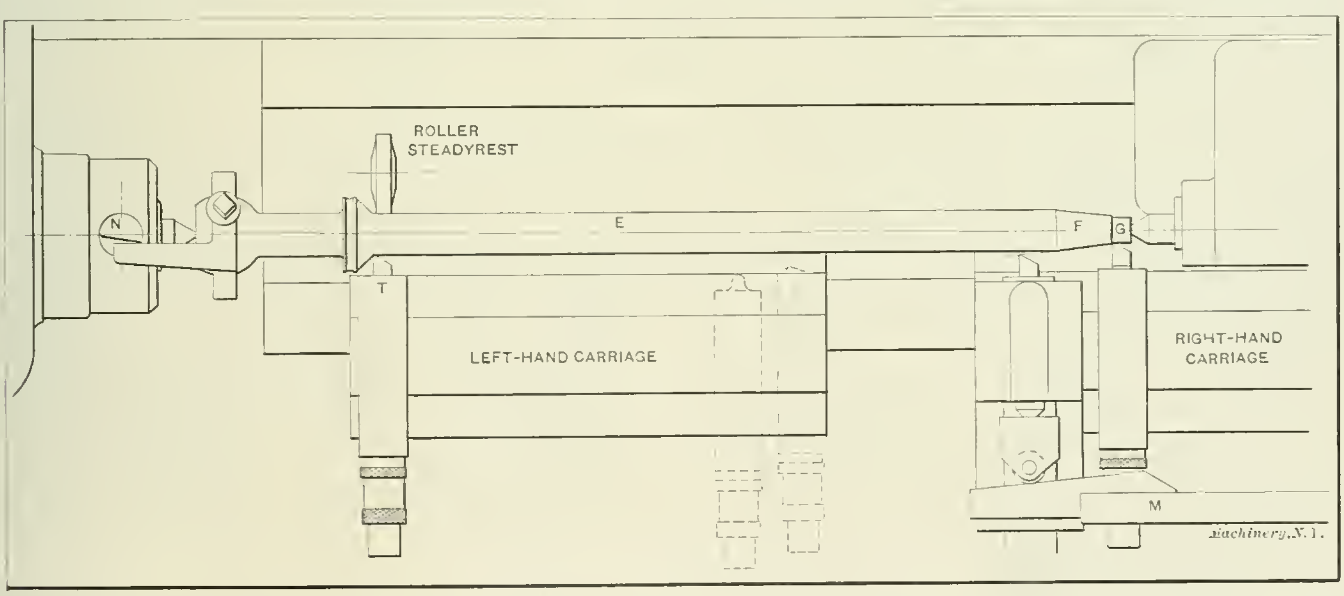


Fig. 4. Tool Arrangement for Second Operation on Propeller Shafts

was necessary to have this ball-shaped end true within 0.001 inch, which accuracy has been easily obtained.

After the surfaces mentioned have been finished on the required number of pieces, the work is reversed and the tools changed as shown in Fig. 4. The first step in the second operation is to turn the body *E* of the shaft with the tool *T* on the left-hand carriage. The taper *F* and the straight part *G* are then finished, which completes the turning. It will be noted that in setting up the machine for this second operation, it is arranged for taper turning by simply replacing the circular templet with the straight one shown. When this taper attachment is not in use, the swiveling arm *M*, which is attached to a bracket, is swung out of the way.

in Fig. 6, which also indicates the arrangement of the four tools used. This part, like those previously referred to, is finished in two operations. The tool setting is identical for each operation, however, except for diameter adjustments. As the illustration shows, three of the four tools employed are used for straight turning on different diameters, while the fourth finishes the taper. These pieces, which are rough drop forgings, are first reduced to the approximate size. When it becomes necessary to grind the tools, they are reset and those parts which have been roughed out are turned to the finished size. During both the roughing and finishing operations, the work revolves at a speed of 375 revolutions per minute. The feed for roughing is equivalent to 50 revolu-

tions per inch of tool travel, while for finishing it is reduced, the work making 100 revolutions per inch of travel. By finishing in this way, it has been possible to maintain the size of the straight portion at the large end of the taper within 0.0005 inch. The average time for the first operation, which includes starting, stopping, turning and replacing the piece, is one minute, while for the second operation with the finer feed, an average time of two minutes is required.

The work is driven by sleeve *S*, which fits over the spindle and is held in position by the regular driver, as shown. This sleeve is notched to fit the knuckle, so that the latter can be

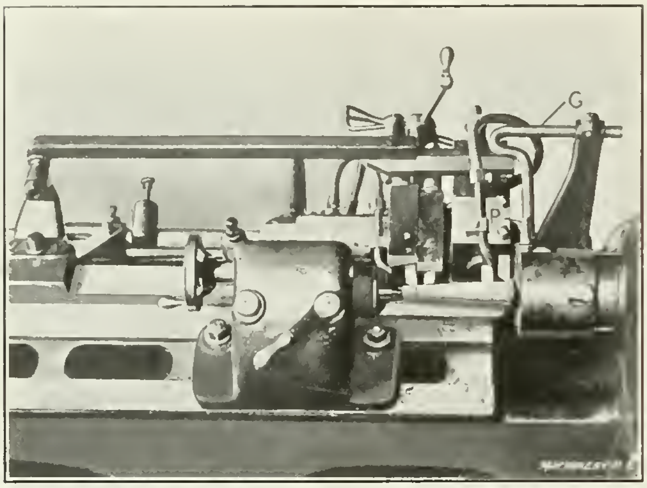


Fig. 5. Lo-swing Lathe set up for Turning a Steering Knuckle

easily and quickly replaced when finished. One of the interesting features of this job lies in the method of locating the shoulders on each knuckle at the same distance from the hole *H* which is drilled previously, and which receives the bolt on which the knuckle swivels when assembled in a car. As soon as the knuckle has been placed between the centers, a close-fitting plug *P*, Fig. 5, is inserted in this hole and the

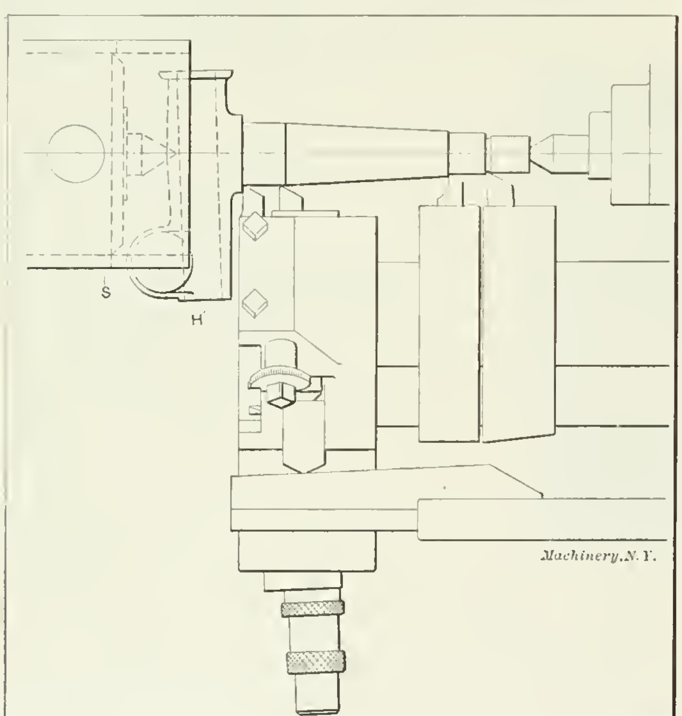


Fig. 6. Plan View showing Method of Driving Steering Knuckle, and Tooling

indicator arm with its attached gage or caliper *G*, is swung up to the position shown. The stop-rod on which the stops have been previously set for the correct distance between the shoulders, is next adjusted axially until the gage *G* just touches the plug *P*. The indicator is then swung out of the way, and the piece turned. If the next knuckle were centered, say deeper than the previous one, which would, of course, cause it to be located near the headstock, obviously all the shoulders would be located farther from the finished hole, providing the position of the stops remained the same as before. In such a case their position would, however, be changed by shifting the stop-rod until the gage *G* again touched the plug, thus locating all the stops with reference to the hole. As the adjustment of the stop-rod changes the position of the taper templet as well as the stops, it is evident that both the shoulders and the taper are finished the same distance from the hole in each case. The connection of the bracket (to which the templet arm is attached) with the stop-rod is clearly shown in Fig. 5; this bracket can be locked to the ways or adjusted to slide when the stop-rod is moved.

In Fig. 7 another turning operation is shown, the work in this case being a rear axle for a motor truck. The turning of this part is a good example of that class of work where the rapid removal of superfluous metal is the important feature. As the engraving shows, the stock prior to turning is $3\frac{1}{2}$ inches in diameter and it is reduced to a minimum diameter of 1 1/16 inch. This metal is turned off with one traverse of the carriage or by one passage of the five tools, and the weight of the chips removed from each end of the axle is approximately twelve pounds. The time required for the actual

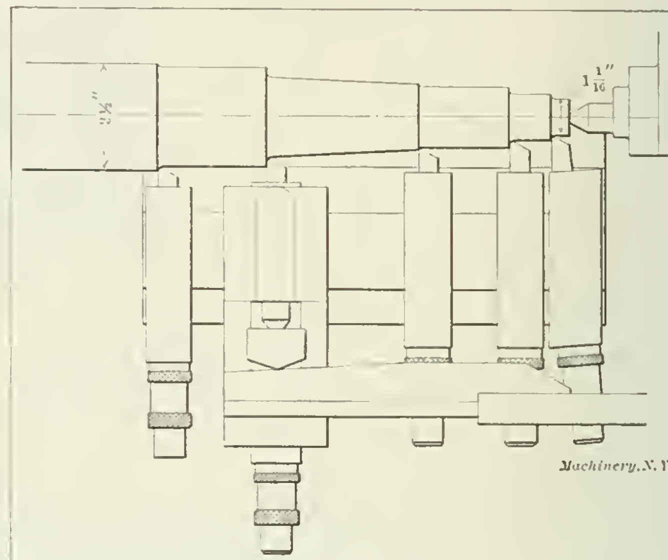


Fig. 7. Axle End which was reduced, as shown, in One Traverse of the Five Tools

turning is about 9 minutes, while the total time for the operation, which includes placing the heavy piece in the machine, turning, and removing the work to the floor, is 12 minutes. The work revolves while being turned at 110 revolutions per minute, and a feed equivalent to 1 inch of tool travel to 60 revolutions of the work is used. It will be noticed that the taper attachment is also employed on this part, the taper being turned by the second tool from the left. As the axle is equipped with roller bearings, it was found desirable to finish the bearing part by a separate operation, therefore, in the operation shown the axle is simply roughed down rather close to the finished dimensions, leaving enough material for a light finishing cut.

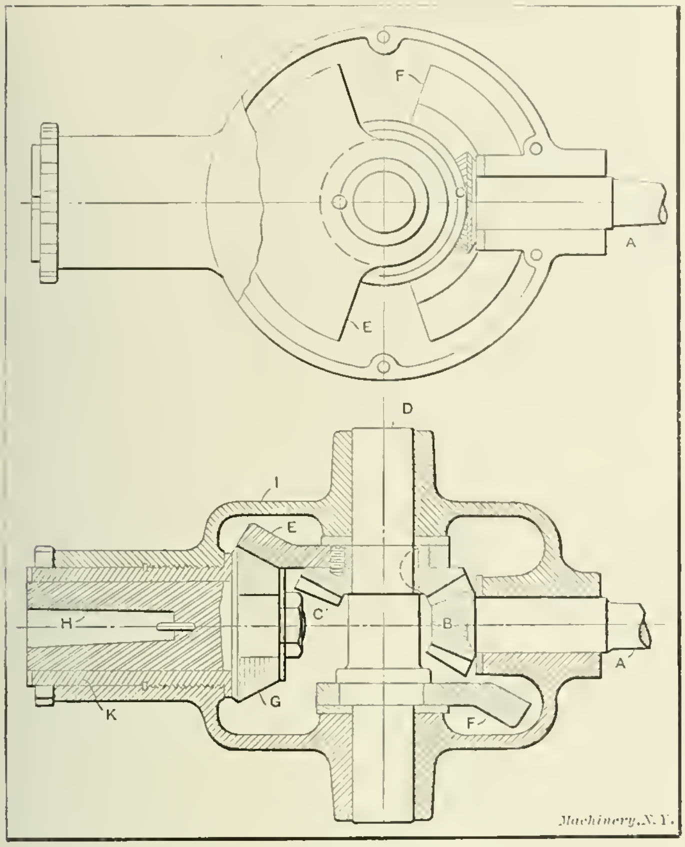
* * *

The aeroplane industry has developed in France with as much rapidity as the manufacture of automobiles in the beginning of that industry. A little over a year ago there were less than 100 aeroplanes in all Europe, principally in France. Statistics show that since the first cross-channel flight, Bleriot has built 250 machines, duplicates of the machine in which he crossed from Calais to Dover, and Farman has built at his works over 100 biplanes. The machines built by other makers bring the French production to over 800 which have sold for something over $2,500,000. The small Bleriot monoplane sold at first for $2000, but after its success in crossing the English channel, the price was raised and the latest type now costs from $3100 to $5100; the price of the Farman machine is $5600; Voison, $4600; Antoinette, $500; Wright, $5000; and Sommer, $5000.

A TOOL FOR GRINDING IN GAS-ENGINE VALVES

By ARTHUR C. PLETZ*

As the manufacturing of gasoline engines is becoming a great factor among American industries, many a superintendent, foreman and draftsman is putting in hard days of



Efficient Tool for Grinding in Gas-engine Valves

work racking his brains for new ideas in tools which will help toward increasing the output and keep up with the present demand. Among the many tools that have been designed and tried out I think the valve-grinding tool is quite important. Many different designs of these tools have been tried with more or less success. Some superintendents still cling to the hand method, as they think it is the most satisfactory. The writer has tried several methods, and the accompanying illustration shows a tool which gives satisfactory results.

The driving end of this tool is made with a No. 1 Morse taper, thus making it interchangeable with any light drill press. The reciprocating motion is obtained in the following manner: Driving shaft *A* has a bevel pinion *B* on one end. This pinion drives bevel gear *C* on shaft *D*, which carries two segments *E* and *F*. These segments are of the friction gear type, and engage alternately with rawhide or fiber reciprocating pinion *G*, which revolves about one and three-quarter turn in each direction. Spindle *H* runs in the bronze bushing *K*, and is arranged to adjust pinion *G* so that it will bear tightly enough against the driving segments to drive the valve. Pinion *G* has a No. 1 Morse taper, thus enabling it to take any style of tool to drive the valve. The case *I* is made from a thin aluminum shell, which reduces the weight considerably.

* Address: Swift Auto Co., Detroit, Mich.

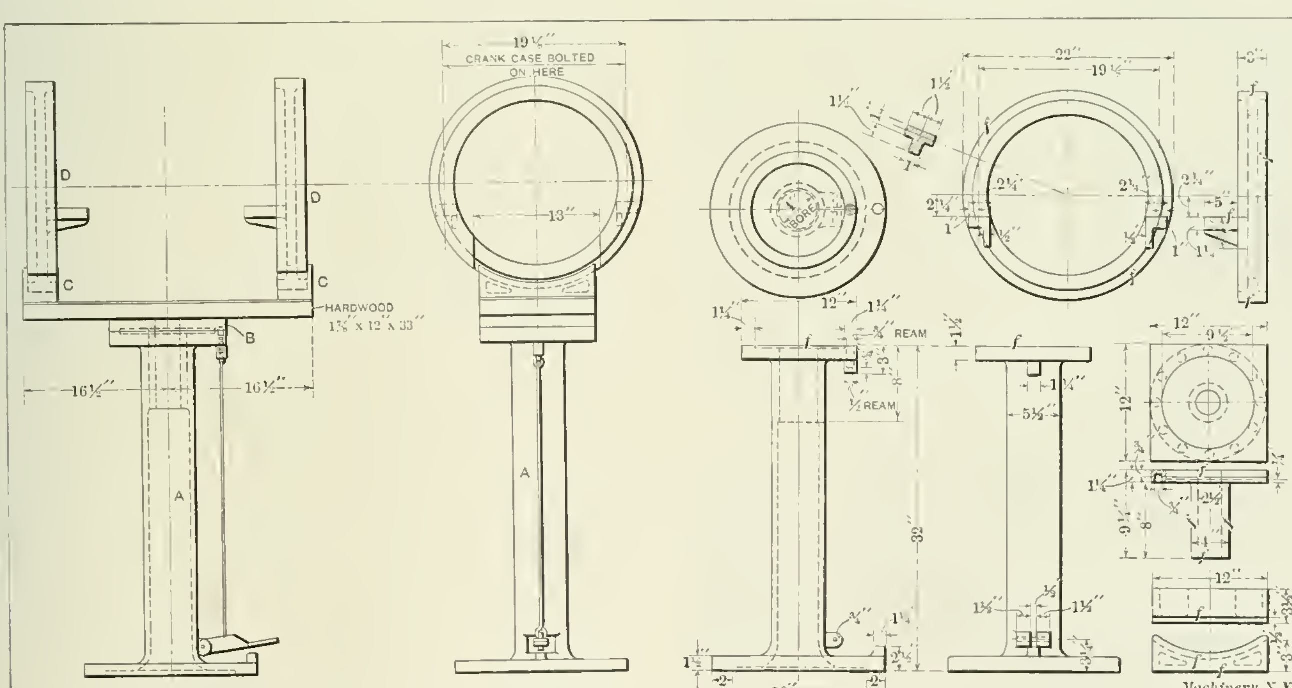
* * *

MOTOR ASSEMBLING STAND

By JIG AND TOOL DESIGNER

In a well-equipped shop, where several thousand automobile motors were being manufactured, a convenient assembling stand was necessary and the design shown in the accompanying illustration was made. There are several different styles of these stands on the market, and besides, almost every factory has a design of its own. The particular design illustrated is not entirely original, as some of the points in different types now being used in other factories are combined in this one; in fact, practically all the good points of other types are here combined, with a few new and original ideas, thus making this stand very convenient and satisfactory.

The engraving shows the stand assembled and in detail. It is composed of a column or base *A*, to the top of which is fitted a trunnion *B*, that may be swiveled about a vertical axis. Bolted to the top of this trunnion is a hard wood plank, at the ends of which are fastened shoes *C*, which fit the rings *D* that support the motor being assembled. These rings have the same radius as the shoes in which they rest, and they are provided with projecting brackets to which the motor crankcase feet are attached. By referring to the detail of the trunnion *B*, it will be seen that 12 holes are drilled in its under side. These are used for locking the plate by means of the foot lever and spring plunger shown in the assembled view. This indexing arrangement makes it possible to swing



Adjustable Stand for Holding Motors while Assembling

the motor around to the most convenient position for the workman. With a well-balanced motor, no matter what the weight, the finished supporting rings and the shoes in which they rest, furnish just enough friction to give a firm but even hold so that the motor, besides being sprung about a vertical axis, may also be turned over to the most convenient angle.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Ethan Viall,
Douglas T. Hamilton,
Associate Editors

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

OCTOBER, 1910

PAID CIRCULATION FOR SEPTEMBER, 1910, 26,209 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

INFLUENCE OF THE AUTOMOBILE

Forty or fifty years hence historians probably will refer to the marked influence that the automobile had on the life and trend of thought of the American people during the latter part of the nineteenth and first part of the twentieth centuries. Even we, living in the midst of the age of transition, are struck with wonder at the great change in traffic plainly observable on the streets of any large town. Ten years ago, even five years ago, the horse-drawn vehicle was the common individual means of conveyance in New York, Chicago, and other cities. To-day the auto taxicab preponderates, and the number of motor trucks in use is large and rapidly increasing.

But of even greater significance is the conversation of people operating, owning, or hoping to own automobiles. Their conversation abounds in references to cylinders, carburetors, magnetos, differentials, gaskets, lubricators, horsepower, and hundreds of other mechanical terms almost unknown to the mass but a few years ago. Not only do men talk thus, but women converse animatedly about things purely mechanical, displaying knowledge amazing to those accustomed to think that they have no capacity for such matters.

The effect of familiarity of a large class of intelligent people with the operation and details of a rather complex machine whose parts have to be adjusted with skill must be to make them more interested generally in machinery and motors, and to concentrate more minds on improvements of importance. It should also tend to stimulate manufacturing through awakening in individuals a taste for mechanics and comprehension of the basic principles, and thus give a still greater impetus to the mechanical progress of the age.

* * *

BAD OFFICE SYSTEM

It is a bad office system in a manufacturing business that does not provide means for keeping track of responsible officers whose duties often call them into the factory. The public doing business with the members of a concern has a right to expect that the time of salesmen and others shall not be wasted in vainly waiting for some one to turn up with whom they may hope to do business. When a person calls to see the president, superintendent or buyer he should be told at once if possible where the desired party is, if not in the office, and if an appointment can be made. In the event of making an appointment he should be told what the probable time of waiting will be.

In the management of some concerns it seems to be the custom to let the officials chase about the works and show up at the office when they please. No one ever seems to know where they are or when they will be accessible. The salesman may either take a chance on a long wait, or leave and call again and perhaps repeat the experience. The philosophy of factory office management would seem to the unprejudiced observer to be summed up in the paraphrase of the golden rule, "Hand out to others what you would like handed out to you." Remember when you are tempted to let some unwelcome visitor cool his heels for an hour or two in the ante-room, and then give him a curt dismissal, that you and your representatives are likely to receive similar treatment when suppliants at the doors of other concerns. Politeness and courtesy beget considerate treatment and are well worth while as part of a policy of "enlightened selfishness."

* * *

A PROBLEM IN SHOP ECONOMY

One of the most difficult problems with which the shop manager must grapple is that of determining when to replace old types of machinery with new. Judging from statements sometimes seen in the daily and semi-technical press, one would think that engineers in general consider it economical to throw out an old machine and install a new one if it can merely be shown that the new machine will perform a certain operation at less cost than the old one. This, however, is not the only consideration. If the old machine is still in good condition and can be used for several years without any additional capital outlay, then it might prove advantageous to retain it, even though the cost per piece were slightly higher than on the new machine.

If the same operation is performed throughout the greater part of the year, and if it is possible to determine the exact reduction in cost of output by the new machine in comparison with the old one, the problem would be one of simple arithmetic, as the only factors to be taken into consideration would be the number of pieces to be made per year and the additional interest charges on the capital invested in the new machine. In most cases, however, the problem is not so simple. The machine is not used for making the same parts throughout the year, but is changed from one class of work to another. For some work the new machine may not be more economical than the old one—for other work, the economy may be very marked. Exact comparisons are then impracticable, and keen judgment, rather than calculation, is required on the part of the shop manager. Should he decide to install the new machine, and sell the old one for junk, merely because some particular piece for which the new machine is especially well adapted can be made with marked economy, he may make a mistake and incur considerable loss.

On the other hand, it is likely that a greater number of people err on the side of keeping old, worn-out machinery when a new equipment would cut down their costs. Especially is this true of long-established firms whose reputation and well-cultivated markets make them feel the keenness of competition less severely. It is a well-known fact that the most modern machinery is often found in the smaller, comparatively inconspicuous shops. The retention of old machinery long after its term of usefulness has expired is probably a greater mistake than that of scrapping tools and devices prematurely. The question of when to install new machinery and scrap the old equipment is, therefore, one that calls for better judgment of the requirements of shop practice than almost any other the shop manager has to consider. In order to decide it successfully, a comparative study of the capacities of new and old machines extending over long periods of time is often necessary. In that way only is it possible to decide with reasonable accuracy whether it be more economical to retain old equipment or to install new.

CAPACITY OF HIGH-SPEED STEELS

During the last decade high-speed steel has been developed from a product popularly regarded as a metallurgical curiosity to a cutting material that has largely displaced carbon steel in most up-to-date and progressive machine shops. It is saying only what every mechanic knows to be a fact to state that high-speed steel has worked a tremendous change in speeds and feeds and in the design of machine tools; also that the quality of high-speed steel has been greatly improved.

In the early years of high-speed steel history, there were all grades ranging from very good to very bad. Certain brands came to the front because of uniformity and general superiority. The situation to-day is that practically all the recognized brands of high-speed steel are good, but this does not mean that they are all alike. Far from it. The reason one brand of steel is found superior to others in a certain shop is that it has certain peculiarities of temper, speed, capacity, etc., which the men in that shop have recognized and to which they have adapted themselves and their machines; consequently the steel stands up and does good work. Another brand of steel equally good, but requiring different heat treatment or different regulations of speeds and feeds would be found far inferior in that shop because it would be treated and used as was the first steel.

The situation seems to be that each steel, when treated and used in accordance with its peculiarities, will do about as much work as any other good brand. This we have on the word of a well-known engineer who has assisted in making thousands of tests of high-speed steels. This brings us to the matter of making high-speed steel tests, on the results of which many concerns have pinned their faith. There are shops which have made extensive tests of high-speed steel and wasted many dollars in the experiments. It is a huge job to properly test a high-speed steel, and few engineers have the experience and qualifications for such important work. Very small differences in speeds, feeds, heat treatment, etc., will make almost unbelievable differences in results. Tests conducted seemingly with the utmost impartiality may be thoroughly unreliable because certain factors have not been recognized or the effect of slight variations in materials, etc., has been ignored.

* * *

READINESS TO SHOULDER RESPONSIBILITY

What is the secret of the startling and rapid rise to responsibility and power of the world's successful men? Impartial investigation shows almost invariably that it is in their readiness and willingness to accept responsibility; but especially in their *readiness*. The career of almost any successful man shows that he had prepared himself long before for the crisis he might have to meet, for the problems he might have to solve; and had trained himself for work he would surely have to do if his opportunities came. This explains simply enough why it is that men whose names become widely known for successful achievement are found equal to the difficulties that arise—they are *prepared*.

While it is true that undue influence sometimes aids in the promotion of a man, only thoughtless men would ascribe advancement in general to "pull" or "luck." As a rule, the secret of success of most men engaged in mechanical work, is that they were ready with knowledge and skill at the moment when these were demanded. The man picked for promotion is not the man who says, "I will get ready," but the man who can say, "I *am* ready." No man can prepare himself for a position of real responsibility in a week, or a month, or perhaps even in a year.

The men who now occupy leading places in the mechanical world began to qualify themselves in their early years. Those that will occupy these places ten, fifteen or twenty years hence are now fitting themselves by study and observation, and by practical training for the responsible work to come in later years. It is the apprentice who by evening study qualifies himself for the first simple duties of the drafting-room that is picked for further training when a vacancy occurs. It is the machinist who has prepared himself, who is ready for more exacting duties, that is made foreman of the new department. It is the foreman who has fitted himself for larger and greater responsibilities who becomes superintendent of the new shop; and when the "old man" retires it is the trained and prepared superintendent that is made manager. In every field of endeavor, and on every rung of the ladder, it is the man who is ready—who is prepared—that is promoted.

* * *

THE DEVELOPMENT OF MACHINIST APPRENTICES*

By F. W. SEBELIN†

The question of developing machinist apprentices seems to be uppermost in the minds of many employers, and it is gratifying to note that the superintendents and foremen in many factories are also awakening to the crying need of more learners of the trade. But it needs a united action on the part of employers to adopt a system that shall be as nearly uniform as possible.

The rate of wages should be regulated according to the class of work that each shop is equipped for. For instance, a higher rate of pay should be given in a shop where the work is rough, because it requires less instruction to produce the same result financially in a shorter time than where the work is fine, necessitating a careful and painstaking training. If the same rate of remuneration were offered by all classes of shops it would have a tendency to attract the boys to the shops doing the finer grade of work, which would place the other shop doing the rougher work at a decided disadvantage.

The boys should be placed where they are best adapted. The average boy does not know his own capacity well enough and needs the guidance of men who have been "up against it."

The importance of the machinists' trade has been greatly underestimated, due no doubt to the degrading influence of a floating element which one sees in our shops, who are not even fair mechanics, but are classed as machinists. The word "machinist" is too freely used by men, every machine hand or man who can operate a power back-saw or cutting-off machine is classed as machinist, by those who do not know the definition of a machinist. Is it any wonder that the average American boy of fair education shudders at the thought of associating himself with such cheap help? He does not know any better.

Manufacturers should at all times be in close touch with the schools, especially the high schools and technical schools in order to encourage the boys who are interested in the mechanical trades. Invitations should be extended to the boys to visit the factories at stated times under the guidance of capable men, those especially who are interested in the boys, thereby assisting many of them to choose their future vocations and helping manufacturers in securing the right talent for their future superintendents and foremen. A boy's worth should not be considered only by the dollars and cents that he may earn for others, but also by the good that he may do for the world at large.

The automobile industry has opened up a new avenue for mechanics, and has proved a veritable gold mine for vast numbers of men. Good workmen are picked as foremen and superintendents, causing a shortage that has played havoc with the machine tool builders. The automobile industry is but in its infancy, and more mechanics will be needed as the business increases, consequently the opportunities for good men will be better than ever before—more hard luck for the other fellow who does not take time by the forelock and fortify himself before it is too late.

I dare say much of the fault lies with superintendents and foremen because more boys are not being developed in our shops. They do not want to bother with apprentices, because (as one frequently hears) the boy will not remain long enough to repay the boss something on the investment; he suddenly

* For previous articles on apprentices, apprenticeship, and apprentice conditions see: "Gould & Eberhardt's Apprenticeship System," July, 1910; "Apprenticeship Certificate," May, 1910; "United Shoe Machinery Co.'s Apprentice School," February, 1910; "Apprenticeship Conditions," January, 1910; "Need of a Good Apprenticeship System," January, 1910; "The Apprentice Problem," April, 1909; "Instruction of Apprentices in the Cincinnati Milling Machine Shops," December, 1908, and the previous articles there referred to.

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vanishes, someone having offered the partly developed boy a little more pay.

But a remedy can and must be applied to stop this traffic which is filling our shops with undesirable men. There should be a uniform apprentice system established in all shops where apprentices can be used. Each employer should respect the rights of his competitors and not hire an apprentice who severs his connection from his former employers unless he agrees to work out the unexpired term of his apprenticeship with the second employer. This would benefit not only the employer, but the boy himself, because it would be the means of making him independent and a better citizen. These reforms cannot be brought about unless the shop's environment and surroundings are of such a nature as will attract a better class of boys than is usually found in them.

There should be perfect harmony between foremen and apprentices, and the boys should not be treated as if they were in the way. On the contrary, they should be made to understand that they are producers the day they enter the shop, and they will soon feel that they are of some use after all. Much depends upon the personality of the foremen to encourage the boys.

There are many shops where there are no apprentices, their managers arguing that their production would suffer if apprentices were employed, but that is a mistake. I can cite instances which have come under my own charge where I was, until recently, general foreman of the Cleveland Twist Drill Co. We had many boys working as apprentices, and some who were in their third year were on a par with the best journeymen we had in the shop, and their knowledge was not limited to any particular branch. These same boys were used as instructors to those who followed them, because our ideas and methods were so thoroughly inculcated in them that we could safely use them as instructors to hand down their experience to others. Every man in the shop was expected to assist the boys wherever it was possible. If at any time a boy sought information from a journeyman and received a discourteous answer that man was reprimanded.

A system of classifying apprentices which has many good features has been adopted by several Eastern manufacturers. A boy who has a natural talent for mechanical pursuits, but has not the means to serve a four-years' apprenticeship, can fit himself for any one of the different branches of the machinist's trade. For instance, to become a proficient lathe hand he might serve two years; a milling machine hand, two years; planer hand, one and one-half year; bench hand, two years, etc. This system would produce experts in the different branches, but their sphere of usefulness would be limited, and their opportunities would not be as good as those who have served the full apprenticeship.

This system would place many expert classified men on the market who could command higher wages than now prevail, and it would go a great way toward solving the labor problem which now confronts manufacturers all over the country.

A bill was introduced before the legislature of Ohio making it a misdemeanor and a felony, punishable by a fine or imprisonment, for any organization to limit the apprentices in the different trades. This bill was introduced by Mr. Smith of Marion, Ohio, and was bitterly opposed by labor unions, their reason not being apparent to the writer, who was recently called upon to say a few words in defense of it. There should be no barrier in the way of any American boy who desires to learn a trade or profession, but on the contrary, the doors of our factories and business houses should be thrown wide open to give opportunities to develop the brains, muscle and skill of our young men.

* * *

The automobile industry in Germany has increased considerably in the last few years. The import of automobiles to Germany has constantly decreased—27 per cent in 1908 as compared with 1907, and 11 per cent in 1909 as compared with 1908. Meanwhile the exports of automobiles from Germany have shown an increase in the last year of 20 per cent. Thus, the German automobile industry has not only proved itself able to better meet the demands of the home market, but has proved itself able to obtain a considerable portion of the market in other countries.

ELECTRIC BUTT WELDING

By A. E. BUCHENBERG

In contemplating the practicability of using electric welding machines, the principal questions that should be given serious consideration and be definitely determined by the manufacturer, are as follows: 1. The efficiency and reliability of electric welds. 2. The output of machines in welds per hour. 3. Adaptability of electric welding machines to his work and shop requirements. 4. The cost of operation. 5. The initial cost of machines and such auxiliary apparatus as may be required.

The following article will be devoted to a general discussion of electric butt welding as opposed to brazing and the ordinary forge method of lap welding, with particular reference to shop requirements.

Efficiency and Reliability of Welds

The manufacturer is not so much concerned with the fact that perfect welds can be made electrically, but more vitally interested in the efficiency, uniformity, and cost of the welds, that he may reasonably expect on his product and under his shop conditions. In some classes of work there can be no allowance made for even a very small per cent of breakage from imperfect work, and every weld must be a perfect molecular union over the entire area of the welding surfaces. As an example, we may take the case of the steering mechanism of an automobile, where it is found economical in both machine work and stock to electric weld the threaded steering head to the tubular stem. Under service conditions, this weld may at any instant be called upon to withstand severe longitudinal and torsional stresses which can very nearly reach the ultimate safe strength of the tube's cross-section. The safety of the occupants of the car may depend upon the efficiency of this weld, and before adopting the electric process, the manufacturer must be convinced that the welds can be made under commercial conditions so that each and every one can be absolutely depended upon.

There are many instances where the electric weld, if reliable and practical, will reduce production costs very materially in eliminating expensive machine work and the present unavoidable waste of stock. This is especially true where a great reduction in diameter is called for over a considerable length of a bar or rod. It then becomes convenient to weld a rod of one diameter to another of greater diameter which results in a saving both of stock and the expensive machine work which would otherwise be necessary to remove it. Where a clevis or an eye is required on one or both ends of a rod, drop forgings might be welded to a length of cold-rolled steel. A machine bolt in place of being turned from hexagon stock might be made of two pieces, the head—an automatic screw machine product—welded to round stock of the proper bolt diameter. Where large or complicated drop forgings are required and the initial cost and upkeep of the dies would be high, the part might be made in two or more small drop forgings welded together, and allow the use of simple and comparatively inexpensive dies. From the few examples given, it will be plain that the question of reliability of electric welds may determine to a very great extent the shop production costs, assuming of course that the expense of making the welds is low.

The field of electric welding is being rapidly developed and the process is now applicable to a wide variety of work. In many cases the electric method can be conveniently and economically used where the ordinary forge weld or brazing would be out of the question, either from mechanical considerations or cost. An example is the electric butt welding of tubes, or the welding of tubes to drop forgings, where brazing and forge welds are expensive on account of the preparation of the stock and the time required to do the work.

The quality of any weld, whether made by the blow torch method, the ordinary forge method—usually called a "fire weld"—or electrically, depends entirely upon the efficiency of the molecular union between the welding surfaces. With either the electric or the fire weld, the molecular attraction, or cohesion, is brought about by first heating the stock to a plastic semi-fluid condition and then forcing an intimate sur-

* Address: Toledo Electric Welder Co., Cincinnati, Ohio.

face contact between the two pieces by a succession of blows, as in the ordinary fire weld, or by the application of a heavy mechanical pressure as in the electric process. The "scarf" or lap of the fire weld is a convenience for the application of the blows of the hammer while making the weld and in many cases is a requirement, as when welding surfaces equivalent in area to at least the cross-section of the stock. With the electric process, no scarf or other preparation of the stock is required, the two pieces to be welded bing simply clamped in suitable jaws or dies with their ends abutting, the welding pressure then being applied axially.

The Electric Welding Machine

The electric butt-welding machine which in some of its highly-developed special and automatic forms may be a very complicated piece of mechanical and electrical apparatus, is a structure for first heating stock by means of an electric current and then exerting mechanical pressure to force the welding surfaces together.

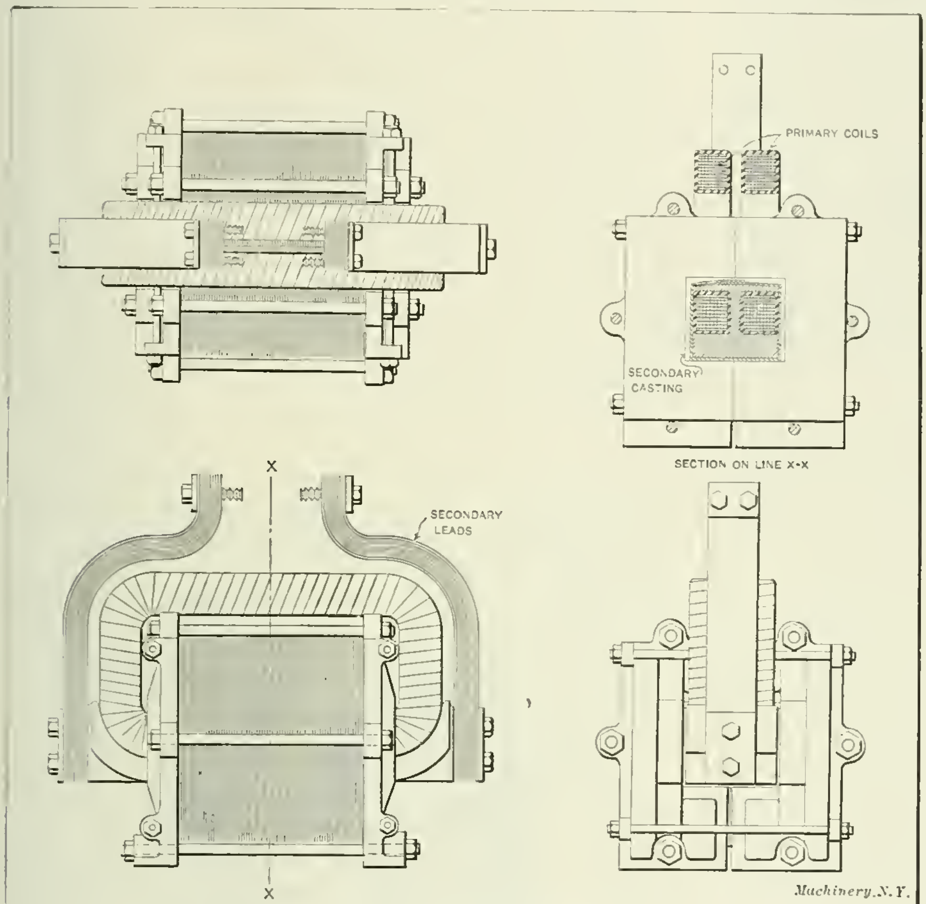


Fig. 1. Elevations and Section of a Typical Transformer for Welding Machines

The component parts of an electric butt-welding machine in its simplest form are as follows:

1. A special type of transformer whose primary coils are connected to an alternating current-supply circuit and whose secondary winding delivers an output of very low voltage but heavy current. The transformer may be operated from any alternating current single-phase circuit of standard voltage and commercial frequency. The usual lighting and power voltages are 110, 220, and 440 volts, while the frequency may be either 25 or 60 cycles. If necessary, the welding machine may be operated from a 133 cycle circuit. Where polyphase alternating current is used, the welding transformer can be connected across one phase of a two- or three-phase circuit. Fig. 1 shows in detail the construction of a typical welding transformer with the connecting leads to the clamping dies attached to the secondary winding. On account of the low voltage required, the secondary winding in this instance takes the form of a solid copper casting extending through the laminated iron core. It will be noted that the secondary leads are each made up of a large number of thin copper strips to afford the necessary flexibility for motion of the clamping dies.

2. Two copper clamping dies and supports in which the stock to be welded is securely held to afford good electrical contact and to prevent shifting and displacement of the work under end pressure. The dies and supports are capable of a limited movement toward and away from each other in suitable guides. In the machine as ordinarily constructed, the left-hand die is stationary but capable of adjustment, while the right-hand support is movable and connected to the compression mechanism. Each die and support is connected to one of the flexible secondary leads of the welding transformer.

3. To afford the heavy mechanical pressure necessary to be exerted at the proper time to force the heated abutting ends of the stock together to form the weld, a number of different arrangements are made use of. The compression mechanism used on a particular machine will depend to a great extent upon the size of the stock to be welded. For the smaller work, a spring or simple toggle lever is used, and for heavier stock, gears operated by a pilot wheel or a hand-operated double-acting hydraulic jack.

Machines for heavy work are seldom made automatic in their operation, since the question of large output per hour is not so important, and it is not always possible to supplant human judgment and skill with mechanical automatic devices.

Fig. 2 shows a simple form of machine for welding straight rods or tubes. The clamping dies A are fitted to the work they are to hold, and are mounted on the sliding supports B and B_1. The supports are mounted in guides shown at C. The clamping dies are operated to grip the stock D by means of the clamping levers E. The left-hand head B is stationary while welds are being made, but it can be adjusted for position by means of the shoulder-screw F. The compression toggle lever G is connected to the right-hand head B_1 by links as shown at H. The welding transformer J can be seen through the opening in the side plate of the machine. The foot switch for closing and opening the current through the primary coils of the transformer is shown at K.

Operation of an Electric Welding Machine

The several steps in the operation of the machine when making a butt weld are as follows: Two pieces of stock are clamped in the dies with the surfaces to be welded opposed and abutting, the dies being separated from each other a short distance to allow a converging motion for compressing the stock at the proper time. A switch connecting the primary coils of the welding transformer to the supply circuit, and which may be hand- or foot-operated, as convenience may dictate, is closed. The induced secondary current of the transformer now flows through the heavy flexible connecting leads, through the clamping supports and dies into the stock to be welded, and across the abutting surfaces. The junction of the welding stock is the point of highest electrical resistance in the entire transformer secondary circuit, which is made up of the secondary winding, connecting leads, clamping supports and dies, and the small projection of stock over each clamping die. The design of the transformer, secondary leads, clamping supports, dies, etc., makes their combined resistance very small as compared to the contact resistance at the point of weld. In conformity to the laws governing the heating of conductors carrying electric currents, practically all the heating will be confined to this point. In other words, nearly all the electrical energy taken from the supply circuit will be concentrated in this one location in the form of heat.

The secondary voltage of the transformer is so designed that the volume of secondary current forced through the junction of the two pieces of stock will produce a welding temperature at this point in a certain predetermined time. The actual secondary voltage required will depend upon the cross-section of the material to be welded, and whether the stock is iron, steel, brass, copper, or aluminum. The voltage varies between one and six volts.

A voltage regulator of the inductive or "choking" type is usually supplied with each welding machine. This regulator is an auxiliary piece of apparatus connected in circuit with the transformer primary coils, and by means of which the secondary voltage can be readily adjusted through a wide range to afford the best operating conditions on varying kinds and sizes of stock.

At the instant a welding temperature has been reached, the switch is opened and the stock quickly compressed under heavy pressure to form the weld. A small amount of semi-fluid material is displaced under the pressure and thrown out all around the stock at the point of weld in the form of a fin or burr. When necessary, this surplus metal can be removed by grinding or chipping, or it can be reduced under a power press to the stock dimensions.

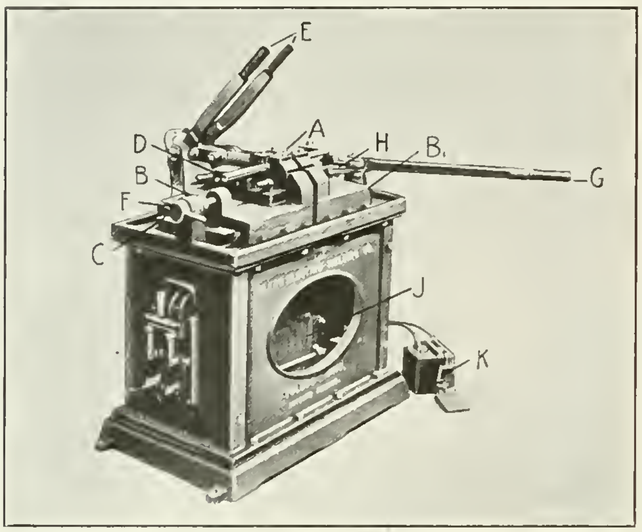


Fig 2. Simple Form of Machine for Welding Straight Rods or Tubes

Conditions Necessary for Perfect Weld

The primary conditions necessary to make a perfect weld between similar or dissimilar weldable metals are as follows:

1. The welding surfaces must be clean.
2. Each of the two pieces to be united must be at its particular welding temperature. The entire surfaces to be welded must be at this temperature, or in other words, the heat distribution must be uniform.
3. Repeated blows or a heavy continuous pressure must be applied while the welding surfaces are each at the proper heat, in order to form an intimate union between the two pieces of stock.

Below are taken up in detail some of the more important conditions as they exist in the operation of an electric welding machine and in the fire method of lap welding:

Conditions of Welding Surfaces

The primary requisite, that the welding surfaces of the stock must be clean, is fully met in the electric process. Furthermore, the abutting welding surfaces are practically excluded from the air while being heated, and with the short time required to bring up the temperature, little or no oxidization can take place; for this reason, no flux of any description is required even on brass, copper, and aluminum. With the fire process, the welding surfaces are exposed to the action of impurities, particularly sulphur in the coal, or the products of combustion in an oil or gas flame. Under these conditions and the length of time required to heat the stock, the use of a flux as a protective covering against oxidization over the welding surfaces, becomes an absolute necessity.

Heating

In the case of the electric weld, the heating begins in the interior of the stock and travels out toward the surfaces so that every particle of metal at the point of weld is at a uniform temperature. This condition is automatically attained since the flow of current will always be greatest through the path of least resistance. If, on account of varying surface contact resistance, one part of the stock should heat up more rapidly than another, the increased resistance due to the higher temperature would automatically shunt a greater portion of the total current through the cooler part of the stock which is of lower resistance. This action, in combination with heat conduction, would result in an even temperature throughout the stock at the point of weld.

The heating action is concentrated at the junction of the two pieces to be welded, as the time of current flow is so short that the heat travels back but a short distance each side of the weld by conduction. There is no scaling or pitting due to surface oxidization, and the heat discoloration of the material in the case of round stock is seldom visible on each side of the weld for a distance greater than the diameter of the stock. All the heat is concentrated where needed, and there is no waste of energy or fuel in the useless heating of a considerable length of stock on each side of the weld.

The work is always in plain view of the operator who is able to judge to a nicety the instant at which the proper welding temperature for any particular grade of stock is reached. This is an important factor in obtaining perfect welds between materials of widely varying chemical and physical properties, where the proper welding temperature for each material may be at wide variance. Specific instances are the welding of cold-rolled steel rods to drop forgings or the welding of steel stems to brass bolt heads.

With the fire weld the heat is, of course, applied to the surface of the stock and the interior is heated by conduction only. With an intense fire and under conditions of rapid shop production, the outer surface, and especially the thinner edges of irregular sections, may easily be at a higher temperature than the heavier section. This condition may, and unfortunately often does, result in imperfect welds. It is particularly noticeable on lap welds where the stock has been scarfed previous to heating.

With a fire weld using oil, gas, or coal as a fuel, a considerable length of the stock is brought to a high temperature. There is always more or less scaling and pitting of the stock owing to the length of time required for heating, during which time the surface of the stock is exposed to the oxidizing action of the air. It is a practical impossibility to forge-weld brass and other alloys of copper as the component metals of low fusing point will volatilize before the copper has reached a welding temperature. The stock is buried under a cover of coal or partly hidden in the flames of a gas or oil fire so that it is difficult to judge the temperature without uncovering the stock or removing it from the fire. The result is that the


Fig. 3. Hand-operated Machine with Output of 250 Welds on Straight Stock with Welding Area Equivalent to 3 4-inch Round Cross-section

stock is, in many cases, underheated or overheated, the consequence in either case being an imperfect weld.

When the output of welds per day is large, a very considerable saving of stock is effected by using electric welding machines, since the amount of stock wasted in the upset or fin is much less than the stock required for the overlap and scarf for a fire weld.

There is no danger from an electric shock to the operator of the machine since the primary coils of the transformer are heavily insulated, and the possible voltage to which the operator is subjected is no more than that of the ordinary door bell battery, and so slight that it cannot be felt under any conditions.

Output of Machines

The output, say in welds per hour, of any machine, will be determined by both the electrical and mechanical design. With automatic machines designed for a particular piece of work on light stock, the output is large. As an example, a machine for welding wire barrel hoops will take the wire from the reel, cut it into the proper lengths, and deliver the welded hoops at a rate of approximately 650 per hour. In the case of a hand-operated machine, the output will be determined by the mechanical design of the clamping dies and compression mechanism, the time required to heat the stock, and the facility with which the stock can be inserted in and removed from the machine as determined by its general shape and welding cross-section. Fig. 3 illustrates a hand-operated machine whose output on straight stock with a welding area equivalent to the cross-section of ¾-inch round stock, will be approximately 250 welds per hour. As a general rule, the larger the stock, the smaller will be the machine output, both on account of the longer time required for heating and the greater length of time required to handle the heavier stock.

Adaptability of Electric Welding Machines

Except in the case of a welder especially designed for one particular piece of work, quite a range in the shape and size of stock can be handled by one machine. A welder equipped with a voltage regulator can be adjusted to weld stock much smaller in sectional area than the rated capacity. As an example, a welder whose maximum capacity is one inch round stock, or an equivalent cross-sectional area in an irregular section, will, with a proper adjustment of the regulator, weld one-quarter inch round stock. However, as a commercial proposition, it is not good practice to weld very small stock on a large machine, as all the working parts are necessarily heavy and cumbersome on light work. For this reason the output would naturally be less than with a smaller, lighter, and more easily operated machine. Usually a change in the size of stock to be welded entails only a few moments time to change the clamping dies to conform to the new stock, and make the proper adjustment of the voltage regulator.

From the standpoint of maximum output, an important consideration in the selection of a welding machine is the facility with which the stock can be gotten into the clamping dies, and the proper arrangement of jigs for accurate alignment of the work. Welders are now designed in standard forms for different general classes of work, and a machine whose welding capacity is ample for a particular piece of work, might be entirely unsuitable for economical production on account of the mechanical design. For instance, a machine designed for welding straight bars or rods would be impractical for taking care of such work as vehicle dash frames; these require a special machine designed so that the dash frame may be conveniently swung into the several welding positions.

Cost of Operation

The operating cost will depend npon the size and material of the stock to be welded, upon the cost of the current, and the number of welds made. No current is used while the stock is being inserted into the clamping dies of the machine, or while being removed after the weld is completed. The amount of electrical energy required will depend upon the kind and shape of the material, and its cross-sectional area. The actual cost of operation is very low as is indicated in the following table, which gives the time and kilowatts per weld required for a number of sizes of iron or steel stock. The tabulated cost per 1000 welds is based upon a unit current cost of one cent per kilowatt hour. The actual cost in any particular instance can be determined by multiplying the cost per 1000 welds as given in the last column of the table by the price of current per kilowatt hour at that locality. The costs given do not include the time of the operator.

TABLE GIVING TIME AND COST OF WELDING VARIOUS SECTIONS IN IRON OR STEEL

Diameter, inches	Area in square inches	Kilowatts, Transformer	Seconds to make Weld	Cost per 1000 Welds, Current one cent per Kilowatt hour
¼	.05	5	5	$ .07
⅜	.11	7½	6	.13
½	.20	8	10	.22
⅝	.31	10	12	.33
¾	.44	12	15	.50
⅞	.60	15	20	.83
1	.79	18	30	1.50
1⅛	.99	20	30	1.66
1¼	1.23	26	40	2.89
1½	1.77	40	60	6.67
1¾	2.41	45	70	8.75
2	3.14	56	80	12.44

Initial Cost of Machines

The first cost of a welding machine will depend to a great extent upon the sectional area of the stock to be handled, and whether the material is iron, steel, brass, aluminum, or copper. The higher the electrical conductivity of the metal, the greater the amount of current required to raise it to a welding temperature in a given time, and the larger the welding transformer required. The cost of the machine will also be governed to some extent by the shape of the section of the stock quite independently of the actual sectional area. Heavier and more expensive clamping dies will be required to weld stock ¼ × 6 inches than would be required for the same area of metal in the form of round stock. In the case just given, special mechanism must be used in connection with the clamping jaws in order to obtain an equal distribution of current along the abutting edges of the stock. Where a great output in the number of welds per hour is demanded, automatic or semi-automatic features become necessary and the cost of the machine is materially increased. Machines built for special work or to meet extraordinary conditions are, of course, much more expensive than standard stock machines. Up to sectional areas equivalent to ¾-inch round stock, machines are usually operated by means of a simple hand toggle lever. From ¾-inch to 1-inch round, a handwheel operating through gears may be used. For larger stock it becomes necessary to resort to a special double-acting hydraulic jack.

From the foregoing it will be seen that the first cost will be governed by size and kind of stock, shape of the parts to be welded, and the capacity of the machine in welds per hour.

While a welding machine, especially the smaller sizes, can be connected directly to the circuit supplying light or power to the shop, it is usually better, on account of the line disturbances set up by the intermittent inductive load, to install a separate transformer to supply the welder only. This transformer is usually furnished by the local power and lighting company. Where alternating current is not available, a small alternator driven from the line shafting can be installed to operate the welder.

* * *

Roller chain used for transmitting power has been known to stand up at a speed of 2000 feet per minute, and to transmit 25 horsepower at 1250 feet per minute. Speeds of 1000 feet per minute and under, however, give better satisfaction. Block chain is best adapted to slower speeds, about 700 feet per minute and under. Other conditions being the same, it is preferable to keep the speed high and the chain pull low.

* * *

According to a report by Consul James M. Shepard, practically all Canadian manufacturers of the lighter grades of wood-working machinery and tools have merged into one company, known as the Canadian Machinery Corporation, with headquarters at Galt, Ontario. The complete authorized capitalization of the company is $4,000,000.

MAKING ROLLER BEARINGS

By ETHAN VIALL*

The Elgin Tool Works, Elgin, Illinois, makes all the roller bearings used by a well-known motor-cycle firm, and as the rollers must be extremely accurate, their production on a profitable scale is interesting. Superintendent Hasselquist is, by his practical methods, making money for his firm on a contract that could easily be a loser. In order that the reader may have a clear idea from the beginning as to the kind of bearings referred to, a side and end view as well as a set in a cage are given in Fig. 1.

The rollers are made from long round bars of carbon steel, and the first shop operation consists in running these bars through an automatic machine, as shown in Fig. 2, which drills a hole through the center and cuts them to length, the operator in charge inspecting the pieces and keeping the sizes within certain limits. Next the rough rollers go to a punch press where the drilled holes are "countersunk" by being squeezed between centers as shown in Fig. 3. In the next operation the spherical center in the ram of the press, is replaced by a three-cornered center, A, shown in Fig. 4, which is used to mark one of the countersunk ends with three nicks or notches for the purpose of driving, in some of the following operations. The rollers are now placed ten at a time in a grinding cage or jig A, shown in Fig. 5, and the ends ground by holding them against an emery wheel as shown in Fig. 6. This grinding removes the


Fig. 1. View showing Roller Bearings and Cage

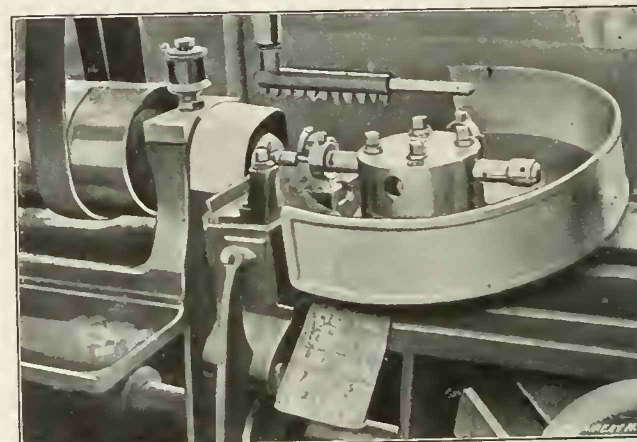


Fig. 2. Automatic Machine in which Bearings are drilled and cut off

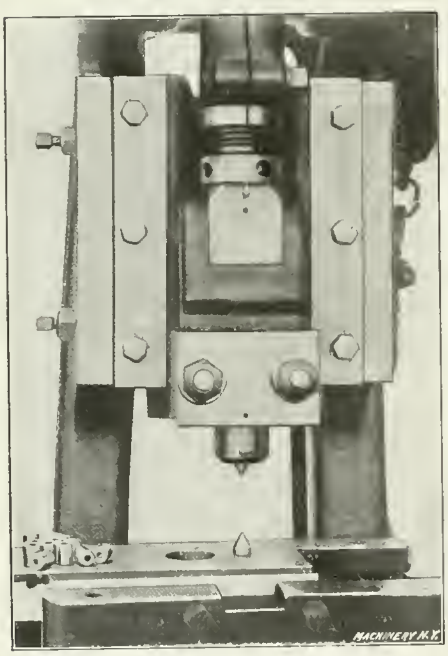


Fig. 3. Punch Press arranged for "Countersinking" the Bearings

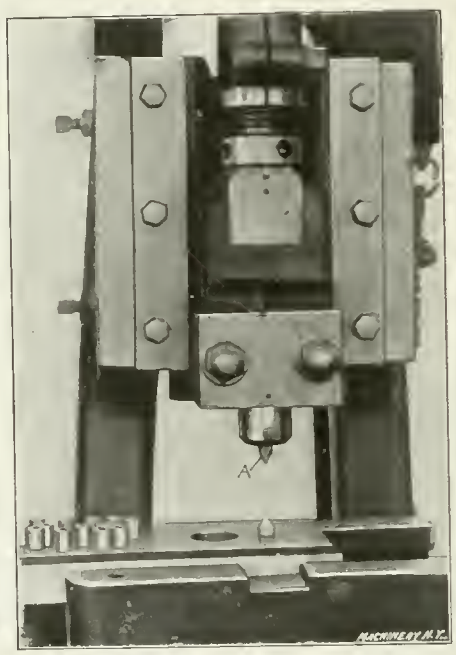


Fig. 4. Making a Three-cornered Center used for Driving, in the Grinding Operations

Fig. 5. Jig in which Bearings are held while Burrs are being removed by Grinding


Fig. 6. Grinding off the Burrs which have been thrown up in the Punch-press Operations

Fig. 7. Inspecting the Bearings for Length

* Associate Editor of MACHINERY.

burrs raised by the punch-press operations and leaves a smooth finish on the ends. A rigid inspection for length comes next as shown in Fig. 7. Snap gages are used for this operation, the limits of which are 0.495 and 0.4975 inch, after which the bearings are heated in the furnace *A*, Fig. 8. From this they are quenched by being raked out of the front, where they drop down a chute into a barrel of water. They are then drawn to 490 degrees F. in the oil bath *B*. The pieces are now dipped in potash to remove the oil, and the outside is next rough-ground on the automatic grinder shown in Fig. 9. This grinder has been made especially for the work it performs. The roller to be ground is placed between the centers *A* and *B*. *A* is a dead center, while *B* is a live one and is ground three-cornered so as to fit into the three nicks previously made in the roller. The roller is rotated as the arm *C* feeds back and forth across the cutting surface of the large cup-wheel. The live center is driven by the belt *D* through a pair of bevel gears in the box *E*, while the arm is given a reciprocating motion by means of cam *F*. A very fine feeding adjustment is obtained through the use of the graduated wheel *G*.

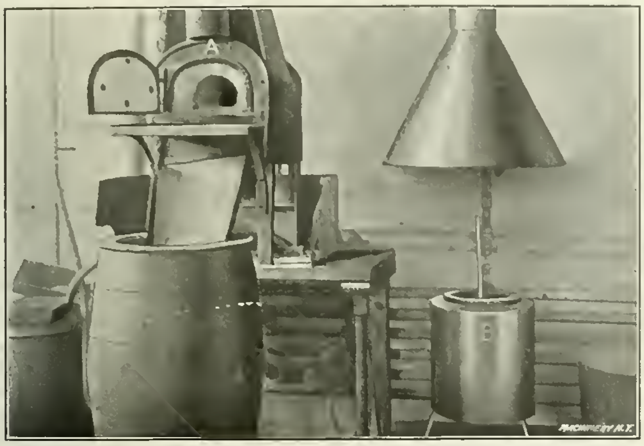


Fig. 8. Furnace and Oil Bath in which Bearings are hardened and drawn

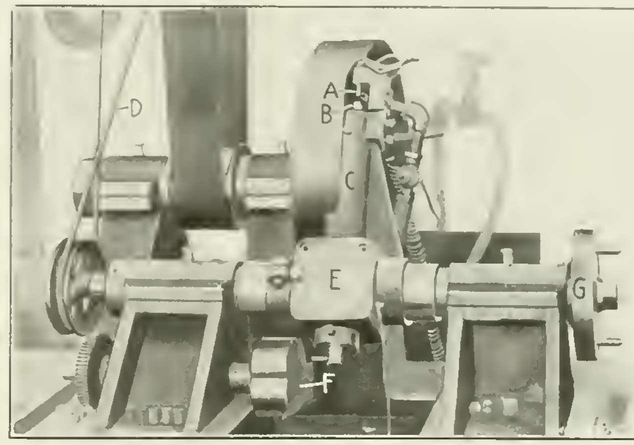


Fig. 9. Automatic Grinder in which Bearings are rough-ground

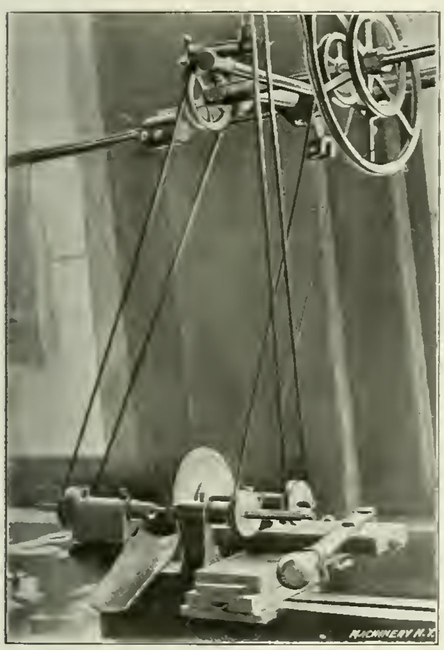


Fig. 10. Grinder in which Bearings are finish-ground

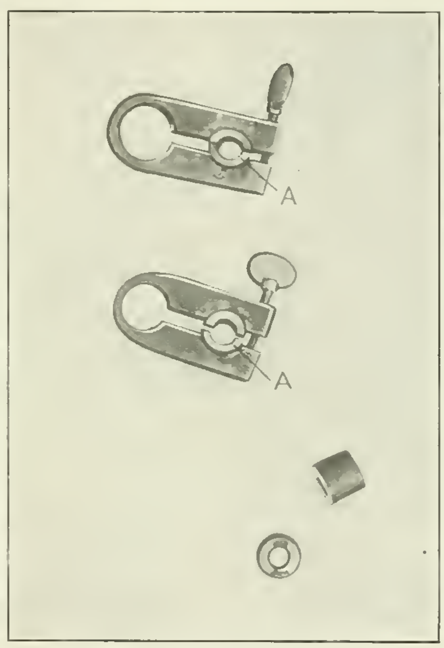


Fig. 11. Laps and Holders used in Finishing Bearings to Size

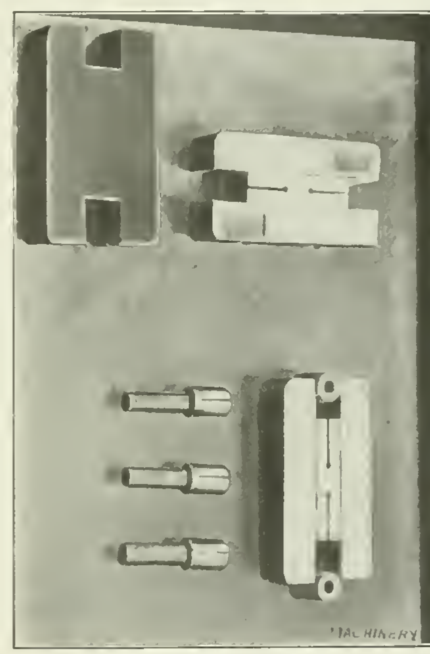


Fig. 12. Snap Gages and Master Plugs for Testing them

Fig 13. Lapping the Bearings to the Finish Size

From this automatic machine the rollers are taken to a grinder shown in Fig. 10 where they are finish ground to within 0.0003 inch of the final size; after which they are placed in the machines shown in Fig. 13, and lapped to size, using the laps shown in Fig. 11. The frames of these laps are made of steel into which are soldered copper bushings *A*, *A*, which are made of copper rod drilled out and cut off in a screw machine, the bushings being first soldered into the frame and then split with a hack saw.

After lapping, the rollers are given a final inspection for length, size and parallelism, by using the gages shown in Fig. 12, the limit on the outside diameter being 0.0003 inch. The plugs shown in this engraving are master plugs for the testing of the snap gages.

Thanks are due to both Mr. Hasselquist and Mr. Graham of the Elgin Tool Works, for the photographs and description of these shop operations.

* * *

Fred Bangerter is the inventor of a machine gun which fires 16,000 bullets a minute without the explosion of powder. A demonstration of the gun was made recently in the factory of the Auto Machine Gun Co., 79 Broad St., Stapleton, Staten Island, which showed the possibility of the invention. It is claimed that the cost of firing is only about one-thousandth part of that of firing machine guns loaded with cartridges. The principle of the new gun has not been made public.

OUT-OF-DATE DIE-MAKING METHODS

By JETHART

In the June issue of MACHINERY F. E. Shailor has an article entitled "Out-of-Date Die-Making Methods," which is open to some comment.

In the first place, his very first paragraph is too sweeping a condemnation of existing practice, as there are many cases in which punches made in the way he condemns so strongly are by far the best. I do not deny that for some classes of work, and especially for large punches, the method he advocates is in some ways all right, but if followed generally, it would result in a large waste of material for punches, because, in order to get the necessary size of shank and flange, the stock out of which the punch should be made would be much larger than necessary. For his example Mr. Shailor takes altogether extreme cases, which, perhaps, show his methods of die-making to be good in some points, but lacking in the general run of small and medium sized dies. I do not think that his methods are any improvement, and in fact, in some points, I cannot see how he makes an accurate punch and die at all.

Again, he makes no mention of whether the stripper is a tight or a loose fit on the punch, which is an important factor in die making, or what thickness of stock his die is to blank and pierce, which is another important factor. If he is going to work thick stock, the construction of the punch shown in Fig. 4 of his article is justified, although the method of holding it in the punch plate is not. Two screws will not stand much when stripping thick stock from a punch of such a shape, which gives a large area of stripping surface; and also, the one dowel in the shank is not of much value if the punch takes a "half" or "quarter cut" in thick stock. Two extra dowels as far apart as possible are desirable, also more screws and the shank riveted over.

The next objection he has is the difficulty of fitting the punch tightly in the punch plate. He makes a very long and tiresome job of it, filing absolutely straight and to 0.0001 inch. He also objects to the manner in which the piercing punch holes have to be transferred from the die to the punch plate. He apparently raises all the obstacles he can in front of any man who would dare to make a die in this manner. Surely in any modern shop it is easy enough to grind a pair of parallels to the same thickness. I may say that after years of experience I have never had any trouble from this cause, providing reasonable means were taken to keep the drill press table square with the spindle.

And now, let me ask Mr. Shailor a few questions about how he makes his punch and die. He says that the punch plate, stripper and die would be doweled together, laid out, indicated, and the holes for the piercing punches drilled and bored. Now which plate does he put uppermost, and on which does he make his layout? From the fact that he says the holes were indicated, drilled and bored, I understand this operation was performed on the lathe faceplate. Now in the die shown in Fig. 4 of his article, the holes are not all of the same size as those in the stripper and punch plate. How does he bore them all at the same time, and which plate does he work from? According to his ideal punch, the holes would be a different size in all of the three plates. If he makes his layout on the face of the die, as is the usual way, and works from it, then it has the smallest holes of the three and they are tapered back for clearance, the holes in the other two plates being much larger. I imagine that it would hardly be practical to make the layout on either of the other two plates, so the way he apparently does is to drill and bore right through, the size of the hole in the die and remount the stripper and punch plates on the faceplate, indicate them again and bore out to size. This means a lot of work and also chances for error. But the part that puzzles me most is—all this is done with the die still to harden. If Mr. Shailor can harden a die of any size without making any alteration or shrinkage, I wish he would let us know his method. Of course, if he uses bushings for his piercing dies, he can transfer the holes again from the stripper, which would be another source of error, but even then, what about his dowels? The whole alignment of the die, stripper and punches depends on the dowels. If the die does not shrink or warp one way or another in hardening, it is something out of the ordinary. Mr. Shailor might enlighten us on this point.

Next Mr. Shailor surely has a curious way of shearing his blanking punch into the die. He says he uses the piercing punches as guides while shearing in the blanking punch. What about the clearance between the piercing holes in the die and the piercing punches? If the stock to be worked is any thickness at all, such as would necessitate such a strong construction of blanking punch, then the clearance between the punches and the die would be no small amount, so that the punches would not be much of a guide while shearing; also the holes in the die are tapered and are open to the same objection for shearing, as for spotting through with a drill.

Mr. Shailor next calls attention to the rigidity, etc., of his style of punch, and the absence of any possibility of its springing on a "half cut." Now if I may be allowed to say so, it has been my experience that, in ninety-nine cases out of one hundred, it is not the punch which springs when taking a "half cut." A punch of such a size and shape as the one shown in Figs. 5 and 6 in the accompanying illustrations, when projecting only 1 3/4 inch from the punch plate, requires something solid to spring it. I have always found that the cause of the so-called "springing" was nothing but slackness in the slide of the press, which with a slack fitting stripper is as liable to bring disaster with a stiff punch as with a slender one. The only remedy, outside of the sub-press die construction, is the tight fitting stripper, which always keeps the punch in perfect alignment with the die, no matter if there is a little slack in the slide of the press. To fit a tight-fitting stripper to a punch made as shown by Mr. Shailor, would necessitate either a very thin stripper, which would be of no use, or else a considerably longer punch.

In the same paragraph Mr. Shailor also calls attention to the reduced chances of the punch springing out of shape when being hardened, when made in his way. Mr. Shailor dwells too much on the chances of the punch distorting and never mentions the chances of the die going any, after being doweled and fitted to the stripper and punch plate while soft.

Fig 6 of Mr. Shailor's article shows a construction which is only permissible on large punches. He draws an absurd example when he asks one to imagine a punch 1 inch long by 1/2 inch wide fitted in this manner. I do not think that Mr. Shailor ever saw very many punches of that size fastened in that way. It would also surely be very foolish for anyone to plane out the slots in the punch plate before hardening the punch. Why not harden the punch first? Then there would be no trouble with the slots fitting the punch, and, anyway, if the punch distorted that much, it surely would not be a good fit in the die. Besides on a punch 1 inch by 1/2 inch the distortion would not be as much on the cross-section of the punch as on the length, and it has as much chance to bend lengthwise when made with a flange and shank as when made straight.

The sectional die referred to I can endorse, as I have found it to be all right, and, in fact, it is the only practical way in which to make a large die containing any number of piercing punches.

The paragraph in Mr. Shailor's article following the editor's reference to Fig. 10 is surely altogether uncalled for. The first statement is open to question, as I have shown, on account of the die warping and shrinking in hardening, which makes the bored holes in the punch plate and stripper of no value. Mr. Shailor tells how some diemakers throw things about and with a twist drill "soak" the holes into the plate from the die, and after the punches are in place knock them this way and that with a hammer. I do not know how you "soak" a hole into a plate, but I think that Mr. Shailor is stretching a point or two in this description. Because he may possibly have seen one or two men do a job in this manner, he should not suggest that it is common practice among toolmakers. At least, in my experience of many years both in the United States and in Great Britain, I never came across any such men. As to his remarks regarding peening,

I will say that, in case it was necessary to peen over a punch, if the stripper were tight fitting, the peened metal would not flow back again, as the punch is kept true by the stripper. It is only when the stripper is slack for the punch that there is any danger of the punch returning to its "old position."

Regarding Fig. 8 of Mr. Shailor's article and his remarks on piercing punches, his ideal punch shown at C seems to me to call for an enormous waste of stock; also the toolmaker must have plenty of time at his disposal to bore the plate and turn so many sizes on the punch. It would have to be enormously thick stock to be pierced to tempt me to make a punch in such a way. Figs. 5 and 6 in the accompanying illustrations show the style I always use. This is made from a standard size of drill rod in the draw-in chuck on the lathe.

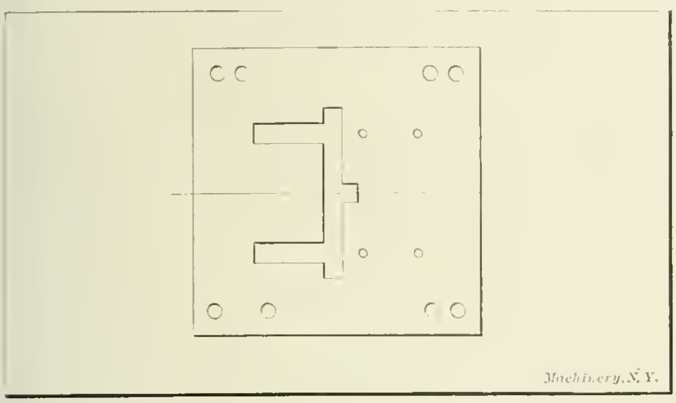


Fig 1. Plan of Die showing Layout

The end is turned down to size as shown for a length of about $\frac{1}{4}$ inch. This allows the body size of the punch to be well entered into the thick stripper in which it is a tight fit, before the piercing commences, so that the punch is properly supported when at work. The body of the punch is a driving fit in the punch plate and is riveted over at the back and filed flush. When made in such a way you can get as stiff a punch as you may want for the minimum of labor; and when well supported in the stripper, a much smaller punch can be used. For very heavy work I usually insert a hardened steel disk in the punch holder above each piercing punch. This prevents any possibility of the end of the punch compressing the metal, and so working a depression in it, allowing the punch to slide up and down at each stroke.

In commenting on boring the holes for the guide posts in Fig. 9 of his article, Mr. Shailor says: "It is a long, expensive and difficult job to bore four one-inch holes in the

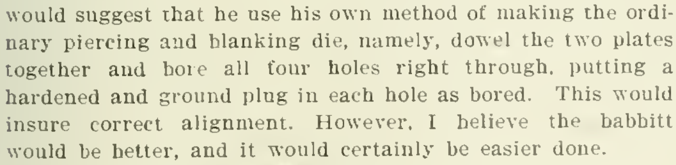


Fig 2. Spotting or Centering Drill Fig 3 Reamer

top plate and four one-inch holes in the bottom plate and have the four pins line up with and travel freely in the holes." I would suggest that he use his own method of making the ordinary piercing and blanking die, namely, dowel the two plates together and bore all four holes right through, putting a hardened and ground plug in each hole as bored. This would insure correct alignment. However, I believe the babbitt would be better, and it would certainly be easier done.

As a final comment on Mr. Shailor's article I might say that there are two ways of doing every job, and because every one does not make their dies as he does, he should not say they are not out of their infancy yet. I venture to say that there is much fine die work done which Mr. Shailor never sees or knows anything about, and which is done in the way he disparages so much. In his descriptions of die work all his work is laid out, indicated, drilled and bored, while the other fellows indulge in "soaking" holes with a twist drill, knocking punches with a hammer and peening metal with a blunt chisel. Does the diemaker who makes his dies in any other way than the one described by Mr. Shailor never use an indicator or bore out a hole? He might show a little more fair spirit.

Now let me state how I would make the same punch and die, making the punch straight all the way up, and compare the two methods. The die would be filed out to fit a templet and the holes drilled and reamed tapered for the piercing dies or counterbored for the bushings, depending on the accuracy required and the size of the die. Fig. 1 shows the layout of the die and shows the positions of the dowel and screw holes. The dowel holes are drilled right through and reamed, and the screw holes are also drilled right through, equal to the body size of the screw, as I would fasten such a die in a good stiff bolster. The die is now ready to harden; but I always plug all dowel holes with fire clay before hardening, as this leaves the walls of the holes soft, and they can be reamed to size after the die is hardened. If the dowel holes are countersunk slightly at each end, it serves to hold the fire-clay plugs in place and also does away with the hardened edge of the hole, which makes reaming impossible. After hardening and tempering, the die is ground top and bottom, stoned or lapped out if required, and the dowel holes reamed. The punch block is then coppered or blued on the face and clamped to the die and the outline of the die scribed through to it. The punch block is then machined to the lines on the milling machine, leaving a few thousandths for filing, making the punch as shown in Fig. 3 of Mr. Shailor's article. After machining the edge all around, the face of the punch is beveled slightly with the file, just enough so that the punch will enter the die evenly all around. It is then placed under a hand press and the impression of the die taken on the beveled edge of the punch face. The punch is then filed away to these marks and the operation repeated, shearing the punch through the die, care being taken to always keep the punch

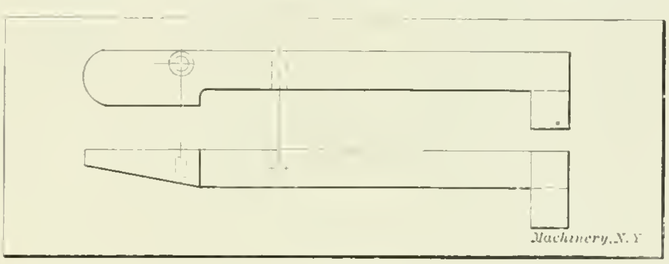


Fig. 4. Finger Stop

square in the die and not to file too deep, so that the punch, when sheared through the die, is parallel all the way up. After relieving the punch the required amount (depending on the thickness of the stock to be worked), the holes are drilled in it for the pilots, these being drilled clear through, so that the pilots can be knocked out when the punch requires grinding. The punch is now ready for hardening, which is done as follows:

The face of the punch for about $\frac{3}{4}$ inch up is held in molten lead until it is an even red color all over. It is then quenched. This hardens the face of the punch for about $\frac{3}{4}$ inch up and leaves the back soft. This method has very little tendency to warp the punch, the large part of it, which is cold, or comparatively so, counteracting it. My experience has been that if properly done, the punch comes out straight and parallel and not warped at all. The temper is drawn from the back in the usual way. After hardening and tempering, the punch is ground on the face.

The stripper plate is now taken in hand. This is made thick, usually from mild steel $\frac{1}{2}$ inch to $\frac{5}{8}$ inch thick and is the same length and width as the die. It is clamped to the face of the die, squaring it up with the sides and ends, and the outline of the die scribed through on it. Then it is drilled, chipped or machined, and filed square all the way through, almost to the lines. The edges of the hole on the top face of the plate are now beveled slightly to allow the punch to enter evenly all around. The punch is put in place under the hand press and the press brought down, marking the outline of the punch face on the stripper plate. The hole is now filed out to this mark and the punch sheared into it, care being taken to

keep the punch square with the plate. If too much stock has been left in the hole, the punch will not shear right through, but it can be forced back again, the surplus stock in the hole filed out and the punch forced in again, this operation being repeated until the punch goes right through. The hole is then polished out until the punch can be pushed through by hand without shake, being a tight fit all the way up. The next operation is the drilling of the holes in the stripper plate for the piercing punches. This is done as follows:

The punch is pushed through the stripper plate until it projects about ¼ inch. It is then entered in the die and the die and stripper plate clamped firmly together, with two ⅛ inch parallel strips between them. When clamped the punch should be easily removable, so that there is no fear of the punch binding hard on one side of the die. The holes are then spotted through with a spotting drill, which is shown in Fig. 2. This drill is easily made from drill rod, being turned to the size of the holes in the die. The ⅛ inch between the die and the stripper plate allows the drill to project far enough through the die before drilling to have a good bearing on the edge of the hole in the die, as, the hole being tapered, it is only the edge which guides the drill. If the drill is fed down gently and is a good fit for the hole in the die, it will make a true center every time. After spotting, the die is removed and the stripper plate drilled and reamed to the body size of the piercing punches. The punches are then made from straight drill rod, being turned down on the end to fit the die, as shown in Figs. 5 and 6, and made a tight sliding fit in the holes in the stripper plate. They are then hardened and tempered. The next step is transferring the dowel and screw holes from the die to the stripper plate. The punch is inserted through the stripper into the die and the two clamped together as before, but without the parallel strips between them. The stripper plate is then adjusted on the die until each piercing punch can be freely inserted through the stripper into the die. When all the punches, blanking punch as well, can be freely inserted and removed by hand, the die and stripper plate are in the correct relation to each other, and the dowel holes can be spotted, drilled and reamed, and the dowels driven into place. The screw holes are then drilled and counterbored.

The guide plates are then clamped in the correct position on the die and are drilled and reamed for the dowels, and drilled for the screws. These guide plates are usually made just thick enough to let the stock slide easily between the die and the stripper plate. The die is then fitted to a cast-iron or malleable bolster, as shown in Figs. 5 and 6, the screw and dowel holes being transferred through it and the holes drilled for the piercing and blanking holes in the die. The punch is now clamped to the back of the punch plate and its outline scribed thereon, and the same procedure followed as in the case of the stripper plate, only the hole is not polished but is left tight. The punch is forced through the plate, leaving just enough projecting to rivet over, the edge of the hole in the plate having been beveled to allow riveting, before the final shearing. A punch fitted in this manner needs no peening to tighten it, and after riveting over it will be found rigid enough for any service. The riveted end of the punch is filed or ground flush with the punch plate, leaving a flat surface for the punch holder to rest upon.

The punch is again inserted in the stripper plate, the punch plate and the stripper plate clamped together and the holes for the piercing punches spotted through the stripper plate into the punch plate, then drilled and reamed to size and countersunk slightly on the back for riveting. The piercing punches are then driven in and riveted over and filed off flush on the back. The punch holder is then screwed and doweled to the punch plate, the holes having been transferred previously.

If all the operations are properly performed, it will be found that the punches enter the stripper tightly, requiring tapping through with the hand, and they will each enter the die in perfect alignment. The pilot pins are then fitted to the punch.

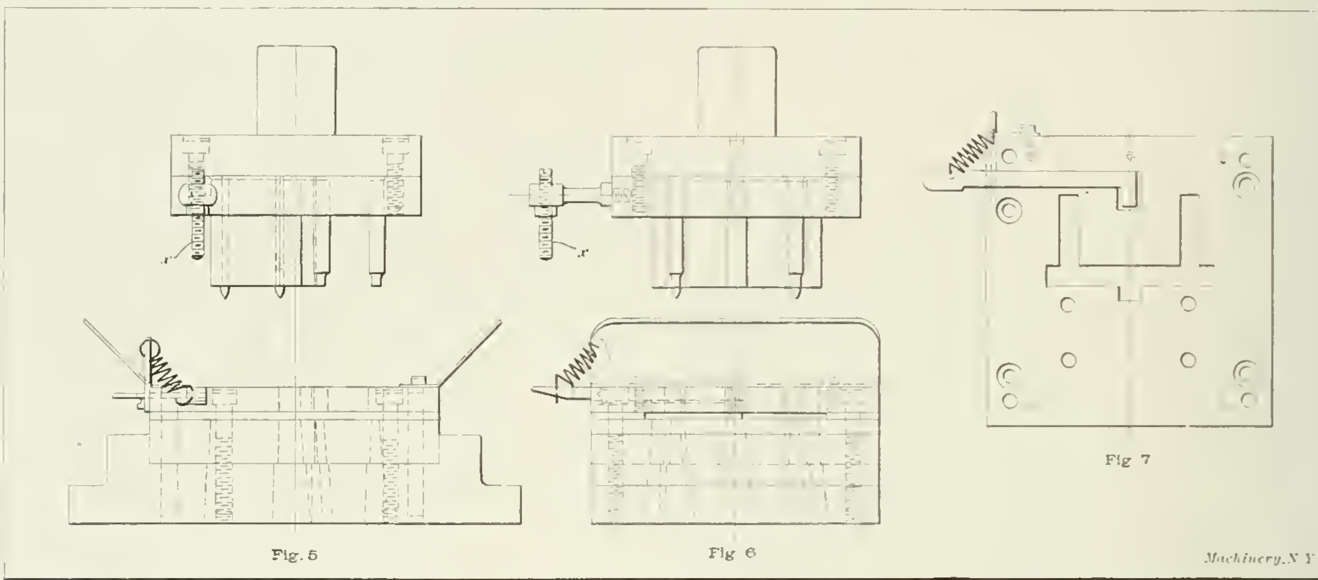


Fig. 5. Side Elevation of Assembled Punch and Die Fig. 6. Front Elevation of Assembled Punch and Die Fig 7 Plan of Stripper Plate showing Stop

The finger stop shown fitted to the die in Figs. 5, 6 and 7, and shown in enlarged detail in Fig. 4, has been found to give satisfaction on blanking dies and on combined blanking and piercing dies, where pilot pins are available on the blanking punch. It is very rapid, as the feeding is continuous, the press never requiring to be stopped until the end of the strip is reached. This stop, however, works best on small work, as on large work the stock cannot be pushed or pulled through the die quick enough to allow of the press running continuously. The stop is fitted rather slack in the slot in the stripper plate, which slot is not cut clear through the plate on account of weakening it. The face of the stop is fitted so that when the stock is pushed against it the pilot pins on the blanking punch will draw the stock back two or three thousandths inch before blanking, thus insuring that the stop is free and does not get jammed. The screw at x, Figs. 5 and 6, which is fastened to the punch plate as shown, is adjusted up or down until the correct position is found and is then locked by the lock-nut shown. The spring shown attached to the stripper plate and to the stop, keeps the stop down on the face of the die when the punch is at the top of its stroke. The action of the stop is as follows:

The stock is pushed up against the stop and the press tripped, and as the punch comes down the screw x, Figs. 5 and 6, strikes the stop and by depressing that end raises the other end until it goes up into the stripper plate. The pilot pins are made of such a length that they just enter the holes in the stock before the stop clears it. On the punch rising,

there being so little space between the die and the stripper, the stock is stripped before the stop descends and there being a constant push or pull on the stock, the stop lands on top of the scrap stock between the blanks, and drops into the next space, the stock coming up against the stop as before. On small work this is the fastest working stop I have yet seen.

The guards shown fitted to the die are made of sheet steel and prevent the operator from slipping his hands under the punch when at work, as the stock is all fed through under these guards. The guards are fastened to the stripper plate with two or three screws each. I should also state that the punches in a die such as I have described should never leave the stripper, only travelling up far enough to strip the stock, an adapter being fitted to the press to make the stroke the required length. If the punches leave the stripper in operation, and there is any slack in the slide of the press, the punches are liable to shear the stripper, thus destroying the effect of the tight-fitting stripper. Fig. 3 shows the type of reamer I use for reaming out dowel holes and holes in the stripper and punch plates for punches. It is made from drill rod of the size required, and is turned parallel to the dotted line *A*, then it is tapered back 0.002 inch or so smaller to line *B*, about 1 inch, then turned parallel to the end, the tapering back allowing for clearance. The end is then filed off as shown and the other end either squared or flattened for a tap wrench. This reamer works satisfactorily, is very cheaply made, and makes a very smooth hole. I usually make these reamers about 0.0005 inch or 0.001 inch under the size of the drill rod used for dowels and punches. By doing so, the slight amount the reamed hole is larger than the reamer and the contraction of the dowels and punches in hardening and polishing to temper, makes the fit just right—a nice driving fit being the result, and the dowels and punches not requiring filing. I ease the body of the punches with the file in the bench lathe, on the part that enters the stripper, just enough to let them slide in the holes in the stripper plate. By hardening and tempering all dowels to a dark straw, they have no tendency to seize in the holes in the soft stripper. These reamers will remove only a few thousandths from a hole, so I use a drill to bring the holes to the required size. By using only standard sizes of drill rod for all dowels and punches, the number of these reamers and drills required is greatly lessened.

* * *

THE ELECTRIFICATION OF THE LAPLAND RAILWAY

The Swedish government has decided upon the electrification of the Kiruna ore-field branch of the Lapland railway, which railway belongs to the Swedish state. No railway electrification has hitherto been undertaken where even approximately the same demands have been made upon the capacity of the locomotives, as will here be the case, namely, the hauling of freight trains of 2200 tons gross weight, inclusive of the locomotive, at an average speed of 23 miles per hour, over a road having long and heavy grades. For this reason some data relating to this undertaking may be of interest.

The portion of the line to be electrified is about 80 miles long and is used chiefly for the carrying of iron ore, only two or three passenger trains passing over the road in each direction daily. The electric power is obtained from water falls in the Great Lulue River, to which the state holds undisputed rights. The maximum power required for the railway traffic at the outset has been put at 23,600 turbine horsepower, and it is proposed to install at first two 12,500 horsepower turbine units in addition to a reserve turbine. The electric equipment, including thirteen ore train locomotives, two express locomotives, transformer stations, feeding lines and overhead conductor lines, is to be furnished by the General Swedish Electric Co. and the Siemens-Schuckert Co.

These companies have bound themselves to very severe conditions as regards the carrying out of the contract. They guarantee that two of the ore locomotives as furnished, one in front and the other behind the train, shall transfer two iron ore trains of 2040 tons and bring back two empty trains of 500 tons weight per day, besides doing the requisite shunting at way stations. The locomotives shall be able to perform this work continually for six days, and each locomotive shall accomplish 56,250 locomotive-miles in the year. The express locomotives must be able to take trains of 220 tons net weight over the line three times daily back and forth. These locomotives must be able to run an aggregate of 62,500 locomotive-miles per year. The consumption of energy is guaranteed by the firms not to exceed, for express trains, 45 watt-hours per ton-mile; for ordinary passenger trains, 45 watt-hours per ton-mile; for iron ore trains, 32.5 watt-hours per ton-mile; and for empty car trains, 34.5 watt-hours per ton-mile. These figures are exclusive of heating and lighting and are to be measured on the locomotives on the high-voltage side of the transformers, under ordinary weather conditions and with rails and rolling stock in good condition. For the handling of the ore train only three men are assumed to be necessary.

When the entire electric installations have been duly tried and taken over by the state railways, the working, maintenance and inspection of the electric installations will pass to the state, but the firms guarantee the maintenance cost for the installation for two years from the day the installation has been definitely taken over by the government. The government, however, has the right to demand the extension of the guarantee for another twenty-three years upon paying to the firms an additional five per cent of the purchase price for the third year, and one per cent for each following year, until an aggregate excess price of ten per cent has been paid for this guarantee. Within a period of three years after the installations have been accepted by the government, however, the firms are bound, should the state railways demand it, to remove without any compensation whatever, the installations delivered, including the electric locomotives, and pay back the payment received up to the time of removal, under any of the following contingencies: *a*. If the working should prove unsafe. *b*. If the machinery should prove unsatisfactory in its working. *c*. If the maintenance cost be excessive. *d*. If the current consumption be excessive.

The firms, on their side, have the right to work the installation, if the results obtained by the government prove unsatisfactory, at the maintenance and working rates agreed upon for the installation, the government in that case paying over to them the stipulated amount yearly. The total amount of the contract of the two firms is approximately $1,420,000.

A few particulars of the line to be electrified may be of interest. The whole length is 81 miles, of which only 22 miles are level, 31 miles having a rising, and 28 miles a falling grade. Over 21 miles have gradients of one in one hundred, and practically half of the whole length of the line is curved, the smallest curve radius being about 1000 feet. The total cost of the installation, including power station, is estimated at $4,800,000.

* * *

GRINDING WHEEL AND WORK SPEEDS

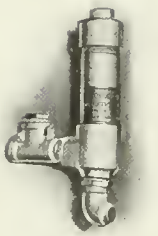
A slow grinding wheel peripheral speed is 3500 feet per minute; medium, 5000 to 6000 feet, and fast, 7000 feet. Certain experts grinding small special work, run their wheels as high as 8000 feet, but that is an exceptional, not to say dangerous, speed. A low work speed, according to the views of one grinding authority, is 20 feet per minute; medium, 50 to 60 feet, and fast, 120 to 125 feet.

* * *

Naval authorities of the leading powers are considerably agitated by the report that the naval engineers of Great Britain are about to develop a dreadnought type of battleship driven by internal combustion engines. The advantage of this new type will be absence of smokestacks and smoke, greater economy of fuel, saving of weight and greater speed. If the internal combustion engine proves successful for naval vessels, all the great navies of the world will be made obsolete and the millions of dollars that have been expended will be wasted. What better proof of the folly of the big navy policy could be had than this possibility of rendering the enormous expenditures of the past twenty years useless?

COOLING GAS ENGINES

By GEORGE J. MURDOCK*



The birthplace of the gas engine was the machine shop, and there its development has been strenuously continued, until it has reached the point where it has driven practically all small power competitors from the field, with the exception of the electric motor. Everything that tends to cheapen the cost of operation and contributes to the design of a compact engine widens its scope of usefulness.

Wherever combustion engines are found the problem of keeping them cool is an ever-present difficulty, and one which is commonly overcome on lines which are almost as antiquated as the fundamental principles on which the engine works. In cities the cost of water for this purpose is high, and in isolated localities it is seldom that running water can be conveniently obtained, thus necessitating pumping from wells or cisterns at considerable expense of power, to keep the temperature of the engine cylinder within permissible bounds. Where city water is available it can be piped to run by the pressure of the mains through the water jacket, but it is always metered, and costs in some cases as much as $10.00 per horsepower annually. A 10-horsepower gas engine is therefore somewhat expensive to run, aside from the cost of fuel.

Investigations conducted by the writer disclosed the fact that out of 500 engines running in the vicinity of New York City with a total capacity of 17,250 horsepower, for more than 15,000 horsepower city water was used for cooling purposes, at an average annual cost of $7.00 per horsepower, thus involving an expenditure of more than $100,000 each year,

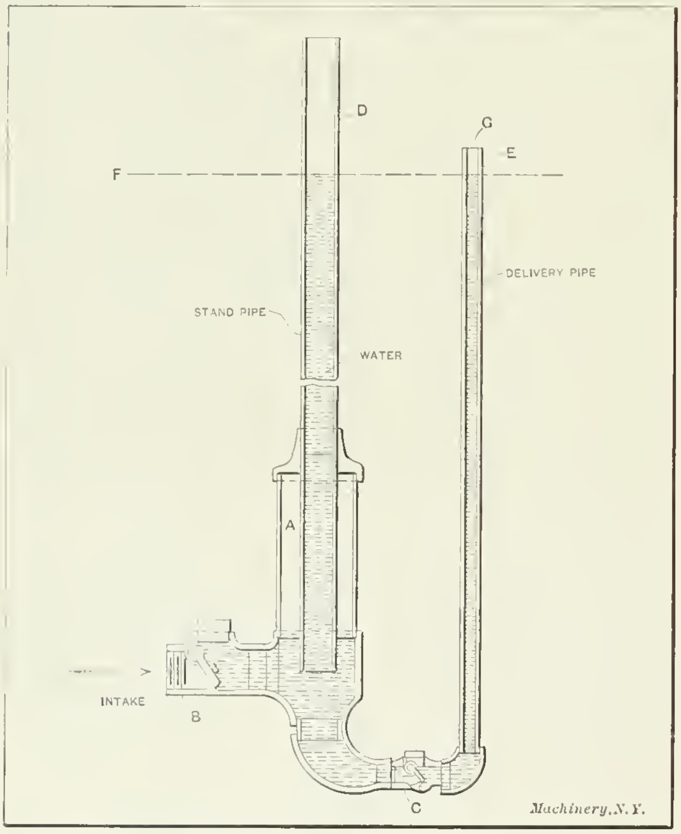


Fig. 1. Diagram showing the Pump, Stand-pipe, Exhaust Pipe and Delivery Pipe assembled

which is a total economic waste, in view of our present knowledge of a better method for accomplishing the same result at practically no expense. On this basis it is estimated that in larger cities of this country not less than $3,000,000 worth of water runs into the sewers every year after having accomplished the purpose for which it is used. This huge waste is not the cost of producing power, but one of the consequences of its production. Space is very valuable in cities, and also of some value everywhere an engine can be used, so the large water tank necessary for use with the thermo-syphon cooling system may easily occupy room, the rental of which, and value for other purposes, may cost more per year than the running water from the city mains. Such a tank is also costly if made durable in the first instance, and can seldom be placed between the floor and ceiling, but must go up through two stories or else be of excessive diameter.

A cooling system has been developed within the last few years, however, that seems to meet all of the requirements for the efficient cooling of even the largest engines, and which

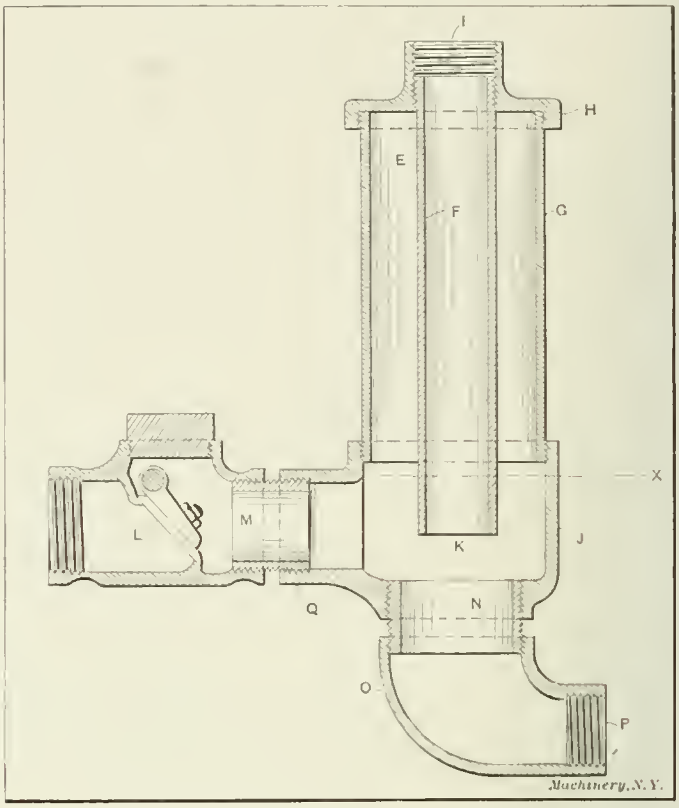


Fig. 2. Small Pump made from Malleable-iron Fittings

does not entail any cost of maintenance when once installed; it also economizes space, as it does not require any more room than that occupied by the engine. It can generally be put in ready to run for a cost which is less than the water bill for one year when the engine is cooled by city water, and it is considerably cheaper to install than the large tank of equal cooling capacity which is necessary for the natural or thermo-syphon method.

This system has been in operation on a 25-horsepower gas engine for about three years, which is used for supplying power in a novelty factory. In this particular instance the demands on the engine are very fluctuating. Sometimes the engine runs for days at a time on full load, and then at other times the load will be comparatively light. The change in the load is partly due to the sudden demands for full power, caused by putting buffing wheels into operation in the nickel plating department. The new method has given no trouble whatever, and in addition to its adaptability for use with stationary gas engines, it also seems to be particularly suitable for service in connection with portable farm engines, such as are used for threshing machines, or in fact for use with any type of gas or gasoline engine using water to keep it cool. The actual waste of money for water, however, is not the only thing to consider with engines as they are at present cooled. It is a well-known fact that in running on variable loads with a constant stream of water passing through the jacket of the cylinder, the engine will consume more gas than it should, owing to being too cold, as the stream of water must be large enough to keep the cylinder sufficiently cool when the engine is working at its full capacity; and when it is running light the same stream makes it too cold to work efficiently, and there is an undue consumption of gas. When the load is thrown

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on, it takes considerable time for the cylinder to warm up to the point where it can give the greatest power efficiency, consequently it seems that a waste of fuel appears to be unavoidable where running water is used for cooling purposes. With the thermo-syphon system the waste of gas is less, as the temperature of the cooling water and the water jacket surrounding the cylinder is kept more uniform, but besides the objections heretofore named, it gets so hot as to generate quantities of steam, which must be conducted outside at considerable expense, and the connections, and even the water in the tank, are likely to freeze in winter. A simple and efficient pump requiring no attention and consuming no power from the engine shaft, is the keystone to the new system. Fig. 1 shows a diagram of the pump, stand pipe through which it derives power from the engine exhaust, and a section of the delivery pipe. While the pump works from pressure derived from the exhaust gases of the engine, none of the exhaust goes with, or comes into contact with the water to be pumped. It is composed of an air chamber *A*, intake check valve *B*, delivery check valve *C*, the stand pipe *D*, and delivery pipe *E*. The lower end of the stand pipe extends into the pump, so as to form the annular air chamber *A*. To illustrate the operation, it will be assumed that the apparatus is filled with water until the latter rises up in the stand and delivery pipes to about the line *F*. If sudden gaseous pressure is now applied in the pipe *E*, and instantly released, the water will jet from the top *G* of the delivery pipe *E*. At the same time the valve *B* will be heard to click, and if the hand is wet, and quickly applied over the outer opening of the valve, a considerable suction will be felt. Immediately after the pressure is applied, the water will again rise up in the stand pipe, following the click of the valve, to the same level it was before the beginning of the operations. The reason for this action is as follows:

When the pressure is exerted on the column of air above the water in the stand pipe, it causes a downward thrust of the water, which compresses the air in the chamber *A*, and also forces the water out of the delivery pipe *E* at *G*. When the air chamber re-acts it throws the water into the stand pipe and upward with nearly as much force as that exerted by the pressure in the first instance, and as the valve *C* will not allow the vacuum thus formed in *A* to be released, the valve *B* opens, and inspires sufficient water to restore the equilibrium. This cycle of operations takes place in an exceedingly short space of time, but investigations scientifically conducted have shown that this is the action. It will be seen that to make a practical working pump all that is necessary to do is to connect the valve *B* to a water supply, and the stand pipe *D* to a source of intermittent pressure such as the exhaust of an engine.

Fig. 2 shows a pump made of malleable-iron fittings screwed together. The nipple *F* is screwed into the reducer *H* on the inside, while the lower end of the stand pipe is screwed in at *I*. The chamber thus formed must be perfectly air-tight; therefore, it is best to take a cut out of the reducer in a lathe, and after the nipple *G* is screwed in, run melted solder into the top, having previously wet the surfaces with a soldering fluid. The swing check valve *L* is united to the reducer *J* by a close nipple *M*, and the elbow *O* is joined to the bottom of the pump by the close nipple *N*. For an engine of say 10 horsepower, a one-inch stand pipe and a one-inch intake valve are large enough, while the nipple *G* may be made five inches long by three inches in diameter. It will be seen that anyone knowing how to use a Stilson wrench, and who is familiar with pipe fitting can make a pump very quickly and at small expense. A pump of this size has lifted a 3/4-inch stream of water 20 feet high with the exhaust pressure of a 10 horsepower gas engine. While this pump has a suction corresponding to the pressure applied to the stand pipe from the exhaust, it is not capable of drawing water from a deep well, and where a well is used or a cistern is available, the pump should be lowered down to the water level, or considerably below it. Pumps of this class have been found to work even better under these conditions, which necessarily involve the use of a longer stand pipe, than when used above the water. Where the water is to be forced through a long pipe, and to a radiator, it is advisable to use a check valve on the delivery pipe, but where the pipes are short, only the intake valve *L* is necessary. This is illustrated in Fig. 3 where a 5-horsepower vertical gasoline engine is shown running at 350 revolutions per minute. The water is being lifted about 4 1/2 feet above the tank, and after passing through the water jacket of the engine cylinder, it may be seen pouring down into the tank *A* at the left of the illustration, at the rate of about three gallons per minute. The tank holds only about six gallons, yet, owing to the exposure of the water to the air in its descent down into the tank, the engine is efficiently cooled. The pump works equally well on governed engines where the exhaust valve is held open for longer or shorter periods, or on those using a carburetor and controlled by a throttle. In the latter case, however, some engineering judgment must be used as to the height of the stand pipe, or when the throttle is nearly closed water is liable to be drawn over into the exhaust pipe.

The initial illustration of this article shows a pump as it

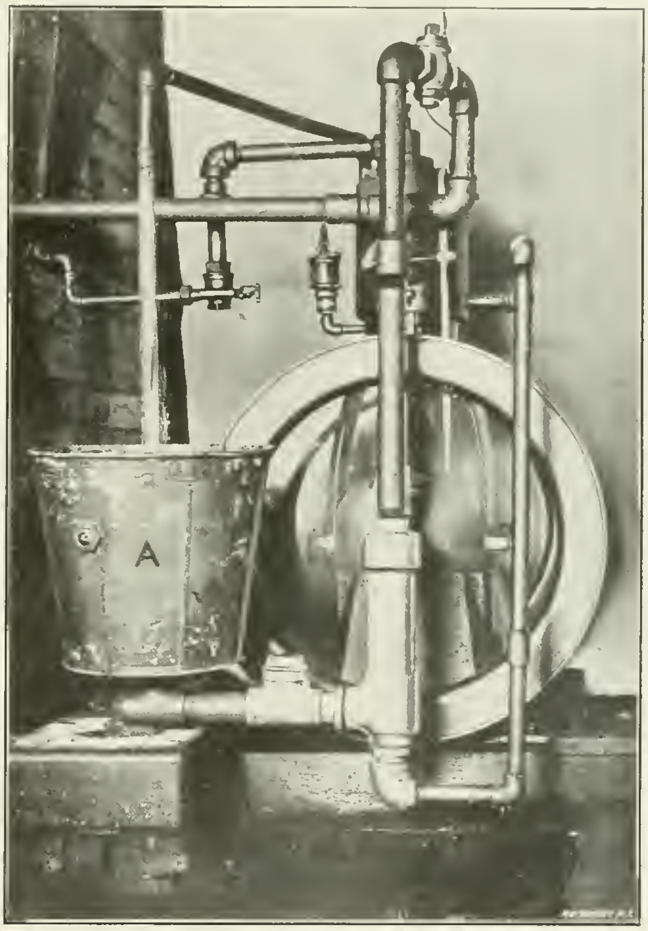

Fig. 3. Five-horsepower Gasoline Engine equipped with Cooling Device

actually appears made up of fittings, and ready to be connected to the stand pipe, which, in turn, is connected to the exhaust pipe of the engine.

Fig. 4 shows the arrangement of the 25-horsepower plant mentioned in the beginning of this article. One of the flywheels has been removed in order to give a clearer view of the end of the radiator, which is of the same type as those used on automobiles. It will be noticed in Fig. 3 that the pipe connecting the top of the stand pipe with the exhaust pipe of the engine is carried up higher than the top of the engine cylinder. This is done so that the suction cannot draw water over in the exhaust pipe as it might otherwise do, owing to the vacuum contained therein, particularly if the exhaust pipe is long. In Fig. 4 the stand pipe is shown connected to the exhaust pipe by a tee-fitting *E*, and the entrance of the stand pipe into the exhaust pipe is several inches higher than the line *F*, which represents the highest water level when the expansion tank is full. The flywheels of the engine act as fans for the radiator, and the temperature of the water never rises above 212 degrees F. It is generally about 150 degrees. The cold water from the bottom of the radiator is taken by pipe *B* to the intake check valve *L* of the pump, and

from there forced through the delivery pipe which in this case has a check valve *A*. It then passes up through the water jacket of the engine and comes out at the top into the expansion tank, which is kept about half full of water by adding to it from time to time, to make up for the small amount lost by evaporation. As the water gets hot it expands and so increases in volume that the tank will be nearly full when the engine is doing heavy duty and, therefore, developing the most heat. From the tank a pipe runs to the top of the radiator as shown. This pipe is 3/4 inch, while the pipe running from the bottom of radiator to the pump is 1 inch. At *C* a plug is provided to draw the water off, which is done about once a week, fresh water being put into the system through the expansion tank. During severe weather in winter the engine jacket and piping is drained every night, and refilled in the morning which is not a serious undertaking, as the whole quantity of water used is only a few gallons.

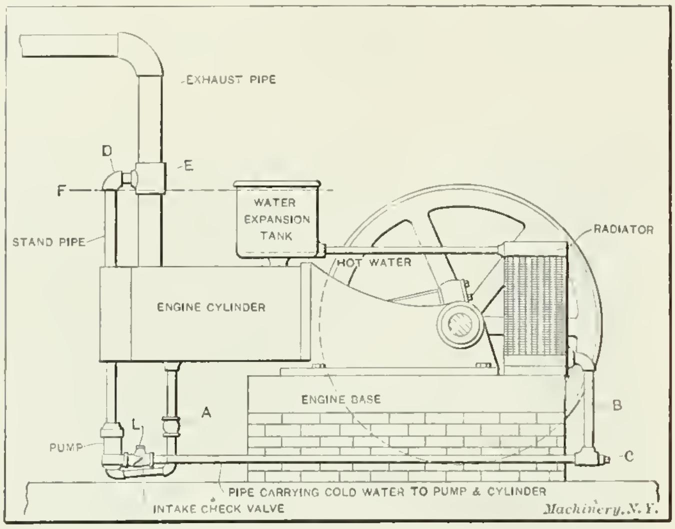

Fig. 4. Arrangement of Cylinder-cooling Device for a 25-horsepower Plant

The water for cooling this engine formerly cost over $125 per year. The present outfit has been running at no cost whatever, excepting $4 paid for repairs to the radiator, thus making a net saving of $371 for the three years, to say nothing of the saving in gas due to the more uniform temperature at which the engine cylinder has been kept. The first cost of installation was $108, most of this being for the large radiator used which has since been found of a capacity considerably in excess of the requirements. This system of circulating water should commend itself to manufacturers of farm engines as it does away with the large and heavy tank now used, which it would seem must cost as much or more than an automobile radiator of equal cooling capacity. The pump used with an automobile engine is quite costly to manufacture as compared with the pump herein shown, besides taking considerable power from the engine shaft to drive it. The power derived from the exhaust to operate these pumps cannot, of course, be applied to any other useful purpose, and it may be stated that they cost nothing to operate, while the cost for lubricating oil, for repairs and financial expenses, are much less with the exhaust-operated system than with any other now in use.

* * *

The rapid elimination of the sailing vessel is indicated by the fact that the percentage of this class of vessels in the merchant marine of Great Britain declined from 1888 to 1908 from 44.1 to 12.6. The decline in the German merchant marine was from 62.1 to 19.1 per cent, and in that of the United States from 80.7 to 30.9 per cent.

* * *

A record for efficiency of hydraulic turbines has recently been obtained in tests which were undertaken with the 10,000-horsepower turbines at the Trollhättan power station in Sweden. The efficiency was found to be 86 per cent for the turbines furnished by the firm of Nydqvist and Holm, Trollhättan. The highest efficiency hitherto obtained anywhere, as far as known, is 85.7 per cent.

GRINDING GAS-ENGINE CYLINDERS

By JOHN F. WINCHESTER*

In the editorial in the July issue of MACHINERY you made some pertinent remarks in regard to the grinding of automobile cylinders. Having had considerable experience on this class of work in various shops, I would like to give my views upon this timely subject, which may be of interest to your readers.

Ten years ago, refinement in cylinder bore finish was accomplished either by lapping with a dummy piston or with an alloy of the expanding type, both processes being slow and unsatisfactory even at their best.

Grinding was little done on this work, partly due to the limited knowledge of this branch of the industry, and also on account of the poor grinding machines obtainable for this class of work. But when the machine tool makers realized the importance of the gas engine business they immediately commenced to design machines for this special purpose, and up-to-date mechanics and managers seeing a chance to make a more accurate cylinder at a smaller cost took up with the idea. They not only produced a cylinder of greater refinement at a lower cost, but also made a talking point of the operation when selling their product.

There are many mechanical men who will say that reaming gives as good results, and at a lower cost. This may be true of a lower-priced engine where engineering refinement cannot be sought for, and where quantity and not quality counts. But with the other class of engines where specifications call for a rough bore within 1/64 inch of size, and the setting aside of the cylinder to "season", the grinding of the cylinder produces much better results. In other words, reaming has its place in the case of a cheap engine, but outside of that, grinding is by far the better operation. It insures greater interchangeability with less supervision than is required in reaming. The best practice in cylinder reaming is to ream in a vertical machine, a boring mill, radial drill, or any special machine of this type, as the reamer generates less heat, stands up longer and gives a more perfect finish than can be obtained in a horizontal machine. In reaming cylinders, a careful man with a watchful eye is required to prevent the reamer striking the head of the cylinder, which makes the reamer cut large and out of round at the most important point of the bore. An observant eye must be kept on reamers to see that they keep their size and cut properly, whereas for grinding it takes no longer to set the cylinder up than for reaming, and the operator can look after his wheel, keeping it in proper shape, and can also duplicate work with little trouble from the shop or toolroom.

At this juncture it may be interesting to note that any machine or discarded tool cannot be fitted up with grinding attachments and yet give good results. An instance of this fact came to my attention some time ago. The firm for which I worked at the time had contracted to build a number of gasoline engines, the bore of which was to be ground to size. Work was started and the cylinder was being bored and reamed when the inspector for the engine firm came along and insisted upon the cylinder being ground as the contract called for. Not having any grinders for this class of work, old lathes were fitted up with grinding attachments with the following results: The bore was not as true as when done with a reamer, showing high and low spots throughout. Nevertheless, the work passed inspection as it had been ground. In that case quality, and I think quantity, had been sacrificed to give the salesman a talking point for his engine.

Some of the best cylinders I have seen have been finished by boring within 1/64 inch of size, baking over night to relieve foundry strain and then grinding to size. These we produced in a shorter time than by reaming, but in the running qualities of the motors about the same results were produced by the reamed and ground cylinders.

* * *

Don't fail to clean away all dirt and chips before screwing a chuck or faceplate on the lathe, and if the screw is dry, put on a few drops of oil.

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PLANER AND SHAPER JACKS*

By H. E. WOOD†

In many respects the planer jack is as important a tool as any around a planer or shaper. Many pieces of work of more or less irregular character cannot be supported properly or clamped adequately in place without the use of some form of planer jack. Not only is it of importance that mechanics in general are familiar with the simpler forms of planer jacks, so that they can easily make one at short notice when required, but the regular tool-room of the machine shop should be provided with a large assortment of different types of appliances of this kind, because a great deal of time which otherwise would be lost, can be saved in this way. Many of the forms of planer jacks shown in the accompanying Data Sheet Supplement are more or less familiar objects to most mechanics, but some of them may present ideas that are new to many.

The planer jack shown in Fig. 1 of the accompanying Data Sheet Supplement, is one of the simplest in form, consisting simply of a block having a drilled and tapped hole and a piece of round bar stock threaded on one end. A check nut is provided to prevent the stud from jarring loose when the cut is taken, and a hole is drilled through the bar so that a jack handle, as shown to the right, may be inserted for turning the bar when adjusting it. Fig. 2 shows another simple planer jack consisting of a square-headed screw and a split lock-nut, the latter being provided with a binding screw. When this planer jack is being adjusted to height, the lock-nut binding screw is loosened; as soon as the correct height has been obtained, the binding screw is again tightened, thereby preventing any motion of the screw in the nut, due to vibration or other causes. Fig. 3 shows another simple form of planer jack consisting merely of a piece of round stock, drilled and threaded for the required distance from one end, for the square-headed screw inserted into it. A small headless set-screw can be used for binding the square-headed screw. As it is not advisable to have the binding screw bind directly against the threads of the square-headed screw, a small piece of brass should be inserted between the threads in the large screw and the end of the set-screw. It is also advisable to relieve the large stud at the lower end, so that it has a bearing only around the edges, as shown in the illustration. This prevents it from rocking on the planer table if the end should not be perfectly square.

Fig. 4 shows a planer jack made of a piece of flat stock and a square-headed screw, the end of which enters into a hole or T-slot in the planer table. A hole is drilled at the other end of the flat piece of stock. This makes it possible to clamp it to the planer table when necessary, to avoid shifting or sliding. A small headless set-screw is provided, as shown, for locking the elevating screw, to prevent it from moving when once set. Fig. 5 shows a planer jack which is similar in principle to the one shown in Fig. 4, but the piece of iron in this case has been bent so that the elevating screw can be adjusted up and down without being required to enter a hole or slot in the planer table. This planer jack has, therefore, a larger range than the one previously shown. Fig. 6 shows a more elaborate type of planer jack, which, however, is a good form for many pieces of work, when a strong support is required. It is made of two pieces of hexagonal stock, one being turned and threaded as indicated; a set-screw is provided, as shown, for locking the screw to the nut.

In Fig. 7 is shown a planer jack having a cast base. This form of device is in common use. The cast base is split for some distance down, and a binding screw provided, so that the correct setting can be preserved. In Fig. 8 is shown another cast-base planer jack which is very similar to the one shown in Fig. 7, except that the locking device consists of an adjusting collar or nut binding directly against the top of the base. In Fig. 9 is shown a planer jack of the cast-base type possessing a feature which makes it preferable in many instances to the two types just shown. In this planer jack the ram or central stud moves up or down without a rotating movement. The adjustment is secured by turning the knurled nut shown. The small knurled-head screw at the left binds against the knurled nut and prevents motion after the proper adjustment has been obtained. The headless set-screw at the right enters a groove or keyway in the ram, thus preventing it from turning with the nut.

In Fig. 10 is shown a planer jack especially intended for supporting work having a surface at an angle with the plane of the planer table. It is made with a cast base with holes provided for bolting it down to the planer table for preventing it from sliding or overturning. A small metal block is inserted between the work and the upper end of the pointed elevating screw. This block prevents the screw point from marking or injuring the work surface. Fig. 11 shows a planer jack which also is intended for supporting work surfaces which are at an angle with the plane of the planer table. In this construction, however, the range of the device is considerably increased by having the block, into which the ram screws, swivel around a pivot in the base. In fact, this planer jack, when properly clamped down, can be used for supporting surfaces that are at right angles with the planer table.

Fig. 12 shows a planer jack to be used for supporting work with inclined surfaces. Here, the swiveling joint permits the supporting surface of the cap to adjust itself freely to the position of the work. In Fig. 13 is shown a universally adjustable planer jack of the ball and socket type. It possesses some advantages over the types shown in Figs. 11 and 12 in that it can be rotated in any direction relative to the base. One of the disadvantages of this particular construction, however, is that no means are provided for locking the sphere in place. In Fig. 14 is shown another universal adjustable planer jack. It differs from that shown in Fig. 13 merely by the introduction of a locking nut at the top of the ball.

Fig. 15 shows a jack used for prying apart pieces of work where it is necessary to be careful not to mar the edges or bruise them by the use of other tools. The jack-screw, in this case, is at an angle with the center line of the device when this is closed, so that when opened to various positions, it will bear against the opposite jaw at approximately a right angle. If it were placed at right angles to the opposite jaw when the device is closed, it would form too acute an angle with this jaw as the device was opened. This would impair the efficiency of the piece and mar the threads at the edges of the point of the screw. Fig. 16 shows a special wedge-type jack-screw used in narrow places. It consists of a ram actuated by the wedge-shaped end of the adjusting screw. The construction is clearly shown in the illustration.

Any shop which provides itself with a first-class collection of planer jacks of these or similar types, and provides for a proper place for keeping them, to which they are returned after having been used, will find that a great economy of the men's time will result. In many classes of work the time lost in hunting for suitable tools, clamping straps, jacks, arbors, etc., is a greater factor than is the actual cutting work on the piece to be made, and besides, with inferior clamping and supporting devices, the work itself is often not as satisfactory when completed as it would have been if proper facilities were provided.

* With Data Sheet Supplement.
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* * *

AMENDMENTS TO THE LABOR LAW OF NEW YORK

Chapter 352 of the laws of 1910 of New York State entitled: "An Act to Amend the Labor Law, in Relation to Employers' Liability," increases the liability of employers as follows:

1. *The "fellow servant" rule is greatly modified.*—The fellow servant rule of law, which relieved employers from liability for accidents caused by an act of a fellow workman of the injured workman, is amended so that hereafter the employer is liable for the act (causing an accident) of any person in his employ when such person is intrusted with any superintendence or intrusted with authority to "direct, control or command" any employe, thus greatly increasing the employer's liability, as it brings within the scope of the amended law a large percentage of all accidents.

2. *"Assumption of risk" abrogated.*—The amendment does away with the rule of law of "assumption of risk," under which a workingman by continuing at work with knowledge of dangerous or defective conditions, was held to have assumed the risk and therefore was not entitled to recover damages resulting therefrom. All work necessarily involves

risk of injury to the workman, but the rule which has always heretofore been the law—that if the workman understood his work he assumed the consequences, no longer exists. This reversal of the old rules adds much to the employer's liability. Probably more accidents come with this class than with any other.

3. *"Contributory negligence"; burden of proof placed on the employer.*—The rule of law (previous to this amendment) was that a workman who was guilty of contributory negligence, however slight, in connection with an accident, could not recover damages for injuries even though the accident was due to the negligence of the employer. Heretofore in all such cases, the workman has been required to prove affirmatively not only the negligence of the employer but that he, on his part, was wholly free from any and all contributory negligence. The law as amended changes this rule and places upon the employer the burden of proving the contributory negligence of the workman. The new law assumes, in the absence of affirmative proof to the contrary, that the injured workman exercised due care to prevent the accident by which he was injured. This amendment will enable the workman to recover in cases where affirmative evidence as to his negligence is lacking, and will be especially useful to the workman's family in death cases where the injured workman by reason of his death is unable to testify and there may not be any living witness of the accident. It must be borne in mind that in death cases, if damages are recovered, they are for large amounts, consequently this amendment will very greatly increase the total amount of damages to be paid by employers.

4. *Defects for which the employer is now liable for damages.*—The old law made the employer liable for damages arising from accidental bodily injuries caused by defects in "the ways, works or machinery" used in his operations. The law is amended by the addition of the word "plant." This amendment makes the employer liable for many accidents to his workmen for which he has heretofore not been liable.

5. *Notice of accidents.*—The act amends the provision of the old law requiring specific service on the employer of a notice of the "time, place and cause" of the accident, by providing that unless such notice to the employer, if defective, is returned by the employer to the injured workman within eight days with a demand for a further notice, which demand must specify the particulars in which the first notice is claimed to be defective, the employer shall be considered as having waived all defects in the first notice. This new provision practically abolishes the hitherto important defense of lack of proper notice.

This law went into effect September 1; also two additional laws creating a new kind of liability for employers. These two additional laws, known as workmen's compulsory compensation law and alternative or permissive compensation plan respectively, introduce in this country an entirely new doctrine as respects the obligation of employers to employes, *i. e.*, the doctrine of compensation to the injured employe, irrespective of the question of negligence, as distinguished from the old doctrine of "damages" to the employe because of the negligence of the employer.

* * *

IMPROVED METHOD OF DIMENSIONING JIGS AND FIXTURES

By JIG AND TOOL DESIGNER

The making of templets, fixtures and jigs, is generally considered accurate work, and the name given to this class of work is toolmaking. The construction of the jigs calls for as great accuracy as any branch of the toolmaker's business, but the accuracy with which the jig should be constructed depends entirely upon the nature of the work to be accomplished, and yet, if the work is within the limit of 1/16 to 0.0005 inch, the drill bushings or locating points should be laid out as accurately as possible, for any inaccuracy in the jig will, of necessity, be duplicated in the work. At the present time, especially in large factories, the toolmaker is guided in the making of a tool by a drawing, and the drawing and designing of jigs and fixtures has become a science in itself. Yet many draftsmen in this line of work, make the work of the toolmaker more difficult and less accurate by giving radial dimensions, or by working from succeeding points instead of always working from a center-line. In Fig. 1 is shown the correct method of dimensioning drawings. This is a simple jig for drilling an automobile gear case cover, the cover being clamped as shown. The dimensions are laid off from a center-line and measured in a straight line from every important point, and are given in thousandths, or fractions as the case may require. Fig. 2 shows the same jig with dimensions improperly arranged. It is easy to see that a toolmaker can work from straight dimensions, or from points that are at

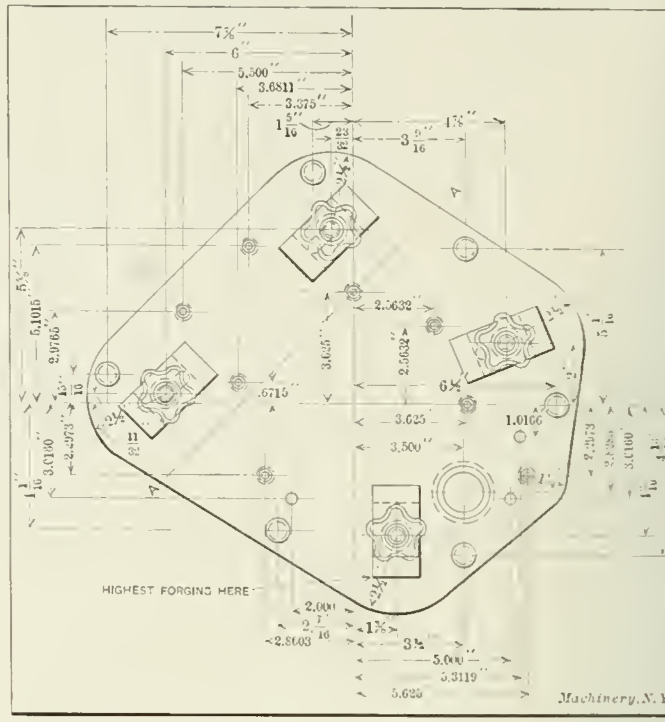


Fig. 1. Correct Method of Dimensioning Drawings

right angles to each other, by using the micrometer dial on the milling machine, the micrometer, micrometer calipers, vernier, etc. When the jig is laid out as shown in Fig. 2, the toolmaker often has to figure the dimensions all over

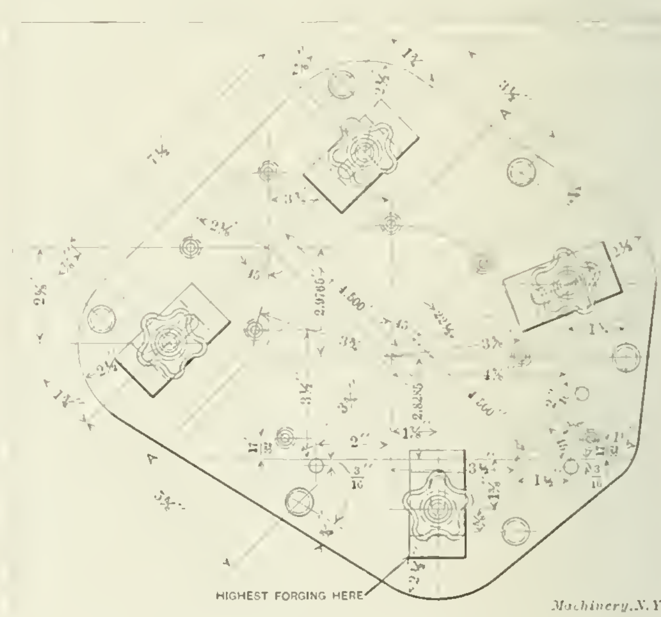


Fig. 2. Incorrect Method of Dimensioning Drawings

again or have some one do it for him, while the draftsman is supposed to understand trigonometry, etc., and could have easily given the dimensions in the manner which would be the easiest to lay out.

* * *

The excess of exports from the United States over imports to the United States during the fiscal year ending June 30, 1910, was the smallest for any year since 1896. Contrary to the opinions of many people, this is not necessarily an unfavorable condition. It may merely indicate that the indebtedness of the United States to Europe is decreasing, and that a smaller amount of excess of exports over imports is required to pay the interest on foreign investments in America's natural resources and industrial enterprises.

EXPERIENCES OF A YOUNG TOOLMAKER*

By T. COVEY

"Jim," said Mr. Corbin, "Mr. Anderson is making a jig that is too large for one man to handle, and I am going to put you on the job with him. There are also some of the smaller pieces that you may be able to make. You may report to him and help him in whatever way you can."

Jim found Mr. Anderson near a large drill press laying out pin holes in a casting, a view of which is shown in Fig. 1. He had wedged a piece of wood into the hole in the center and was laying out the center of the hole on that; then, using a large square, he scribed two lines through the center terminating at the four sides of the piece; with a smaller square he transferred these lines down the sides of the piece and with a center-punch pricked points at about the center of the thickness of the piece on each line, thus locating the position of the pin holes.

"If you want those holes for finger straps to hold the piece down while planing, why do you need four holes, and why are you so particular where they are?" asked Jim.

"Well," said Mr. Anderson, "as far as planing is concerned, two holes are enough and it would not matter so much where they are, but I think that I will have to put this casting on a boring mill, or the faceplate of a large lathe, to bore out that hole and recess it; in that case, you see it would be very handy to have four holes, and it will also save trouble if they are in the proper place to come in line with the tee-slots in the faceplate when the hole is chucked up central, which they will do as they are now laid out."

"There, the holes are drilled, we will put it on the truck and you can return these tools to the toolroom and then come and help me set it up on the planer."

"Now I suppose that you want some finger straps, don't you?" asked Jim, when he returned.

"They are not necessary," said Mr. Anderson. "I have some 5/8-inch pins about 1 1/2 inch long that I keep in my drawer for use on such jobs as this; it is only necessary to put one of them in a hole and let it project out a half-inch or so, then one can use an ordinary strap on it. Finger straps are all right when they can be found handy, but sometimes it takes longer to find suitable ones than it ought to take to set the job up. The casting rocks a little on the bed; we will have to pack up under these two corners with heavy cardboard. Now we want two straps and five or six stops; we will put one strap at each side and two stops at the end that receives the pressure of the cut; we will also put two stops on one side of the piece and one on the opposite side near the middle."

"Why do you want so many stops?" asked Jim.

"Well, I have found through my experience that when one does not want to spring a piece, the best way is not to strap it down too firmly, especially if the surface next to the table or bed is not perfectly true. The duty of the straps should be to simply prevent the work from lifting off the bed, and not to resist any pressure due to the cut; the stops should take care of that. It is a good plan to loosen the straps a little before taking a finishing cut, and on jobs like this one that are to be scraped down to a surface, it is always best to take a roughing cut off all the surfaces that are to be planed before finishing any one surface. On some jobs it is advisable to rough out all the machine work, even to the lathe and milling-machine work, as in this way any tendency of the piece to warp arising from the removal, or partial removal, of the strains set up in the piece and due to the process of casting or forging, is eliminated, because practically all of these strains are due to a difference in the density of the metal lying on the outer surface of a rough casting or forging and that which composes the interior or body of the piece. For illustration, suppose we have a casting 1 1/2 by 3 by 18 inches and fairly straight; we put it on the planer and take a cut over one side removing approximately 1/8 inch from that surface; then we try a straightedge on this planed surface. The chances are that we will find the edge where the cut started in to be curved convex, and the edge where the cut finished to be fairly straight; while that side from which no cut was taken would be found concave, were it possible to apply the straightedge. Then we put the piece back on the planer and take a cut off the opposite side, after which we remove the clamps and pack up under the piece until it rests evenly on the table of the planer, clamp it lightly and take another light cut over it; then on removing the piece and trying a straightedge again, we will find the side over which the last cut was taken to be fairly straight, that the surface over which the first cut was taken has changed, that the edge on which the cut was started is now fairly straight instead of convex, and that the edge on which the cut finished is now concave instead of straight. This would go to show that the outer surface of the casting was in tension and the interior was in compression, or in other words, the outer surface contained a strain trying to make the piece shorter while the interior contained a strain trying to make the piece longer.

"In the case of the above-mentioned piece, neglecting for convenience the two edges, there were three forces acting on it; one on each side tending to make the piece shorter, and one in the middle tending to make the piece longer. When the piece was a rough casting these forces balanced each other and the piece remained straight, but as soon as we took a cut off one side of it, we removed one of the forces that was tending to make the piece shorter, thus leaving only two forces opposed to each other, and as one of these forces is on one side of the piece and one on the other, they are free to act, which they do, bending the piece so that it is concave on the side on which the strain is tending to make the piece shorter. When we take a cut off the other side we remove the one remaining strain acting to make the piece shorter, therefore leaving the piece free to assume its normal or straight condition.

"Generally a forging or a piece of cold-rolled steel will go in the opposite direction that a casting would, though cold-rolled stock is very uncertain and the strains are not always removed on taking a cut off the outside.

"It has been my experience that these strains exist in nearly all castings to a greater or less extent; for this reason, any piece of work that has to be very accurate when completed should have all the surfaces that are to be finished roughed out before any of the accurate dimensions are completed, else the machining of some unimportant surface might affect the accuracy of important completed dimensions, and, while it might not amount to more than 0.001 or 0.002 inch, it should be taken into consideration where accurate results are required. Of course, the shape of a piece would govern to some extent the amount it would be affected by such strains. Take for instance the piece we are working on; we would be pretty safe to plane up and finish all the surfaces that are to be planed before we bore the hole in the center, because boring the hole would not be likely to affect any of the other surfaces, and if it did the planed surfaces need only be accurate in this manner: the top and bottom must be parallel, and the side that is to be finished must be square to the top and bottom surfaces; the thickness of the piece and the distance of the finished side from the hole is immaterial within reasonable limits, and therefore if boring the hole should affect the accuracy of the planed surfaces it could be remedied without much difficulty.

"Well, I guess that we are about ready to start planing on this now. It seems to be chucked up all right."

"Now, Jim, there are two angle-plates that go to make a part of this jig and you may take them to a shaper and plane them. The only particular part of the job is to get them square. Plane them down until they are about an inch and a quarter thick, and take a fair cut off the ends and sides. The ends need not be perfectly square, but the sides and outside faces should be. Leave a good radius or fillet in the inside corner."

Jim had done quite similar work before and had no trouble in planing the angle-plates in a satisfactory manner, stopping once to help Mr. Anderson turn his piece over, and again when he was called to help get the piece off the planer and into the boring mill department As he was helping to get the piece

* For previous installments of this series of articles, see "Experiences of a Young Toolmaker," with accompanying references, August, 1910.

off the planer, he noticed that one side had been left roughly planed and asked if that was to be the bottom.

"No," said Mr. Anderson, "that is the top. I can finish that to better advantage in the boring mill; it will be the first surface that I finish after I get the hole and recess roughed out. You see, when I get it faced off so that it is parallel to the bottom, it will not be necessary to do any further chucking to get the recess right, as any error that exists will be easy to detect with the micrometer by measuring around the outside of the piece, and even such errors as are shown in this manner would be magnified."

When they got the piece on the boring mill table, Mr. Anderson called Jim's attention to the advantage of having the pin holes drilled in the proper place, it being an easy matter to chuck the piece in position and the results being much better then placing it in chuck jaws. "I will rough out the hole and recess first," said Mr. Anderson, "and then as there will be no more heavy cuts to take, I will loosen the clamps a little and take a light cut off the top, if it comes out parallel, which it should. I will then finish the hole and recess without disturbing the clamping. I guess that I will not need your help for a while, and you can go and finish up your angle-plates."

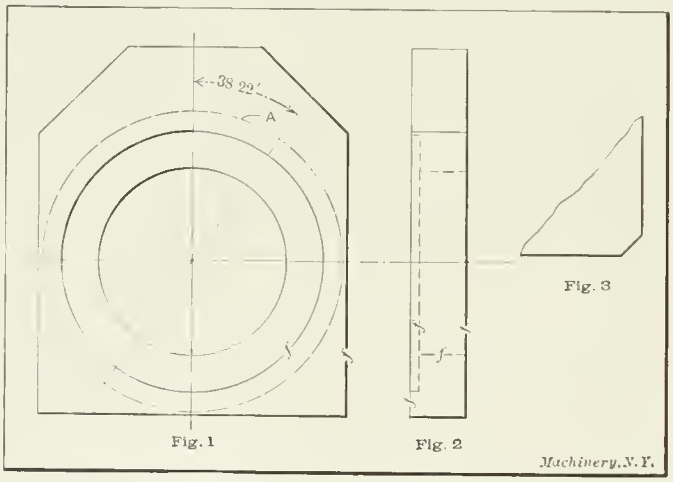
Jim got the angle-plates all planed, and then went back to the boring mill department to see what was next for him to do. He found that Mr. Anderson was nearly through. "Ready for some help?" he asked.

"Nearly," replied Anderson. "Have you got the angle-plates all planed?"

"Yes."

"See if you can find a sharp V-thread tool for me, no matter about the size as long as it has a sharp point."

Jim returned in a few minutes with a thread tool that he had ground to make sure that it was sharp. Mr. Anderson took it, and after stoning it to a smooth edge, put it in the tool pocket and brought it down onto the piece carefully, making a very light circular line on the top of the piece as large in



Figs. 1 and 2. Jig Baseplate and Desired Angular Setting of the Angle-plate. Fig. 3. Shape of Corner Recommended to avoid scratching Surface-plate

diameter as he could conveniently. (See broken line *A*, Fig. 1.)

"Now what did you do that for?" asked Jim.

"I shall use that line in laying out the angle to which the face of one of your angle-plates is to be set, as it is impossible to use a bevel protractor, and if I could it would not be as accurate as this way. You will see how it is done when we get to it."

"Couldn't you put it on with a pair of trams from a false center?"

"Yes, but false centers are rightly named—they generally *are* false—and I want that line to be as near right as possible. By putting it on in the machine, at the same setting that the hole is bored, I know that it is as near concentric with the hole as it can be gotten. Now we will get the piece on the truck and take it back to the toolroom. You get your scraper and I will get mine, as well as some files and squares, and then we will so some scraping.

"Now the first thing is to break all of the corners that are to be rounded over, that is, file them off like this." (See Fig. 3.)

"Why do we have to do that?"

"We will have to handle these pieces considerably and the sharp corners are disagreeable to the hands, and then on my piece there are several rough edges where the scale would come in contact with the surface-plate and would be likely to scratch it."

"But why not round them over now as long as it has to be done?"

"Because even though one is as careful as possible to clean all the dirt off the surface-plate before putting a piece on it, particles of dirt are liable to drop on the plate while rubbing the piece around on it, and a rounded corner is likely to draw these pieces of dirt in between the work and plate, which will scratch both, while an angle (as shown in Fig. 3) is more likely to push the particles along and keep the plate in better condition. In some shops it is the practice to file all corners off at an angle and not round them at all. I don't know but what it is just as good if not a little better, and it certainly takes less time.

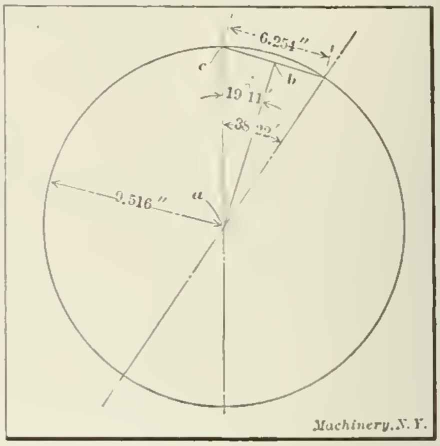


Fig. 4. Illustrating Method employed in laying out the Angle

"Now let us look your angle-plates over. This one is to have the bushing in it. It seems to be quite square, but this edge is a little the better. We will put the angle-plate on the base so that the best edge is toward the finished edge of the base, as our measurements will be taken from there. This will be the face that is bolted to the base and none of the corners of this face should be broken. These two faces and this side of the angle-plate must be scraped and spotted down so that they are perfectly square; the rest of the surfaces need only be scraped enough to smooth off the tool marks, and need not be spotted or squared. On this narrow angle-plate that is to locate the lugs of the cylinder, only the two outside faces need to be scraped up perfect and the rest of the surfaces need only be smoothed. The short end goes next to the base, so don't break any corners on it."

Mr. Anderson and Jim had just about finished scraping up the pieces when a helper came up with a cylinder on a truck and said, "The boss told me to bring this up here to you."

"Ah," said Mr. Anderson, "that is the piece that we are making this jig for. You see, Jim, these lugs are planed on a radial line through the center of the cylinder, and here where this boss is, a hole is required 38 degrees 22 minutes from the lugs, and 3 1/2 inches from the end of the cylinder. On the drawing the face of the lugs comes to the center line, but on the jig we will place *our* center line parallel to the edge that is finished, and set the cylinder on the jig so that the required hole comes on the center line of the jig. To put our center line on we will set the jig up on its finished edge and measure the distance from the edge of the hole down to the surface-plate. There are several ways of doing this, but we will use an indicator attached to a surface gage and an adjustable parallel; when we have the parallel adjusted so that when set upon the plate it is the same height as the lower edge of the hole, and have proved the same with the indicator, we have only to measure the thickness of the parallel with a micrometer to get the distance from the edge of the hole to the plate; to this distance we add half of the diameter of the hole and thus get the height of the center of the hole through which our center line passes. To this height we will set the scriber of a height-gage and scribe the center line. The next thing to do is to lay out another line passing through

the center at an angle of 38 degrees 22 minutes from the center line. To do this, we first lay the jig down flat and find the diameter of the circle that I put on in the boring mill. We take a pair of trams and set one leg on each side of the circle where the center line intersects it; you hold the trams in position while I examine the points with a magnifying glass to make sure that they are properly located. There! Now we will transfer the trams onto a scale and see what they measure—19.032 inches. Now we want to find the chord of 38 degrees 22 minutes with radius 9.516 inches, which is half of the diameter of the circle.

To make it clear, we will construct a diagram. (See Fig. 4.) We bisect the angle which gives us a right angle triangle *a b c*, which has a hypotenuse *a c*, 9.516 inches in length, and an angle of 19 degrees 11 minutes. The sine of 19 degrees 11 minutes is 0.32859, which multiplied by 9.516 is 3.12686,

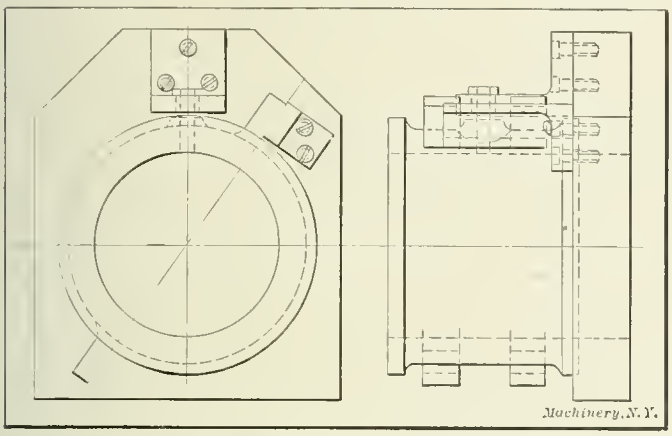


Fig. 5. The Completed Jig, and Work-piece in Place

and is equal to half of the required chord or *b c*. Multiply it by 2 and we have 6.25372, or 6.254 inches as the length of the chord.

"We set our trams to this distance, and with the point of one leg resting at the intersection of the circle at the top with the center line, we scribe a line crossing the circle at the right, and with the point of one leg resting at the intersection of the circle at the bottom with the center line, we scribe a line crossing the circle to the left. Now we have only to lay a straightedge across the piece with one edge of one end of it coinciding with the point where the chord intersects the circle, and the same edge at the outer end coinciding with the chord and circle at the opposite side of the circle. We will clamp it fast at each end and inspect it very carefully with a magnifying glass to see that it is in the proper position, and when it is we will take a scriber and scribe a line along the edge of the straightedge; this line will be 38 degrees 22 minutes from our center line.

"Now we can proceed to fasten on the narrow angle-plate. The long face comes just to the line; then when the cylinder is in the jig, and the lugs bearing against this angle-plate, it will be in such a position that the hole that is required will come in exact line with our center line, and now we have only to locate the angle-plate in which we place the bushing so that the center of the bushing comes parallel to the finished edge of the jig and the same distance from it as the center line, and of course have the bushing located in the angle-plate properly to get the hole the right distance from the end of the cylinder.

"Now you see why I wanted the circular line, and why I was so particular about having it accurate. We have used no bevel protractor, yet we have the angle more accurate than it would be possible to set a bevel protractor, to say nothing of the inconvenience, and practical impossibility of applying one in this case.

"The jig will be used on a horizontal boring mill, and to set it properly it is only necessary to place it on the table with the finished edge parallel to the boring-bar, and then line the bar up so that the drill enters the hole perfectly central."

The completed jig with the work-piece in place is shown in Fig. 5.

INTERNAL CUTTING TOOLS—2

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

In the previous installment of this article, particular attention was given to drilling operations, feeds and speeds, drill holders and drilling attachments. In this article, which is a continuation of the same subject, internal cutting tools, the following subjects will be reviewed: counterbores and counterboring, feeds and speeds and holders for counterbores; reamers and reaming, feeds and speeds for reaming, and reamer holders.

Counterbores and Counterboring

As a rule, more trouble is experienced in applying counterbores to the work on automatic screw machines than any other cutting tool. This is probably due to the fact that they are generally improperly made for the work on which they are to operate. Generally speaking, there are several reasons for the unsuccessful working of counterbores, some of which may be summed up as follows:

1. Too many cutting edges, not allowing enough chip space and also not providing for sufficient lubrication.
2. Too much cutting surface in contact with the work.
3. Insufficient clearance on the periphery of the teeth.
4. Improper location of the cutting edges relative to the center.
5. Improper method of holding the counterbore.
6. Improper grinding of the cutting edges.
7. Having too weak a cross-section.
8. Using a feed and speed in excess of what the tool will stand.

For general work, and especially for automatic work where the counterbore cannot be withdrawn when it plugs up with chips and seizes in the work, it should not have more than three cutting teeth. The periphery of the teeth should be backed off eccentrically and also be tapering towards the back. The amount of taper generally given varies from 0.020 to 0.040 inch per foot. As previously explained, the relation of the cutting edge to the center also has an important bearing on

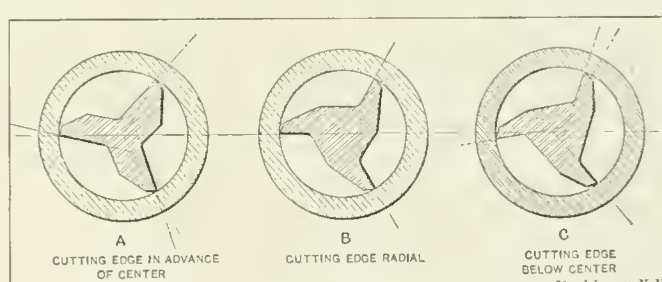


Fig. 11. Location of the Cutting Edges for Various Conditions

the efficiency of the tool. For deep counterboring where the difference between the diameter of the teat and the body of the counterbore is great, the cutting edge should never be located ahead of the center; in fact a little below the center would give far better results. This is only general, of course, as the material to a considerable extent governs the location of the cutting edges.

Location of the Cutting Edges

At *A* in Fig. 11 is shown a three-tooth counterbore with its cutting edges located ahead of the center. (These views are to be understood as looking on the front end.) Locating the cutting edge ahead of the center is advisable when the counterbore is to be used as a facing tool, or used for counterboring brass where it is not required to extend into the work to a depth greater than its diameter, but it should preferably be used for facing operations only. If the counterbore is made in this manner and used on steel, the cutting teeth have a tendency to force the chips against the surface of the work. Consequently when it is not properly lubricated, the work and counterbore become heated, and cause the chips to seize,

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thus producing poor work and generally resulting in a broken counterbore.

At B are shown the teeth cut radially with the center. For general work this is the best location for the cutting edges relative to the center. It has not the same tendency of forcing the chips against the surface of the work and will not heat up as rapidly. Cutting the teeth radially with the center is suitable for either brass or steel work, but when used on steel it is preferable to have the teeth cut spirally. A spiral which will give a rake of from 10 to 15 degrees generally gives the best results.

At C are shown the teeth cut below the center. This is the proper location for the cutting edges of the teeth where the difference between the diameter of the teat and the body of the counterbore is not very great, and where the counterbore is to extend into the work to a depth greater than its diameter. This as can be seen, gives a lip to the counterbore which has a tendency to lift the chips from the cutting surface of the work, thus not allowing them to seize.

Various Types of Counterbores

When counterboring a hole where a large amount of material is to be removed, and where the counterbore is to extend into the work to a depth greater than its diameter, it is generally advisable to rough out the hole to the diameter of the body of the counterbore with a three-fluted drill, such as shown at A, Fig. 12. Then the counterbore is used only for squaring up the shoulder at the bottom of the hole. This method is especially advisable when counterboring machine or tool steel.

At B is shown a counterbore which can sometimes be used to advantage on brass work, but is not advisable for steel. It is made on the same principle as a flat drill with the exception that the teat has two cutting edges. At C is shown another counterbore for brass work, which has three cutting edges, and at D is shown a counterbore for steel work, having

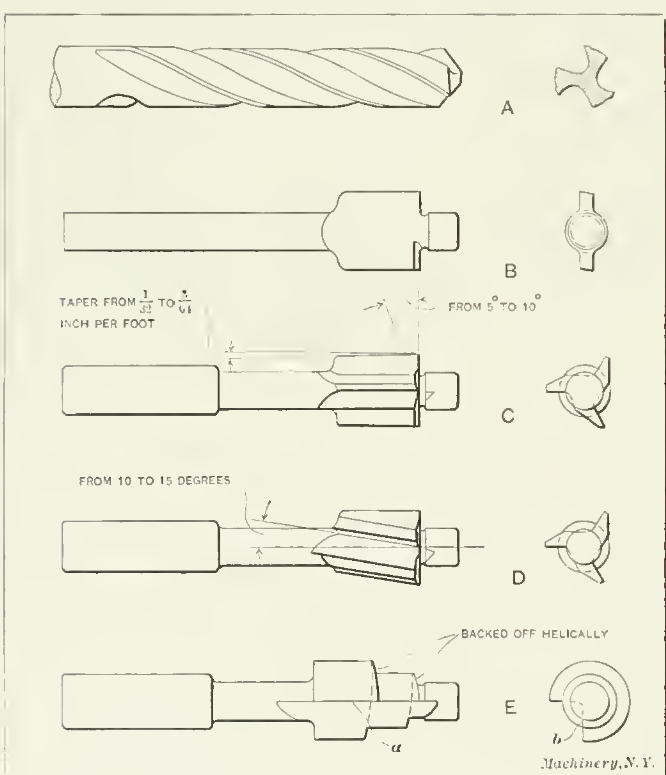

Fig. 12. Various Types of Counterbores

its teeth cut spirally. Having the teeth cut on a spiral which will produce a rake angle of from 10 to 15 degrees, is generally found suitable for machine or tool steel. Counterbores of the type shown at C and D should have inserted leaders or teats to facilitate their being re-sharpened.

At E is shown a counterbore which is recommended for work having complicated shapes, or requiring to have two or more diameters finished with the same tool. This tool is backed off helically as shown, thus allowing it to be ground and still retain its initial shape and size. The backing off is accomplished on the lathe in the following manner.

The lathe is geared up to cut six or eight threads per inch, depending on the diameter of the counterbore and the amount of clearance required. The counterbore after being turned to the required dimensions is milled as shown at b. It is then placed on the centers of the lathe, being driven by a dog, and a facing tool used for backing it off. The backing off is accomplished by pulling on the belt for each cut, starting and finishing at the groove b until the backing off is completed. Where a backing-off attachment which is operated by a removable cam is available this tedious operation can be accomplished with

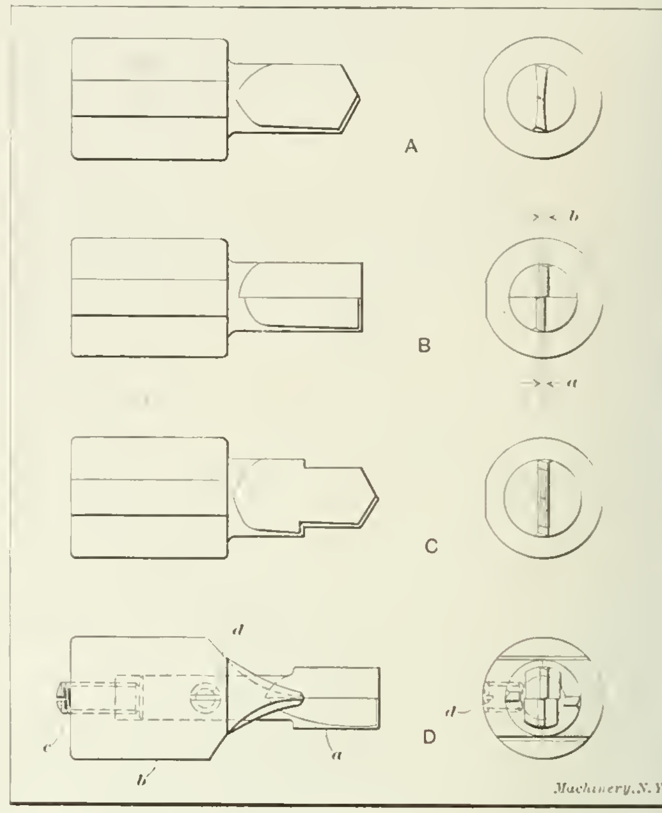

Fig. 13. Flat Drills and Combination Counterbores

greater ease and rapidity. The cutting edge a on a counterbore of this description should be radial with the center for cutting brass, but for cutting Norway iron, machine steel, etc., it should be cut spirally producing a rake angle on the cutting edge of from 10 to 15 degrees. The counterbores as previously described were for making pieces where the hole extended through the work or to a depth which admitted using a leader or teat; but for work where the hole bottoms, that is, does not extend far enough into or through the work, these counterbores could not be used. The ordinary method used in producing holes which bottom is to use flat drills and combination counterbores and facing tools.

Flat and Combination Counterbores

At A in Fig. 13, is shown a flat drill which is used for roughing out a hole having one diameter, and at B is shown the counterbore or facing tool which is used for squaring it up. The cutting edge a on the tool should be set about 0.10 inch times the diameter ahead of the center, and the thickness of the blade b should be about 1/8 of the diameter. At C is shown a flat drill or counterbore which is to produce a hole having two diameters, and at D is shown the combination counterbore and facing tool for squaring it up. This counterbore is made adjustable, the part a being adjusted out from part b by means of the headless screw c, thus governing the distance between the shoulders, the headless screw d being used to prevent the part a from rotating. When the part a projects out from the part b to a distance greater than one-half its diameter, care should be taken to have the shank a good fit in the part b. These counterbores can be used for either brass or steel work, but for steel work it is preferable to use a spiral drill for roughing out the hole, instead of a flat drill, as the material can be removed with greater ease and rapidity.

Speeds for Counterbores

The surface speed at which a counterbore can be worked is slightly less than the surface speed used for drilling. The surface speeds given below are recommended for counterbores made from carbon and high-speed steel.

SPEEDS FOR COUNTERBORES MADE FROM CARBON STEEL

Material	Surface speed in feet per minute
Brass (ordinary quality)	150-160
Gun screw iron	50-60
Norway iron and machine steel	40-50
Drill rod and tool steel	30-35

SPEEDS FOR COUNTERBORES MADE FROM HIGH-SPEED STEEL

Material	Surface speed in feet per minute
Brass (ordinary quality)	180-200
Gun screw iron	80-90
Norway iron and machine steel	70-80
Drill rod and tool steel	45-50

Feeds for Counterbores

The method of holding a counterbore when applying it to the work, and the strength of the cross-section in proportion to the width of the chip being removed, governs to a considerable extent the amount of feed to be given. The material being cut, and the depth to which the counterbore penetrates into the work, also has an important bearing on the rate of feed. These conditions should be taken into consideration when using the feeds given in Table IV. These feeds are for counterbores having three cutting edges, but for counterbores having one cutting edge the feed should be decreased from 40 to 50 per cent, and for two cutting edges, should be decreased from 15 to 20 per cent. Of course, it is obvious that no definite rule can be laid down in regard to the exact feed to use, on account of the number of conditions which govern the rate of feed. The feeds given in Table IV should be used only when the counterbore penetrates from one-half to three-quarters its diameter into the work. When the counterbore penetrates to a greater distance the feed should be decreased from 15 to 25 per cent. It is good practice to always drop the counterbore back after it has penetrated to a depth equal to half its diameter, to remove the chips, and to cool and lubricate it. The same method can be used for dropping back the counterbore as was given for deep-hole drilling in the preceding installment of this article.

Holders for Counterbores

For counterbores having leaders, a rigid holder should not be used, as the leader will follow the hole previously drilled or reamed, and if the counterbore is not allowed to float, it will produce poor work and sometimes result in a broken tool. At *A* in Fig. 14, is shown a floating holder which will be found very serviceable for the conditions just mentioned. The sleeve or shank *a* is made to fit the turret and is bored out from 1/32 to 1/16 inch larger in diameter than the shank of the holder *b*. The holder *b* is kept from turning by the driving pin *c*, which is made a driving fit in the part *b* and a loose fit in the part *a*. The hole in the part *a* should be about 1/32 inch in diameter larger than the pin *c*. The two headless screws *d* are used for adjusting the counterbore so that it will enter easily into the drilled hole. They also help to keep the holder *b* from turning. It is good practice, where possible, to chamfer the hole so that the leader will enter easily. The counterbore is held by the split bushing *e* and set-screw *f*.

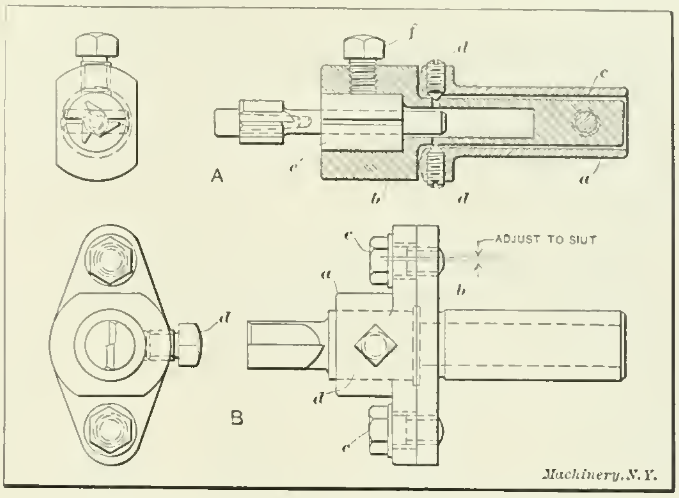

Fig. 14. Method of Holding Counterbores for Various Conditions

If this holder is properly made and set it will be found to give good results for general work.

At *B* in Fig. 14 is shown a "floating" holder for holding the flat counterbore shown. This holder in reality is not a floating holder, but would be better named an adjustable holder. It is made adjustable so that the tool can be set concentric with the center of the work. After adjusting, the part *a* is held tightly against the part *b* by the cap-screws *c*. The clearance holes in the part *a* for the cap-screws *c* are made about 1/16 inch in diameter larger than the body of the screw. The counterbore is held in the part *a* by set-screw *d*. This holder is also found very serviceable for holding a counterbore when the hole to be counterbored penetrates into the work to a distance greater than its diameter and a chucking drill has been used to rough it out.

TABLE IV. FEEDS FOR COUNTERBORES MADE FROM HIGH-SPEED AND CARBON STEEL

1/32-inch Chip				3/32-inch Chip				3/16-inch Chip			
Diameter of Counterbore in Inches	Brass Rod, Feed per Revolution	Mach. Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Diameter of Counterbore in Inches	Brass Rod, Feed per Revolution	Mach. Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Diameter of Counterbore in Inches	Brass Rod, Feed per Revolution	Mach. Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/8	0.0025	0.0018	0.0015	3/8	0.0040	0.0032	0.0020	9/16	0.0045	0.0035	0.0025
3/16	0.0030	0.0023	0.0020	7/16	0.0045	0.0035	0.0025	5/8	0.0048	0.0038	0.0028
1/4	0.0035	0.0030	0.0025	1/2	0.0050	0.0040	0.0030	11/16	0.0050	0.0040	0.0030
5/16	0.0045	0.0040	0.0030	9/16	0.0055	0.0045	0.0035	3/4	0.0055	0.0043	0.0032
3/8	0.0050	0.0045	0.0035	5/8	0.0060	0.0050	0.0040	13/16	0.0060	0.0045	0.0035
7/16	0.0060	0.0050	0.0038	11/16	0.0070	0.0055	0.0045	7/8	0.0065	0.0048	0.0038
1/2	0.0075	0.0052	0.0040	3/4	0.0075	0.0060	0.0050	15/16	0.0070	0.0050	0.0040
1/16-inch Chip				1/8-inch Chip				1/4-inch Chip			
1/4	0.0030	0.0028	0.0020	1/2	0.0050	0.0042	0.0025	11/16	0.0040	0.0030	0.0020
5/16	0.0035	0.0030	0.0025	9/16	0.0052	0.0045	0.0030	3/4	0.0042	0.0032	0.0022
3/8	0.0040	0.0035	0.0028	5/8	0.0055	0.0048	0.0032	13/16	0.0045	0.0035	0.0025
7/16	0.0045	0.0038	0.0030	11/16	0.0058	0.0050	0.0035	7/8	0.0048	0.0038	0.0030
1/2	0.0050	0.0040	0.0035	3/4	0.0060	0.0055	0.0040	15/16	0.0050	0.0040	0.0032
9/16	0.0055	0.0045	0.0038	13/16	0.0065	0.0058	0.0045	1	0.0050	0.0045	0.0035
5/8	0.0060	0.0050	0.0040	7/8	0.0070	0.0060	0.0050	......	......	......	......

Reaming and Reamers

When it is necessary to make a perfectly round and accurate hole in the work a reamer is used, the drilled hole being left slightly smaller to allow enough material for the reamer to true it up and bring it to the desired size. It is always advisable not to leave any more material to be re moved by the reamer than is absolutely necessary. For general work the amounts given in the following list will give good results for reamers ranging in diameter from 1/8 to 3/8 inch. For reamers over 3/8 inch diameter, a drill 1/64 inch

less in diameter is generally used, and this would leave from 0.012 to 0.015 inch to remove on the diameter, as it is obvious that a drill will cut slightly larger than its nominal size.

Diameter of reamer in inches	Diameter of hole previous to reaming, in inches
1/8	0.120
3/16	0.182
1/4	0.242
5/16	0.302
3/8	0.368

There are various reasons for the inefficient working of a reamer, some of which are the following:

1. Chattering, which results when the teeth are evenly spaced or of an equal number.
2. Chips clinging to the teeth, which action results when high periphery velocities are used and insufficient clearance given.
3. Expanding and contracting of the hole which is caused by too great a feed and insufficient clearance on the cutting edges.
4. Enlarged and tapered hole due to holding the reamer rigid instead of floating.

TABLE V. FEEDS FOR REAMERS MADE FROM HIGH-SPEED AND CARBON STEEL

Diameter of Reamer in Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/8	0.007	0.004	0.002
3/16	0.008	0.004	0.003
1/4	0.009	0.005	0.004
5/16	0.010	0.006	0.005
3/8	0.011	0.007	0.006
7/16	0.012	0.008	0.007
1/2	0.013	0.009	0.008
9/16	0.014	0.010	0.009
5/8	0.015	0.011	0.010
11/16	0.016	0.012	0.011
3/4	0.017	0.013	0.011
13/16	0.018	0.014	0.012
7/8	0.020	0.015	0.012

There are various methods adopted to prevent reamers from chattering, but the unequal spacing of the teeth has been found the most satisfactory and inexpensive. The effects produced by unequal spacing of the teeth were clearly explained in MACHINERY, May, 1910. For machine reamers varying from 1/8 to 1/4 inch three cutting edges are sometimes used, but the difficulty encountered in measuring prohibits their use to a certain extent. As a general rule four and six cutting edges are used on reamers varying from 1/8 inch to 3/8 inch, and 8 to 12 cutting edges on reamers varying from 3/8 inch to 7/8 inch. When reamers are cut with an equal number of teeth the cutting edges are generally spaced unevenly. A practical table illustrating an efficient method of irregularly spacing the cutting edges of reamers was given in MACHINERY, January, 1906.

Chips clinging to the teeth is generally due to high periphery velocities and improper lubrication, the clearance given to the cutting edges also heating the work to a considerable extent, which causes the chips to cling. The clinging of the chips is more noticeable on steel containing a small percentage of carbon than it is on brass or steels which contain a high percentage of carbon.

Reamers are generally made slightly tapering towards the back; a taper varying from 0.002 to 0.005 inch per foot is generally used and a less taper should be used for brass than steel, as brass work, especially thin tubing, contracts and expands more readily than steel, so if a perfect hole is desired the reamer should be tapered very slightly. For reaming machine steel a rose reamer is generally used, as it has been found satisfactory for producing straight and perfect holes. This reamer is made tapering towards the back and is not relieved on the periphery of the cutting edges, the end of the reamer only being backed off.

The cutting edges of reamers are generally cut on the center for steel, but for brass work they are sometimes cut slightly ahead of the center, which produces a scraping action, and makes a smooth cut.

Reaming Feeds and Speeds

The surface speeds used for reaming should be slightly less than those used for counterboring, as the reamer generally penetrates to a greater depth and has more cutting surface in contact with the work, which tends to produce excessive heating of the work and reamer, resulting in chips clinging to the cutting edges. As is known, chips clinging to the cutting edges produces rough and inaccurate work. For general conditions and where a good supply of lard oil is used, the following surface speeds will be found satisfactory.

SPEEDS FOR REAMERS MADE FROM CARBON STEEL

Material	Surface speed in feet per minute
Brass (ordinary quality)	120-125
Gun screw iron	35-40
Norway iron and machine steel	30-35
Drill rod and tool steel	20-25

SPEEDS FOR REAMERS MADE FROM HIGH-SPEED STEEL

Material	Surface speed in feet per minute
Brass (ordinary quality)	150-160
Gun screw iron	65-75
Norway iron and machine steel	50-60
Drill rod and tool steel	30-40

The feeds for reamers given in Table V will be found suitable for general work, when no more material is removed on the diameter than previously given. When reaming thin tubing, especially brass, the feed should be decreased somewhat as excessive cutting pressure tends to produce an imperfect hole.

Holders for Reamers

The method used in holding a reamer when applying it to the work governs to a considerable extent the quality of the hole produced. When reaming a deep hole, if the reamer is held rigidly, it will nearly always produce a hole which will be tapered and larger in diameter than the required size.

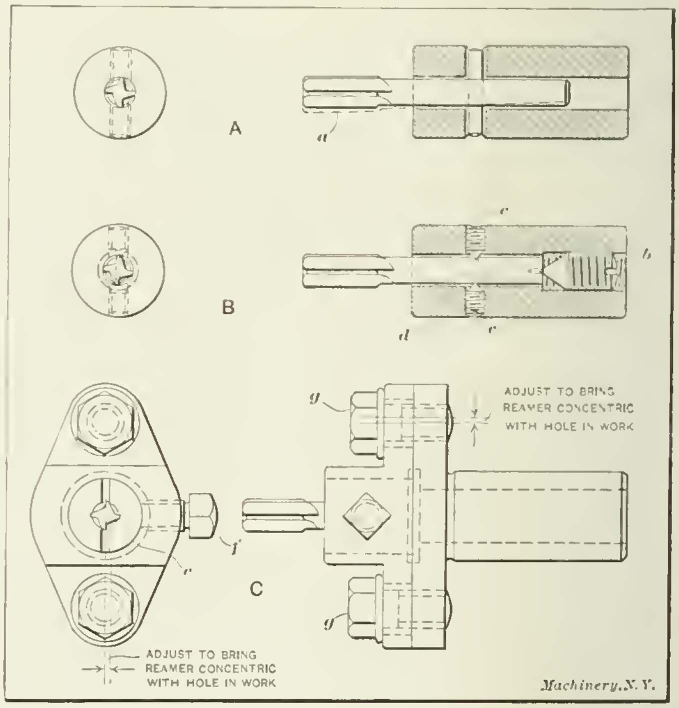

Fig. 15. Method of Holding Reamers for Various Conditions

At *A* in Fig. 15 is shown a floating holder which is sometimes used. This holder is cheaply made, but is not a commendable holder for automatic screw machine work, but can sometimes be used to advantage on the hand screw machine. One of the disadvantages of this reamer holder, is that the reamer drops down as shown at *a* if much clearance is allowed between the diameter of the reamer shank and the diameter of the hole, thus preventing the reamer from entering easily into the work, which generally results in a broken reamer.

At *B* is shown a more efficient holder, especially for deep hole reaming. The reamer is guided at the rear by a cone pointed screw *b* and is kept from rotating and guided at the same time by the two cone pointed screws *c*. By means of these screws the reamer can be set so that it will enter

the drilled hole easily, and at the same time be allowed to adjust itself to correspond to the eccentricity of the hole in the work. The small hole *d* is drilled through the shank of the reamer allowing the cone pointed screws to prevent it from rotating. This holder will be found very satisfactory for holding reamers when it is not necessary to remove an excessive amount of material. At *C* is shown a floating holder which is used for reaming shallow holes. The reamer is held rigidly by a split bushing *e* and set screw *f*. The reamer is set concentric with the hole in the work by loosening the cap-screws *g* and then locating it in the hole by the bevel or radius on the end. It is always advisable to do this when the spindle is not running, as otherwise the reamer may jump into the work and snap off.

* * *

MACHINE SHOP PRACTICE*

LOCATING WORK BY THE BUTTON METHOD

Among the different methods employed by toolmakers for accurately locating work such as jigs, etc., on the faceplate of a lathe, the one most commonly used is known as the button method. This scheme is so named because cylindrical bushings or buttons are attached to the work in positions corresponding to the holes to be bored, after which they are used in locating the work. These buttons, which are ordinarily about ½ inch in diameter, are ground and lapped to the same size and the ends squared. The diameter should, preferably, be such that the radius can be determined easily, and the hole through the center should be about 1/8 inch larger than the retaining screw, so that the button can be shifted.

As an illustration of the practical application of the button method, we shall consider, briefly, the way the holes would be accurately machined in the jig-plate in Fig. 1. First the centers of the seven holes should be laid off approximately correct by the usual methods, after which small holes should be drilled and tapped for the clamping screws *S*. After the buttons *B* are clamped lightly in place, they are all set in correct relation with each other and with the jig-plate. The proper location of the buttons is very important as their positions largely determine the accuracy of the work. A definite method of procedure that would be applicable in all cases cannot, of course, be given, as the nature of the work as well as the tools available make it necessary to employ different methods. In this particular case, the three buttons *a*, *b* and *c* should be set first, beginning with the one in the center. As this central hole must be 2.30 and 2.65 inches from the finished sides *A* and A_1, respectively, the work is first placed on a surface-plate as shown; by resting it first on one of these sides and then on the other, and measuring with a vernier height gage, the central button can be accurately set. The buttons *a* and *c* are also set to the correct height from side A_1 by using the height gage, and in proper relation to the central button by using a micrometer or a vernier caliper and measuring the over-all dimension *x*. When measuring in this way, the diameter of one button would be deducted to obtain the correct center distance. After buttons *a*, *b* and *c* are set equi-distant from side A_1 and in proper relation to each other, the remaining buttons should be set radially from the central button *b* and the right distance apart. By having two micrometers or gages, one set for the radial dimension *x* and the other for the chordal distance *y*, the work may be done in a comparatively short time.

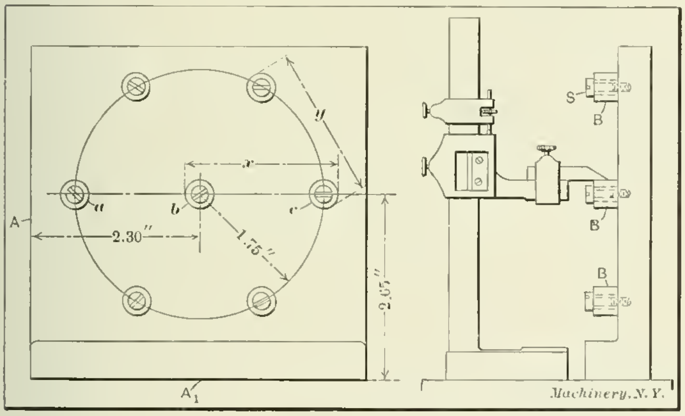

Fig. 1. Jig-plate with Buttons attached, ready for Boring

After the buttons have been tightened, all measurements should be carefully checked; the work is then mounted on the faceplate of the lathe, and one of the buttons, say *b*, is set true by the use of a test indicator as shown in Fig. 2. When the end of this indicator is brought into contact with the revolving button, the vibration of the pointer *I* shows how much the work runs out of true. When this pointer remains practically stationary, thus showing that the button runs true, the latter should be removed so that the hole can be drilled, bored and reamed to the required size. In a similar manner the other buttons are indicated and the holes bored, one at a time. It is evident that if each button is correctly located and set perfectly true in the lathe, the various holes will be to the required dimensions within close limits.

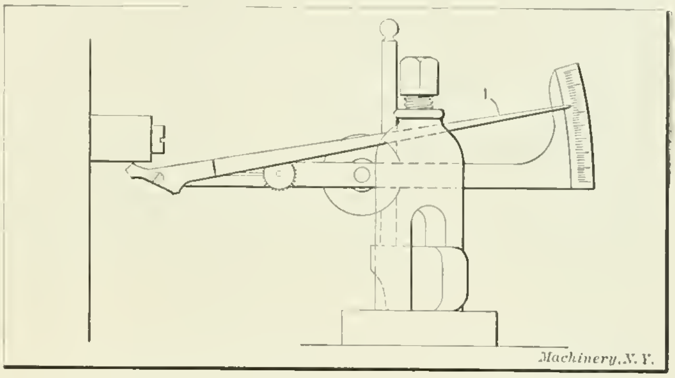

Fig. 2. Setting a Button True with a Test Indicator

When doing precision work of this kind, the degree of accuracy will depend upon the instruments used, the judgment and skill of the workman and the care exercised. A good general rule to follow when locating bushings or buttons, is to use the method which is the most direct and which requires the least number of measurements. As an illustration of how errors may accumulate, let us assume that seven holes are to be bored in the jig-plate shown in Fig. 3, so that they are the same distance from each other and in a straight line. The buttons may be brought into alignment by the use of a straightedge, and to simplify matters, it will be taken for granted that they have been ground and lapped to the same size. If the diameter of the buttons is first determined by measuring with a micrometer, and then this diameter is deducted from the center distance *x*, the difference will be the distance *y* between adjacent buttons. Now if a temporary wire gage is made to length *y*, all the buttons can be set practically the same distance apart, the error between any two adjacent ones being very slight. If, however, the total length *z* over the end buttons is measured by some accurate means, the chances are that this distance will not equal six times dimension *x* plus the diameter of one button, as it should, as even a very slight error in the gage would gradually accumulate as each button was set. If, in this case, a micrometer were available that would span two of the buttons, the measurements could be taken direct and greater accuracy would doubtless be obtained. On work of this kind where there are a number of holes that need to have accurate over-all dimensions, the long measurements should first be taken when setting the buttons, providing, of course, there are proper facilities for so doing, and then the short ones. For example, the end buttons in this case should first be set, then the central one and finally those for the sub-divisions.

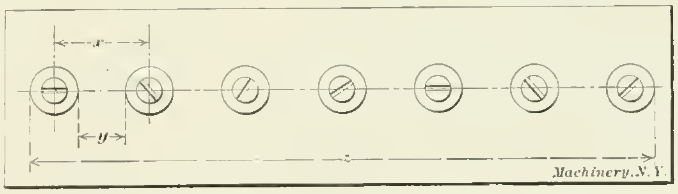

Fig. 3. Example of Work illustrating Accumulation of Errors

* With Shop Operation Sheet Supplement.

TAPER TURNING ON THE BENCH LATHE

By WALTER GRIBBEN*

The modern way of placing the slide-rest directly on the bed of a bench lathe has many advantages over the old method of having a shoe between the slide-rest and bed, especially when it is desired to do taper turning with the cross-slide, as is sometimes necessary. Those who have the old-style slide-rests can easily fix them so they will do all the "stunts" that the more modern designs are capable of by simply making a flat cast-iron washer of the same thickness as the shoe, and of a diameter not greater than the width of the shoe, the hole in the washer being a duplicate of that in the shoe, through which passes the holding-down bolt. By substituting this washer for the shoe as an occasional job demands, the cross-slide may be clamped at any angle with the bed that the work in hand calls for.

The job that was instrumental in making this washer an accomplished fact is shown in Fig. 1. This is made of ½ inch round Bessemer steel, and about 100 pieces were wanted. The point was to be turned to an angle of 60 degrees and the part *a* was to be just cleaned up with the turning tool, but was to be true with the point. The total length of the piece need not be very accurate. No screw machine was available for this job, so it was decided to cut off the stock with the power hack-saw and then do the turning in the bench lathe.

With the slide-rest as originally fitted up by the makers these pieces would have to be chucked twice; the slide-rest set first to turn the parallel part on all the pieces, and later set to turn the conical point, and each piece chucked a second time for this operation. If this had been done there would have been considerable uncertainty about the truth of the work when finished. Bessemer rod is not always exactly round, and the lathe was old and had been abused. It would have been extremely difficult to chuck these pieces a second time and have the part that was turned at the first chucking run true, so that scheme was abandoned as not even worth trying.

Another way that might have been used is to set the top slide around for each piece, turning the parallel part of the first piece and then setting the top slide around for the cone of that piece. When the second piece was chucked the cone might be turned first and the slide-rest afterward set for the parallel part. For the third piece the parallel part might be turned first, and so on. This would have been a very slow way, and the 60-degree parts might have varied somewhat among themselves as to the proper angle.

The way these pieces were actually made is shown in Fig. 2. A washer was made, as previously described, and put in place of the shoe under the slide-rest, so as to enable the cross-slide to be set at any desired angle. The top slide was first swiveled around 60 degrees from its usual position and clamped fast to the lower or cross-slide, after which the entire slide-rest was set around on the bed until the top slide would turn parallel when tried on a scrap piece. The pieces were then chucked and the parallel part turned by means of the upper slide, while the conical point was turned by means of the cross-slide, each piece requiring but one chucking, and the two parts being true with each other, according to specifications.

To Mr. A. E. Clark is due the credit of having first suggested and used this washer under the slide-rest. It is a very handy appliance when turning bevel gear blanks, especially if a number of one kind is to be turned at a time. Also it is very useful when making saw washers, which are much better if turned slightly dishing.

When the taper to be turned is almost flat, like the dished saw washer just mentioned, and an attempt is made to turn it by setting the top slide around, the cross-slide remaining on the regular shoe, the difficulty is encountered of having no good way to feed the tool in for depth of cut, as then the two slides are very nearly parallel, and if it is a job where the depth of cut is required to be measured by the micrometer disk on the feed screw, the micrometer will not denote the true value of the depth of cut, but its indications will have to be multiplied by the sine of the angle included between the axis of the feed-screw and the surface of the work being turned. The plain round washer under the rest eliminates these objectionable features, as the two slides of the rest may then be left at right angles to one another, so that the feed-in for depth of cut is not only more easily accomplished, but the depth of cut can then be correctly measured, if desired, by the micrometer disk on the feed-screw.

In the case of a lathe having raised V's on the bed instead of a flat top, it is not necessary to put V grooves in the bottom of the washer, but it may be left flat on the bottom and rest directly on the flat part of the bed between the V's, as shown in Fig. 3. It should be cut away adjacent to the V's, as shown, so as not to touch them. The total thickness

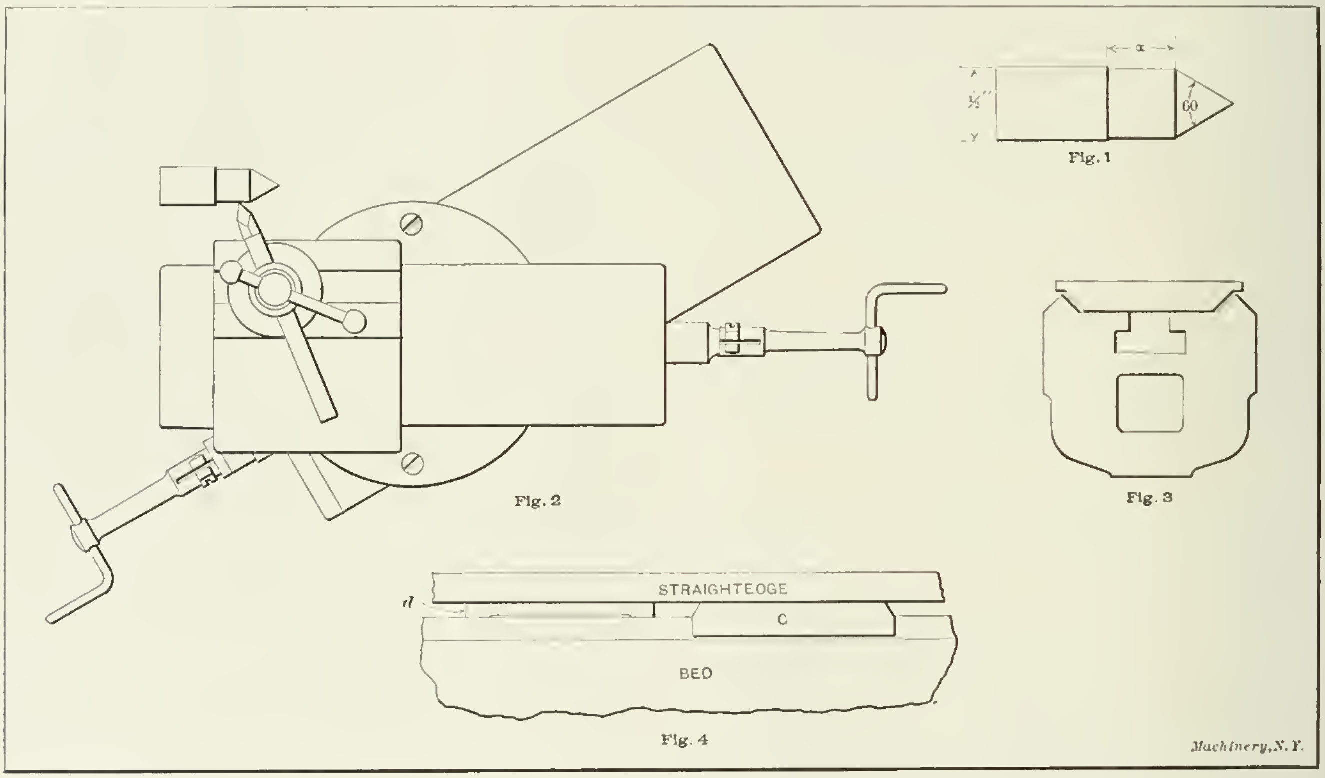

Fig. 1. Piece to be made. Fig. 2. Method used in making the Piece shown in Fig. 1. Fig. 3. Showing how Washer is placed under Slide-rest. Fig. 4. Showing how Washer is leveled up

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of the washer in this case should be such that when placed on the bed beside the regular shoe, a straightedge laid across their tops should touch both, as shown in Fig. 4, which is a front elevation, *C* being the original shoe, while *d* is the round washer.

Fig. 2 shows the extension handles that are put on in place of the regular ball handles when the top slide is set around very much, so as to avoid interference. These extension handles are made of a composition casting for the shank, bored out to fit the end of the feed-screw, split and closed with a pinching screw, while the cross handle is made of Bessemer wire bent to shape and soft-soldered in. This makes a good enough job for a handle that will only be used at comparatively long intervals.

* * *

PERTINENT POINTS ON JIG AND FIXTURE DESIGN

By T. COVEY

I read with considerable interest the article on the above subject by Mr. C. Nosrac, in the August number of MACHINERY. In fact, I am always interested in articles of that nature, and being a mechanic myself, I have some ideas of my own on the subject. I do not agree with Mr. Nosrac's idea of a correct design for jig bushings, though I will say that they might be permissible for the very small sizes.

He states that "the length of a bushing should be sufficient to support the drill on each side regardless of the fluting," and in his diagram designates the length of the drill bearing to be equal to the lead of the spiral of the drill. The angle of spirals of drills varies from 18 degrees to 35 degrees. The Cleveland Twist Drill Co. has adopted, after exhaustive experiments, an angle of 27 1/2 degrees as the most satisfactory for all classes of work. This angle makes the spiral groove of all drills start at the point with a pitch equal to six diameters of the drill; hence, according to Mr. Nosrac's standard, a bushing for a one-inch drill should be six inches long.

He also states that "the lower end of the bushing should stop about the same distance above the work as the diameter of the drill." Now as I look at it, the object of clearance between the bushing and the work is to prevent the chips from wedging between the bushing and the work and thereby springing the jig or wedging the work fast, so that it is difficult to remove it from the jig. I think that 1/16 inch on the smaller sizes, varying to 3/16 inch on the larger sizes, is ample to overcome this difficulty. I know of some designers who advocate placing the bushing as close to the work as possible without interference and thereby force the chips up through the bushing, but I think that is a poor plan.

He says further that "the heads of the bushings should be large enough to prevent the operator from starting the drill on the outside of the bushing instead of on the inside." In my opinion, an operator that would do that should be classed with one that would run a drill through the drill press table, or the spindle of the lathe—such a person should be immediately discharged. The heads of the bushings should be made as small as is consistent, leaving sufficient shoulder to locate the bushing properly, and in the case of fixed bushings the shoulder may be dispensed with entirely, as a matter of economy in stock and manufacture. The radius at the entrance of the hole should never exceed 1/32 of an inch because a larger radius decreases the length of the bushing acting as a guide, and makes it difficult work to locate the drill over the hole when the jig is fixed to the drill table, or base, or is too large to float into position. The lower end of the bushing should have very little or no radius at all so as to prevent the chips from drawing in between the drill and the bushing.

Mr. Nosrac also shows the lower end of the bushing slightly tapered to drive easily thereby, suggesting that the bushing should be considerably larger than the hole in which it is placed. From one-quarter to one-half thousandth of an inch larger than the hole is ample; more than this is liable to decrease the size of the hole and make it necessary to lap it out again, or to place a strain on the jig and impair its accuracy. If the corner is rounded just enough to prevent shearing the hole, and the bushing driven reasonably carefully no difficulty will be encountered. In his diagram he shows a long bushing with the diameter of the hole increased at the top "to prevent the drill binding on account of excessive bearing." All standard makes of twist drills are made with longitudinal clearance, which is obtained by decreasing the diameter from the point to the shank varying from 0.0005 to 0.0015 per inch, thereby automatically obtaining the desired clearance. If relief from the excessive bearing was considered desirable, the place to put it, from a mechanical standpoint, would be in the center of the bushing thus giving the drill the benefit of a more rigid guiding.

* * *

CONE-BELT SHIFTER

By ALVIN C. RENNER*

In operating large lathes having cone drives and driven by wide belts which are drawn tight, it is a difficult task to shift the belt from one cone to the other. We had this trouble in our shops, so I thought out a scheme for shifting the belt with greater ease and rapidity.

On one of our 30-inch three-cone engine lathes driven by a 4-inch belt we had to shift the belt onto the largest cone to

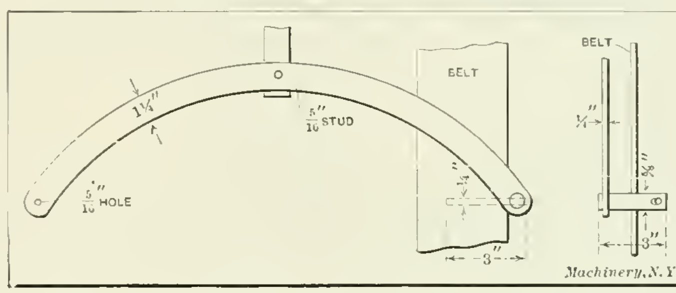

Fig. 1. Details of Cone-belt Shifter

get the desired cutting speed. When changing the speed from the larger to a smaller cone, the belt being drawn tight, made it difficult to shift. The belt could not be shifted by hand, so it was necessary for the operator to climb up on the lathe or use a long pole to shift it. To eliminate this difficult and slow operation, I devised the belt shifter shown in Fig. 2.

Taking a piece of 1 1/4 by 1/4 inch flat machine steel 24 inches long and bending this to a circular shape, as shown in Fig. 1, I drilled a 5/8-inch hole in one end and then drove in a piece

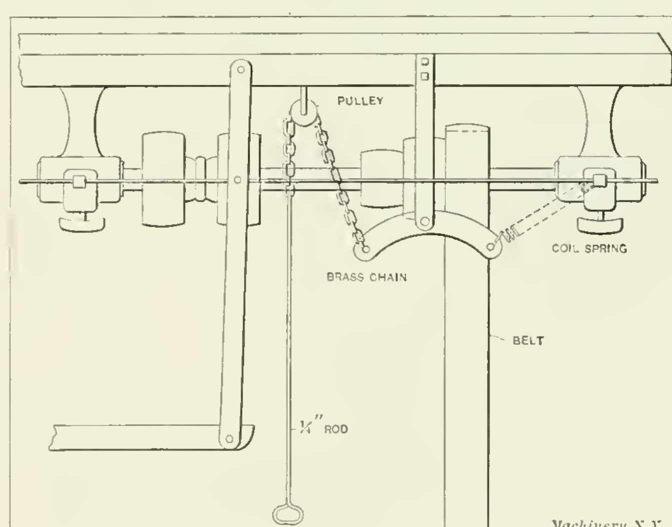

Fig. 2. View showing Cone-belt Shifter in Position

of machine steel about 3 inches long. Through one end of the 5/8-inch rod I inserted a piece of 1/4-inch rod about 3 inches long, bending it slightly on the end, as shown. The circular strip was then attached to a piece of flat machine steel, cut to the required length, by a 5/16-inch stud. This strip was then fastened to the countershaft block with two lag-screws. The other details of the shifter are clearly shown in Fig. 2, and will not require further explanation.

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LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DIE WITH AUTOMATIC STOP FOR BLANKING WASHERS

The following description of an automatic stop which is used successfully in blanking washers, three at a time, may be of interest to some of the readers of MACHINERY. The die shown in Figs. 1 and 2 was made similar to an ordinary die, but was held to the die bolster by means of four fillister-head screws, and four dowel pins, instead of being held in a bolster which is grooved, and the die set into it. Holding the die in this manner obviated the necessity of planing an angle on the edge of the die, and also held the die satisfactorily. As the way the die is made and held is clearly shown in Figs. 1 and 2, it will not be necessary to give any further explanation regarding it, so we can turn our attention to the stop, which is the main feature of this design. The two brackets *A* are made of cast iron, and passing through them is a rod *C* to which the stop is attached by a split knuckle *D*, this knuckle being held to the rod *C* by means of the cap-screw *K*. Two washers *E* are fastened to each end of the rod on the outside of the brackets, to obviate any longitudinal movement, but allowing it to rotate easily in the bracket *A*. The stop can be adjusted through the knuckle *D* by means of the adjusting nuts *F*. The manner in which this stop operates is as follows:

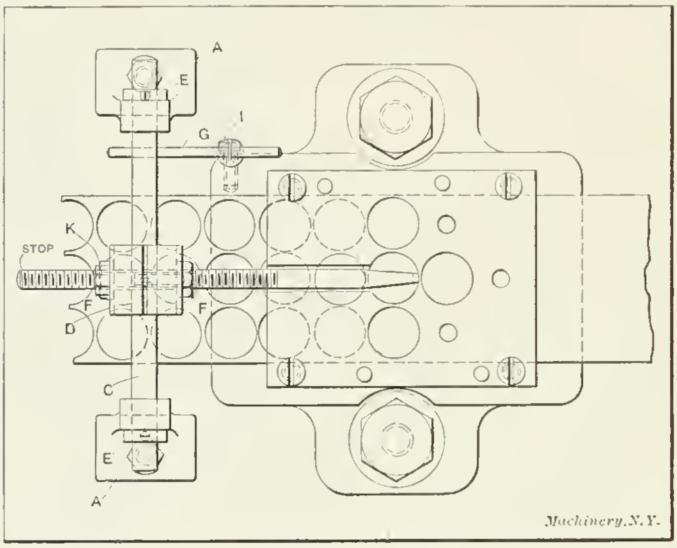


Fig. 1. Plan View showing how Three Washers are blanked with One Stroke of the Press

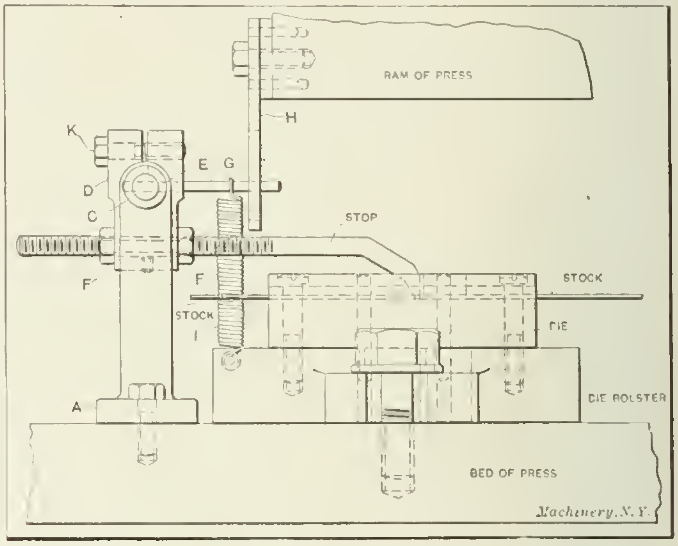


Fig. 2. Side Elevation showing how Automatic Stop is attached and operated

As the ram of the press ascends, the block *H* (Fig 2) which is fastened to the ram, as shown, and has a longitudinal slot in it, raises the pin *G*, which is driven through the rod *C*. As this pin is lifted it rotates the rod *C* and consequently raises the stop against the tension of spring *I*. When the stop is raised, the feed-rolls force the stock through the die, but the ratchet is so set that the stop drops before the stock has been fed the required distance. The feed used is the ordinary ratchet feed and is set so that it feeds 1/16 inch further than the required distance to compensate for any slip, such as often takes place in ratchet feeds which are used for punch and die work. By referring to Fig. 1 it can be seen that three washers are punched out with each stroke of the press, and as the press was operated successfully at 90 strokes per minute, it can be seen that this gave a large output in a day.

Philadelphia, Pa. CHARLES W. DORRICOTT

FOREMEN I HAVE WORKED FOR

A man who has worked in twenty-five states naturally meets a great many men of various types whose skill or experience has entitled them to a foremost position.

My first boss certainly had his troubles. There were about 16 boys ranging from fourteen to twenty years of age in the shop, and he had his work cut out for him to produce results. This he accomplished without being harsh with us. He just had the knack of getting along and also of helping others. I might say that at the present time George is superintendent of a large plant in the East, so I guess he still has the knack of getting along with the boys.

The remark of a lawyer in regard to the temper of one of the judges would just suit my next boss. He was the most even tempered man I ever saw. He was mad all the time. Whether the sun shone or it rained, he was always the same. It made no difference to him. We paid no attention to him and did as little as we possibly could to hold our jobs.

A man of ability could write a book on what happened at one place I worked in. It happened that the previous foreman—a man well-liked—had been discharged, and a Russian Jew replaced him. This man was hired just for the purpose of driving us, and being, in the language of the trade, "a bunch of boomers," we would not drive at all. We were all single—it was a small town which none of us liked—spring had arrived and most of us had worked from coast to coast and all were anxious to be on their way again. The only reason we did not strike was because we thought we could have more fun there than in any other place we knew of, and I think we succeeded. We slowed down our machines, did poor work, loafed half the time, and if a man was fired he cussed the foreman. The foreman had to take it because he knew if he resisted, he had to "lick" the gang. When one man was discharged the next man would be just as bad, so the foreman brought in a revolver with him one day and left it in his coat pocket over his desk, from which one of the men took it. The foreman asked one of the boys if he had seen anyone near his coat, that he had lost some valuable documents which he had in his coat. The boy told us, and the next day one of the men hung a glass revolver above his desk, with the sign "Valuable documents have been found." I never heard any more about this, as I left, and when I quit things were just as bad as ever.

Another foreman with whom I worked was the man who thought everything might come in handy some day. He had the floor and the benches piled up with scrap iron which was of no earthly use except to be in the way. If he found a horseshoe in the yard he brought it in saying that it might come in handy some day.

I think the meanest foreman a man could work for is the one who is incompetent and who makes lots of mistakes and gives wrong orders and then blames the man or men for the mistakes. I think most men have met this kind of a foreman, and if a person started a contest for the meanest man he would have first place. Friendship usually puts him in this position and the men have to suffer until the company wakes up.

I worked for one man who was stuck on his job and he was afraid he would lose it. He let us all know what a swell job he had and how many would like to have it. This kind of a man seldom has the best class of men working for him as he feels that in keeping a good man any length of time he will get his position, so he finds some means of dispensing with his services.

I might also mention the foreman who listens to tattling. The truth is that a man who tattles on his fellow workmen to the foreman usually tells on the foreman to the man higher up, so that the foreman who encourages tattling as a rule digs his own grave.

My experience has been that the best foreman for both men and company is the one who has a standard of work both in quality and quantity, insists on having a high standard and also insists, in return, that his men be well paid. This man has little to say during working hours except about business matters; he shows no partiality, never looks for trouble and keeps only the men who are good men in their particular line of work, and above all, is a competent man himself. With such a man the men and company are sure to be satisfied.

K. P. C.

A MOTOR CAR REPAIR JOB

Motor car repairing has brought us face to face with much that is novel and interesting, not to say a little perplexing, inasmuch as most of such work is double-tagged "rush," and expedients have to be employed that would be unnecessary if the work were allowed to take its regular turn. To the credit of machinists in general and for the benefit of car owners, who, by the way, are wont to discover that everything associated with the automobile has a special "high" price affixed to it, be it said that they take hold of such work with a zest that goes a long way toward a reasonable repair bill. All of which leads up to a job we did on the rear axle housings of a machine of the well-known Jackson make.

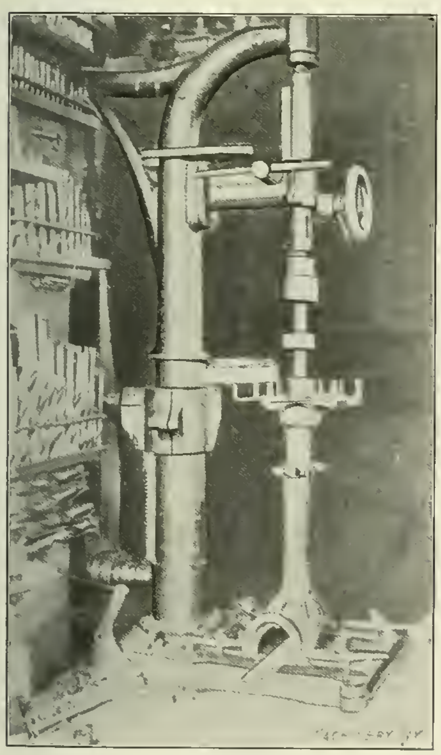


Fig. 1. How Rear Axle was set up to bore the Housing

During a winter's overhauling at a garage, the spiral roller bearings used on the axle had been removed and, in replacing, they had not been fastened in securely, thus permitting them to "work" until the housing was worn 1/16 inch on the top. It was proposed to bore it out and put in a sleeve that would obviate lost motion. Now this boring was really more formidable than its telling would imply, because of the brake and guard supports that were riveted to the housing as shown in Fig. 1. This construction dissipated any hope of getting a steadyrest within a foot of the end, so we turned to the drill press for assistance and, finding it easier than we expected, soon had a cut going.

Fig. 1 shows how the housings were clamped and bored. The rear axle was strapped lightly to the base of the drill press until it was brought directly under the spindle, and then fastened securely. At the end of the space occupied by the roller cage was a collar *R* (see Fig. 2), with a 1¼ inch hole which centered the boring-bar at the lower end and concentric with the original hole. A piece of 1¼ inch shafting was used as a boring-bar. To guide the upper end, a piece of cast iron *C* was bored, making it a sliding fit on the bar, and recessed to fit snugly over the end of the housing. Fig. 2 shows this cap *C* as well as the lower collar *R* in position for taking a cut when *C* is lowered into place.

To offset any lack of alignment in the machine, spindle and chuck, and also any error in setting, the boring-bar was made in sections. This "universal joint" consisted of a short piece of ¾ inch stock *D*, set in a 13/16 inch recess in the boring-bar *B* and connected by a ⅜ inch pin *P*. The ¾ inch

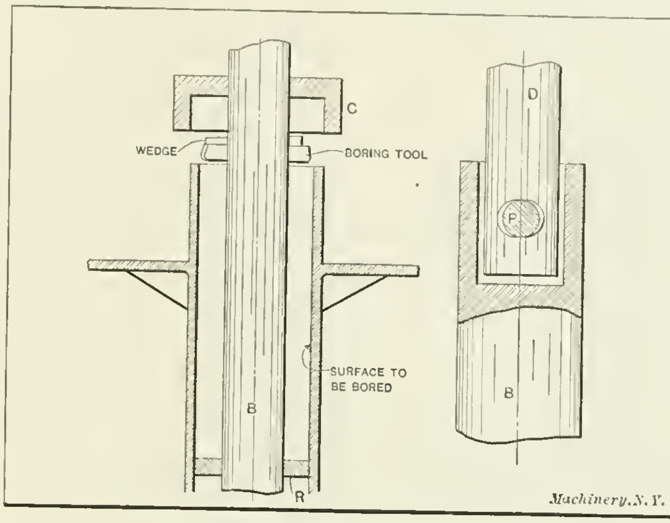


Fig. 2. Details of the Boring-bar and Method of Locating the Boring-bar in the Housing

hole was slotted sideways to allow for a certain amount of lateral movement should that be necessary from any lack of alignment.

Two cuts down the inside of the housing produced a perfectly round and straight hole. A piece of Shelby tubing machined inside and out was driven into the casing, which restored the rollers to their former position in contact with the axle. Before driving in for good, the usual diagonal slot was cut in the sleeve.

DONALD A. HAMPSON

Middletown, N. Y.

AN EFFICIENT FIXTURE FOR DRILLING LEVERS

In no branch of machine design can the draftsman exercise more ingenuity than in the design of jigs and fixtures, and the closer his acquaintance with practical machine-tool processes, the more successful he will be.

It is not always easy to determine the difference between a fixture and a jig, and in many cases their functions seem to overlap so far, that they must be considered as combinations. Broadly considered, a fixture is attached to, and is worked in conjunction with, a regular machine tool, while a jig is a device for holding a part of a machine to be operated upon, but which is not attached to the machine tool. Both have for their object the cheapening of production and the securing of greater accuracy of product.

The apparatus herewith described could be termed a jig, because it holds a lever to be subjected to the operation of drilling, and it might also be described as a fixture, with propriety, because it is bolted to the table of a drill press.

The levers to be drilled are of such a shape that it would be hopeless to try to attain accuracy and speed without the employment of this fixture, and as similar shapes are often encountered in machine construction, a close study of the tool cannot be otherwise than profitable to those who have to produce results. The lever to be drilled, Fig. 1, consists of a long central hub *C*, from the ends of which the journals that form the fulcrums, project. These journals govern the positions of all the other machined parts upon them. The pressure screw *A* transfers its action to other parts of the machine by means of its semi-globular point, and therefore its position need only be approximately correct, but the end *B*, being linked to accurately machined parts of the machine, must have the

center line of its hole exactly parallel with the center line which passes through the journals. Any deviation from correctness would not only add greatly to the cost of assembling, but would also destroy the accurate and smooth action of this joint. The problem is therefore narrowed down to the drilling of two holes, one of which may be approximately parallel with the plane in which the center line of the journal lies,

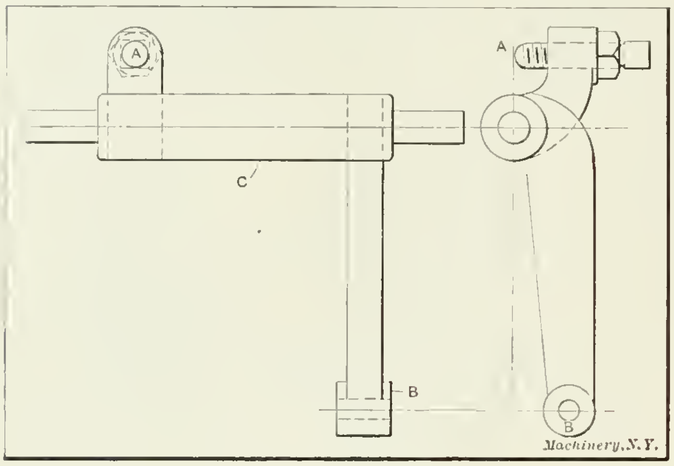


Fig. 1. Lever to be drilled

and the other of which must be parallel with the journal axis.

As the levers come to the drill press with the journals accurately machined, it is evident that this part of the lever is the proper point by which to support it. Necessarily the supports for the journals have to be parallel with the center line of the spindle of the drill press, and they have to be adjustable in that line in order to accommodate all the different sizes of levers. By the adoption of this simple and efficient fixture all the sizes may be drilled.

To accomplish this, a kneeplate *C* (Fig. 2) is provided whose base and vertical face are carefully machined at right angles with each other. The vertical limb of the kneeplate is made long enough to accommodate the largest of the levers, and is provided with a slot extending almost its entire length, for the accommodation of the supports for the journals. The supports consist of V-blocks whose sides subtend an angle of 90 degrees, and which are provided with projections entering into the vertical slot in the kneeplate, thus insuring at all times the parallelism of the V-blocks with the center line of the drill press spindle. A cap *D*, hinged to each V-block and fastened by a hinged bolt, secures the journals in the V-block and gives them the usual "three point" support as is shown in Figs. 2 and 3. As the levers project from the V-blocks from four to twelve inches, it is evident that a support *E*, shown in Fig. 3, has to be provided between the lever and the drill press table. This support must be adjustable by hand, and bear against the lever at three points around the hole to be drilled, so as to accommodate itself to any roughness or discrepancy in the lever casting.

The smallest lever has a ¼ inch hole through a ¾ inch boss and the largest lever has a hole 1¼ inch in diameter in a boss which measures 2¾ inches. As the hole in the support has to be slightly larger than the hole in the lever, so as to clear the drill, the hole in the largest support is made 1⅜ inch, and as the boss of the smallest lever is only ¾ of an inch, the largest support could not be used for the smallest lever, but one support is used for two sizes.

Figs. 2 and 3 show the construction of the supports. The foot *F* into which all the supports fit is a casting with a machined base, which sits loosely upon the drill-press table, its upper end being tapped for a 1 inch gas pipe. The supports *E* consist of pieces of gas pipe, fitting loosely into the foot so that they can be turned easily by hand. The upper end of the pipe is cut away so as to leave only four strips spaced at equal distances, which are bent to enclose the cast-iron cap *G* loosely. This cap is semi-spherical on the under-side, so that it may accommodate itself easily to the boss which is to be drilled. The flange around the edge of the spherical base which is enclosed by the bent strips of the pipe, serves to keep the pipe and cap together. The top surface of the cap is provided with three radial ribs which bear against the under surface of the boss on the lever.

A stand *H* is bolted to the table of the drill press, its upper end terminating in a boss into which hardened interchangeable guide bushings for the drills are inserted. These bushings are all of the same outside diameter with holes bored to correspond to the size of the drills used. There is a screw *L* under the guide bushing by which the location of the boss to be drilled can be regulated horizontally, so that all the holes will be drilled centrally in the boss. As no great accuracy is required in the location of the hole for the pressure screw in the opposite arm of the lever, the pattern is provided with a countersink where the hole is to be drilled, the latter operation being performed when the lever is taken out of the fixture.

A sample of each size of the levers is always kept on hand and when a lot of any particular size is to be drilled the proper sample is selected and by means of it the necessary adjustments of the fixture are made.

By means of the thumb-nuts *M* on the hinged bolts attached to the V-blocks the levers can be fastened into and taken out of the fixture without the use of a wrench. After the fixture has been properly adjusted and fastened to the table of the drill press by the foreman, an apprentice can turn out large quantities of very accurate work, and, at the same time, the breaking of drills is reduced to a minimum.

The lever shown in Fig. 1 is right-hand and the one fastened in the fixture, Figs. 2 and 3, is left-hand. The fixture is so

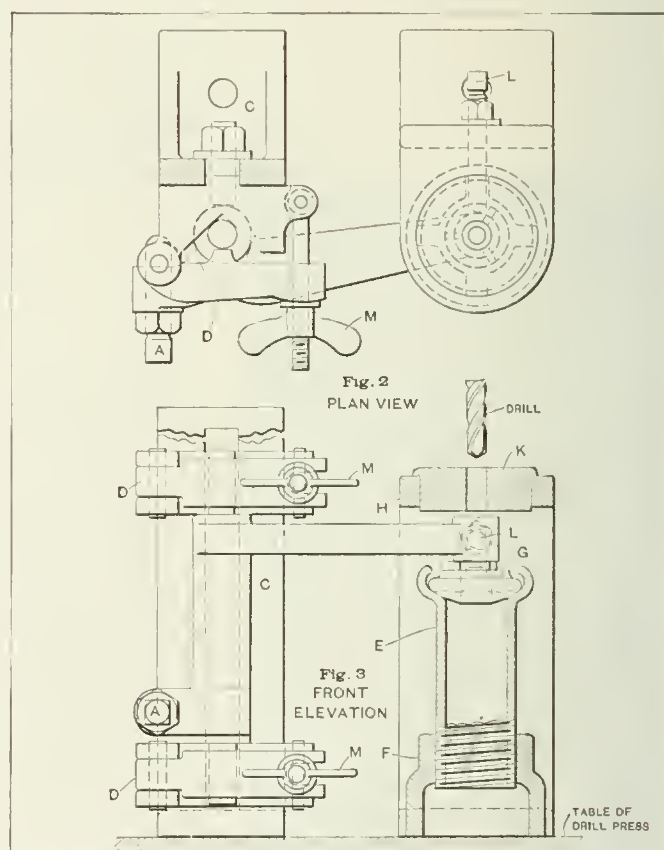


Fig. 2. Plan View of Fixture used in Drilling the Lever shown in Fig. 1. Fig. 3. Front Elevation of Drilling Fixture showing Method of Supporting the Levers

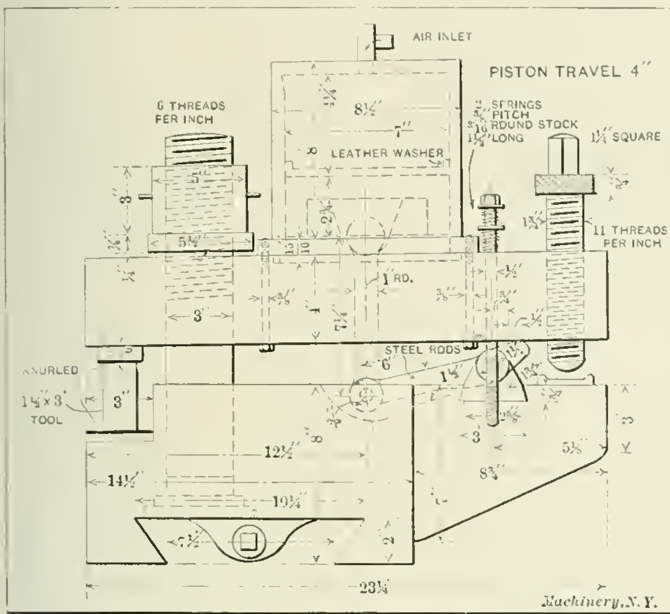
arranged that it will take both right- and left-hand levers. When left-hand levers are to be drilled, the kneeplate is fastened to the left of the drill press spindle, and when right-hand levers are drilled it is fastened on the right side.

When it is considered that there are twelve different sizes of levers and a right- and a left-one of each size, or twenty-four different pieces in all, and that a single fixture with twelve guide bushings and six pipe supports is all which is required to produce accurate work in large quantities, and by the cheapest kind of labor, the design of this fixture must rank as a very successful achievement. CHARLES C. KLEIN

Fox Chase, Philadelphia.

PNEUMATIC TOOLHOLDER FOR TIRE TURNING

With the advent of high-speed steel tools and powerful lathes for turning car wheels, the changing of the tools for each tire and each cut became a laborious and also a very difficult operation. When we consider that the tools have to be changed three times for each tire, and that it takes a short time to complete the turning operation, it is obvious that the amount of time and energy required to change and clamp the tools is enormous. To obviate this laborious and difficult work of clamping, the pneumatic toolholder shown in the accompanying illustration was designed. The pneumatic toolholder shown was used on a John Bertram 36-inch car-and-truck-wheel lathe. Forty pounds air pressure is carried



Pneumatic Toolholder used on John Bertram Car-and-truck-wheel Lathe

throughout the shop and this, in connection with the leverages in the toolholder, was found sufficient to hold the tools rigidly. Selected brands of 3 by 1 1/2 inch high-speed steel tools were used and a surface speed of 17 feet per minute for rough turning, with a cut 1/2 inch deep, and 1/2 inch feed per revolution. Formerly it was necessary to have two men on one lathe. Now it is possible for one man to operate the machine, as the necessary setting and clamping of the tools may be accomplished with ease and almost instantaneously. This holder has been successfully used for six months and has been found so efficient that all the tire lathes have been equipped with similar devices.

Canadian Pacific Railway Apprentice

CONVERTING A SIX-INCH VERNIER INTO A HEIGHT GAGE

Anyone having a six-inch vernier can, at small expense, convert it into a height gage, by making the additional parts shown in Fig. 1.

The outer jaw of the vernier must be ground square with the outer edge of the scale. The slot in the base is then cut deep enough so that the measurement from the bottom of the base to the inside of the jaw will be ¾ inch, plus allowance to be left for grinding, after the base has been hardened (see Fig. 2). Care must be taken in grinding to get the bottom and sides of the slot parallel and square with the bottom of the base. The slot should be wide enough to permit the solid jaw of the vernier to slide freely without side play. The jaw is then locked to the bottom of the slot by the eccentric binding stud, and the adjustable jaw clamped to the movable jaw of the vernier as shown in Fig. 2, when the gage is then ready for use.

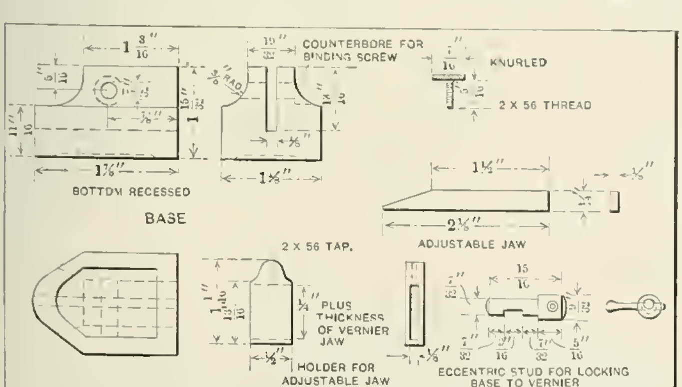


Fig. 1. Parts used for Converting a Six-inch Vernier into a Height Gage

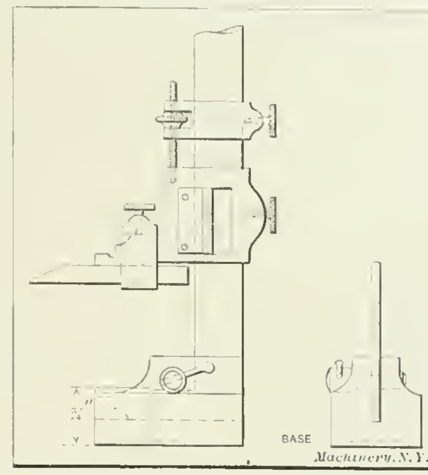


Fig. 2. A Six-inch Vernier converted into a Height Gage by using the Additional Parts shown in Fig. 1

W. C. Betz

New Britain, Conn.

A SETTING-UP TIP FOR SCREW MACHINES

In setting up hand screw machines and turret lathes, to obtain the desired length of the finished piece the operator usually keeps cutting off, measuring and adjusting until he arrives at the correct length; or, perhaps, he has a sample of the work to be produced. In this case he places one end of the sample against the cut-off tool and pushes the stop *A* against the other end, and then locks the carriage. See Fig. 1.

In the majority of shops, especially where most of the work is done from blueprints, and samples cannot be obtained, the first method described is in general use. The following method is my suggestion as an improvement: I would suggest the use of a narrow scale or "hook-rule," as it is commonly called. Most firms make this rule so that the hook can be easily removed. Fig. 2 shows how the scale is applied in measuring the length of the piece. One end is placed against the stop in the turret and the other passes into the spindle of the screw machine. The carriage is brought forward and the stop pushes the scale forward until the proper graduation is in line with the outer edge of the cut-off tool, and the carriage locked to the bed.

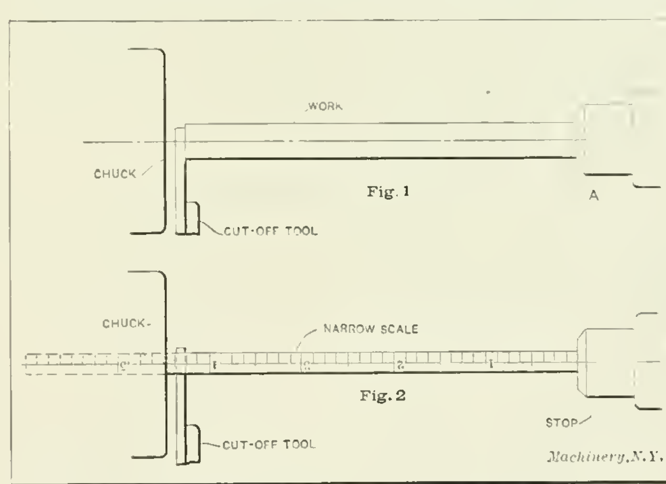


Fig. 1. Using Sample of Work for Setting the Stop. Fig. 2. Using a Narrow Hook-rule for Setting the Stop

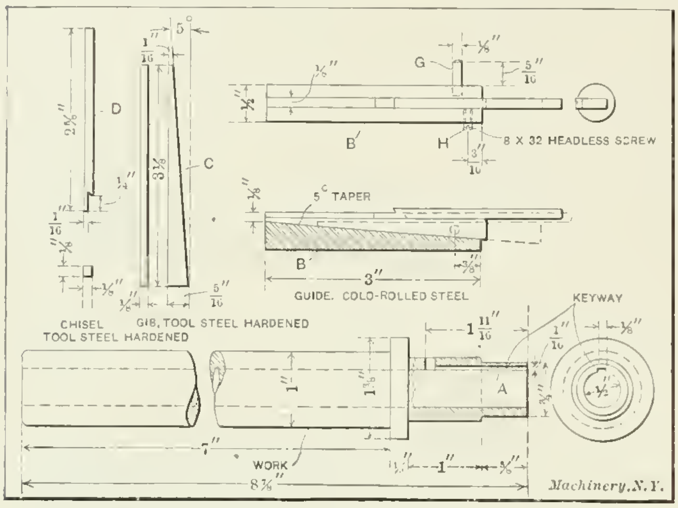
The narrow scale can be used on all work above 1/4 inch diameter, but if the screw machine collet is removed from the spindle, a wide flexible scale may be used instead. It takes but a minute to loosen the chuck cap and remove the collet, and this is done on most set-ups, anyway.

This method of setting up should be appreciated, as it saves time, labor and material, for several pieces are usually made too short when setting up by guesswork.

Designer

CUTTING A KEYWAY IN A SMALL HOLE

The accompanying illustration shows the tools which were used in cutting a keyway in a small hole, which I hope will interest some readers of MACHINERY. It can be seen from the illustration that the hole in the work was ½ inch in diameter and the keyway ⅛ inch wide by 1/16 inch deep. To accomplish this I took a piece of cold rolled steel *B*, ½ inch in diameter by 3 inches long. In this a groove was cut ⅛ inch wide and on an angle of five degrees as shown. A piece of tool steel *C* was then made with an angle of five



A Simple and Effective Device for Cutting a Small Keyway

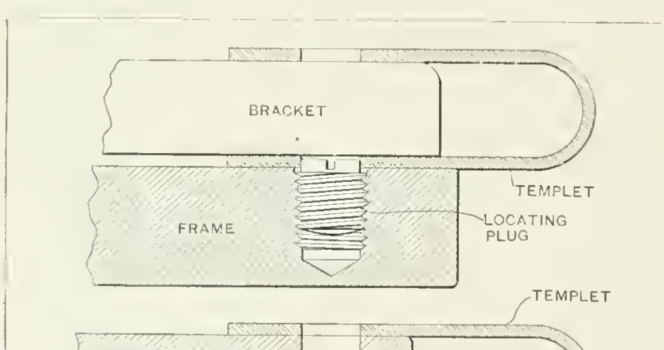
degrees to correspond with the angle on the piece *B*, and then the small chisel *D* was made from tool steel. A small dowel pin *G* was driven in the side of piece *B* to prevent it from being forced into the hole while cutting the keyway, and on the opposite side of the piece *B* a small headless screw *H* was used, which prevented the gib from slipping when the chisel was being driven on top of it. It can be seen that by releasing the headless screw the gib *C* can be moved forward a slight amount for each cut, and then the screw can be tightened, thus preventing it from going any further than the distance desired. This device worked very satisfactorily.

HARRY M. FOSTER

Belvidere, Ill.

LOCATING HIDDEN BOLT HOLES

In the August number of MACHINERY the writer described several methods of locating hidden bolt holes. The accompanying illustration shows another method which many mechanics consider far superior to the ones previously mentioned. The way in which this method is employed is as follows:



Locating the Position of Hidden Holes by means of a Bent Templet

Having obtained a piece of sheet metal of convenient width and length, bend it over somewhat in the shape of the letter U, with an opening sufficient to fit over the bracket in which the hole is to be located. Then take a piece of scrap which will just fill this opening. Place them together and drill a hole the proper size through the three sections as shown at *A*. This will bring the two holes in the templet in line, and at right angles to the flat surfaces. The templet is now placed over the bracket in the manner shown in the sketch and located with a plug of the proper size which is fitted into the tapped hole. With the parts located in this manner the position of the hole to be drilled through the bracket can easily be scribed by means of the templet.

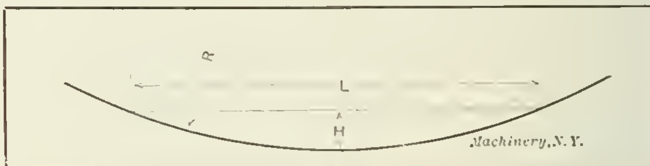
H. E. WOOD

Newark, N. J.

RADII OF CURVES

It is often necessary to find the radius of a large curve, the center of which is not accessible, the curve being, for example, a plate bent to partly cylindrical shape, a spherical end plate, or a templet for a brick arch. There are several ways of finding the radius, a common method being of taking a straightedge or a piece of string of an convenient length, placing it on the curve and measuring the height *H* (see notation in illustration above the accompanying table) between the straightedge and the middle part of the curve.

TABLE OF RADII FOR GIVEN CHORDS AND HEIGHTS OF ARCS



H Inches	Radius L = 6 feet	Radius L = 4 feet	H Inches	Radius L = 6 feet	Radius L = 4 feet
	Feet Inches	Feet Inches		Feet Inches	Feet Inches
¼	216 — 0	....	8¼	6 — 10 5/8	....
½	108 — 0	....	8½	6 — 8 ½	....
¾	72 — 0	....	8¾	6 — 6 7/16	....
1	54 — ½	24 — 0	9	6 — 4 ½	....
1¼	43 — 3	19 — 3	9¼	6 — 2 11/16	....
1½	36 — ¾	16 — 1	9½	6 — 1	....
1¾	30 — 11 ¼	13 — 9½	9¾	5 — 11 ½	....
2	27 — 1	12 — 1	10	5 — 9 13/16	....
2¼	24 — 0	10 — 9	10¼	5 — 8 ⅜	....
2½	21 — 8 ½	9 — 8½	10½	5 — 6 31/32	....
2¾	19 — 9	8 — 10	10¾	5 — 5 11/16	....
3	18 — 1 ½	8 — 1½	11	5 — 4 13/32	....
3¼	16 — 9	7 — 6½	11¼	5 — 3 7/32	....
3½	15 — 7	7 — 0	11½	5 — 2	....
3¾	14 — 8	6 — 7	11¾	5 — 1	....
4	13 — 8	6 — 2	12	5 — 0	....
4¼	12 — 10 ½	5 — 10	12¼	4 — 11 1/16	....
4½	12 — 2 ¼	5 — 6½	12½	4 — 10 3/32	....
4¾	11 — 5 ¾	5 — 3	12¾	4 — 9 7/32	....
5	11 — 0	5 — 0	13	4 — 8 11/32	....
5¼	10 — 6	4 — 9½	13¼	4 — 7 9/16	....
5½	10 — ½	4 — 7	13½	4 — 6 ¾	....
5¾	9 — 7 ½	4 — 5	13¾	4 — 6 1/32	....
6	9 — 3	4 — 3	14	4 — 5 9/32	....
6¼	8 — 10 ¾	4 — 1¼	14¼	4 — 4 5/8	....
6½	8 — 7	3 — 4½	14½	4 — 3 15/16	....
6¾	8 — 3 ¼	3 — 10	14¾	4 — 2 29/32	....
7	8 — 0	3 — 8¾	15	4 — 2 11/16	....
7¼	7 — 9	3 — 7½	15¼	4 — 1 13/16	....
7½	7 — 6 3/16	3 — 6	15½	4 — 1 9/16	....
7¾	7 — 3 ½	3 — 5	15¾	4 — 29/32	....
8	7 — 1	3 — 4	16	4 — ½	....

The radius can now be found by laying out the chord and the height on drawing paper, and, after having found the radius by trial, measuring it directly on the paper. A more accurate method is to calculate the radius from the formula:

$$R = \frac{H^2 + l^2}{2H}$$

in which R = radius of curve or arc,

H = height of circular arc,

l = one-half the chord.

This formula, in the same or slightly modified form, may be found in any mechanical engineer's hand-book. The accompanying table is calculated by this formula, assuming

the length of the chord to be 6 or 4 feet, with a height H varying from $\frac{1}{4}$ to 16 inches. The body of the table gives the corresponding radii in inches. A. WIND

Penn, Wolverhampton, England.

TURNING LONG SLENDER WORK

Turning long, slender work is a very difficult job on an ordinary engine lathe, but it can be accomplished with comparative ease when the tools here shown are used. At Fig. 1 is shown the piece which is to be turned, and it will be seen that the diameter is to be reduced from 0.187 inch to 0.096 inch for a distance of 3 11/16 inches. The die shown at Fig. 2 accomplished this in a satisfactory manner. This die is made similar to an ordinary threading die, except that it is not threaded, but is recessed as shown, the recess acting as a

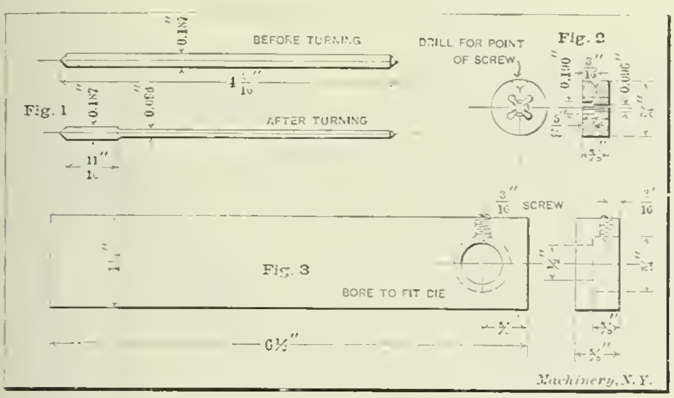


Fig. 1 Work before and after Turning. Fig. 2. The Turning Die. Fig. 3. Toolholder in which the Die is held

guide for supporting the work while being turned. The die is held in a piece of stock, Fig. 3, which, in turn, is held in the toolpost of the lathe. The piece to be turned, Fig. 1, is held in a chuck or collet held in the spindle of the lathe. The turning of the piece is accomplished as follows:

The die is inserted in the counterbored recess in the holder shown and held with a small headless screw. Then the holder Fig. 3 is set square with the faceplate of the lathe and the hole in the die set concentric with the piece to be turned by bringing the tapered end gently up against the flutes, allowing the spindle to revolve, and taking a light cut. The die and holder can then be drawn back, and if found to be cutting exactly right, the feed is thrown in and a good supply of oil used. After turning, if the piece is found to be small at the end nearest the chuck it is an indication that the die has been either set too high or too low, or to one side. By adjusting the die in the right direction this can be remedied. Pieces 11 inches long, of small diameter, have been successfully turned with this method, and although they are sometimes liable to bend slightly in advance of the die while turning, it will be found after cutting that they are perfectly straight. M. H.

A COMBINATION HEAD FOR POLISHING AND LAPPING

The accompanying illustration shows a head which will be found very convenient in small shops for lapping and polishing small parts. The manner in which this head is made is as follows:

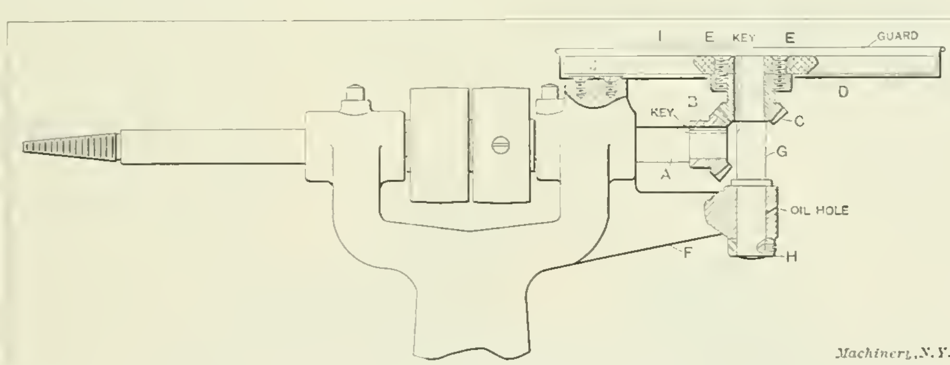
A spindle A as shown extends through the bearings and has fastened to it a loose and a tight pulley. To the left of the engraving is the arbor for holding the polishing brush or wheel, and to the right is shown a metal lap. On the end of the shaft A is keyed the bevel gear B, as shown, and this meshes with the bevel gear C which is attached to the metal lap D by means of the flat-head screws E. The bracket F, as shown, holds the vertical shaft G to which the bevel gear is keyed. A washer H is used at the lower end to prevent the bevel gears from getting out of mesh. A guard I is fastened to the head by two flat-head screws J, as shown. This guard keeps the oil and emery from flying around. It is obvious that when operating the lap, a slower speed will be necessary than when using the buffing wheel. This lap will be found very satisfactory if well made, and will be a valuable addition to any small shop.

Buffalo, N. Y. L. H. GEORGER

CONDUCTING A SUGGESTION DEPARTMENT IN THE SHOP

Every progressive company should encourage among its employes the practice of making suggestions for improvements in regard to their manufacturing methods, and at the same time give them the advantage of such suggestions as may be found helpful.

As many of the operators in every factory, by reason of their close contact with the work, can suggest improvements in methods and equipment or in some cases additions to the machinery and special tools, which would not occur to those not having their peculiar opportunities, they should have the advantage of suggesting what they think in regard to such matters. The company should post circulars in various departments outlining the principles and plan of operation of a suggestion department. A locked box should also be provided and placed in an accessible position where the employes may deposit their suggestions. These suggestions should be written out, and a carbon copy made of them, but the writer should not sign his name, retaining the carbon copy as proof that he was the originator of the suggestion. As often as convenient these suggestions should be taken up by the judges and considered. Preferably there should be five judges, consisting of the president of the company, he being president of the board, general superintendent, master mechanic and any other two officers whom they may consider advisable to have as members of the board. If these judges find any of the suggestions to be of sufficient value to warrant their adoption, wholly or in part, prize money should be distributed to those who have offered the suggestions.



Polishing and Lapping Head for Small Work

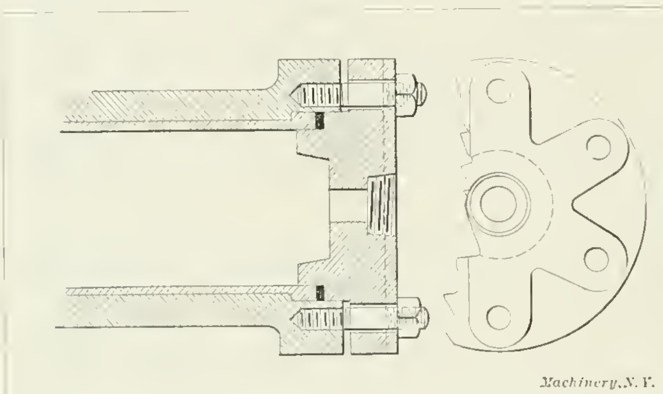
Suggestions for which prizes are to be given should be posted where they may be seen by all concerned and the employe who has offered the suggestion may present his carbon copy and receive the prize to which he is entitled by the decision of the judges. The following employes of the company should not be allowed to participate in offering suggestions: The superintendent, foremen, mechanical, electrical and civil engineers, draftsmen, and others who may be employed in designing or having other executive positions throughout the works. Only those who have no other means of offering suggestions, and have no other opportunity for testing their original ideas should be allowed to participate. This in many cases will be found an incentive to the men and draw out some ideas that might be of special value to the company in regard to their manufacturing methods. ARTHUR Z. WOLGAMOT

Peoria, Ill.

IMPROVED HYDRAULIC CYLINDER LINER

In reading the August number of MACHINERY, I was very much interested in the improved hydraulic cylinder liner which

was described by Mr. Brownstein. I think it is a step in advance of the old-style method which he described in Fig. 2, but why not take a few steps further? I apprehend that there is a chance of the improved packing blowing out. In fact, I have seen that type of packing blow out when it was put in by a careless workman, and as I have had considerable experience in this line, I would suggest that the method shown in the accompanying illustration be used, as I have found it to work very satisfactorily. It will readily be seen that this design if



Method of Inserting Packing so that it cannot blow out

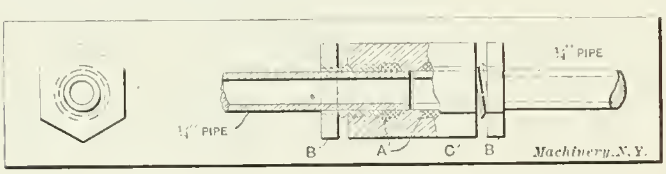
properly fitted will not admit of the packing blowing out. In fact, the packing is so hemmed in that even if it was not fitted with extreme care, it would seldom give any trouble. In this case, it is advisable to use sheet lead instead of copper, as it lessens the expense. This can be used satisfactorily when a design of this description is adopted.

It will be noticed in the engraving that the cap is ribbed, thus saving metal. All that is required is just enough metal to overcome the strain plus a certain factor of safety. After that all the surplus metal put in a casting is waste.

Newark, N. J. H. E. Wood

STUFFING-BOX CONNECTION FOR SMALL PIPES

The accompanying illustration shows a method for connecting small pipes which was found very satisfactory. The stuffing box *A* has a hole drilled through it which should preferably be reamed. It is then tapped in each end to fit the



A Simple and Effective Connection for Small Pipes

glands *B*. At the front end of these glands a lead strip *C* is wound around the pipe so that when the glands are screwed up tight they compress this lead, thus making a steam- or water-tight joint. Where the space is limited, the glands can be made without a head, being flush with the ends of the part *A*, and two small holes drilled in the end of them so that they may be tightened by a spanner, thus reducing the length of the stuffing-box, which is sometimes necessary.

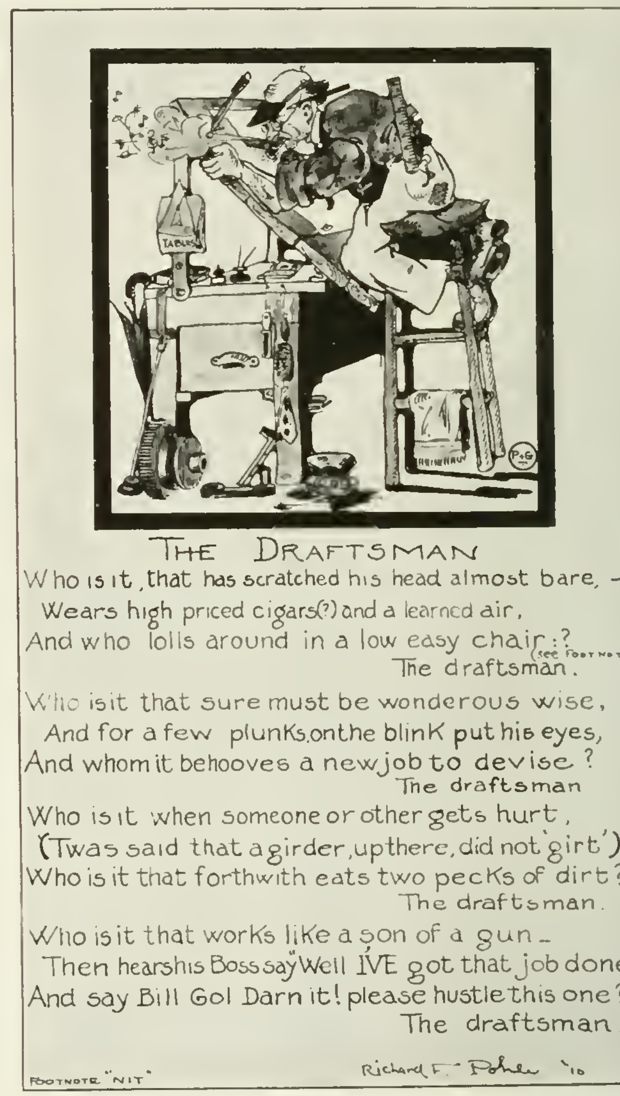
Buffalo, N. Y. Charles Weslow

STARTING A DRILL IN THE LATHE

In boring holes in work which is held in a chuck, it often happens that the hole must go through solid stock, consequently the greater part of the stock must be removed with a drill held in a suitable holder in the tailstock or in a chuck. In most cases it is the practice of nearly every one to make a countersink in the work with a tool held in the toolpost, which is commonly called a centering tool. This gives the drill a chance to start and keeps it concentric with the work. This method involves very accurate grinding and locating of the tool, and, except in certain cases, it is unnecessary. I have found that a very quick and accurate method of centering the drill in the work, is to face the work off square, not making any countersink whatever; placing the drill in the chuck or holder, as the case may be, and centering the drill as near as possible. Then select a lathe tool that is square across the back end and place it in the toolpost so that it will clear the end of the work and be in such position that when fed forward it will bear against the lip of the drill until it appears to be central. Then start the lathe; feed the drill in a little, as is necessary to get the central position, back the tool away from the drill and if it is central proceed to drill the hole; if not repeat the operation again. This procedure is followed until the drill begins to cut to the full size. After a little practice this method can be used unless the drill is very small or in case the work projects so far from the chuck that it has a tendency to spring.

Webber, Kan. J. N. Bagley

THE DRAFTSMAN



* * *

Cast nickel-bronze gears are, according to *Castings*, employed in certain cases in which cast-iron gears have not the necessary strength and toughness, and cast-steel gears are unsatisfactory on account of their lack of uniformity. The alloy for these gears consists of 86 per cent of copper, 10 per cent of tin, 3 per cent of nickel, and 1 per cent of 5 per cent phosphor-tin. The nickel is melted with about 25 per cent of the copper, after which the rest of the copper is added. Then the tin is added, and finally the phosphor-tin, the mixture being well stirred.

* * *

The Cunard steamer *Mauretania* made the western passage over the Atlantic on the short course of 2780 knots in four days, ten hours, and forty-one minutes, arriving in New York September 15. This record is ten minutes less than the *Mauretania's* best previous record.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

CINCINNATI UNIVERSAL GRINDING MACHINE

The universal grinding machine, front and rear views of which are shown in Figs. 1 and 2, respectively, is the product of the Cincinnati Grinder Co., Cincinnati, O. This machine is adapted to the grinding of cylindrical work (either straight or taper), chuck and faceplate work (either internal or external), and, in addition, it can also be used to advantage for grinding gages, dies, jigs and fixtures and other miscellaneous work found in the average shop and manufacturing plant.

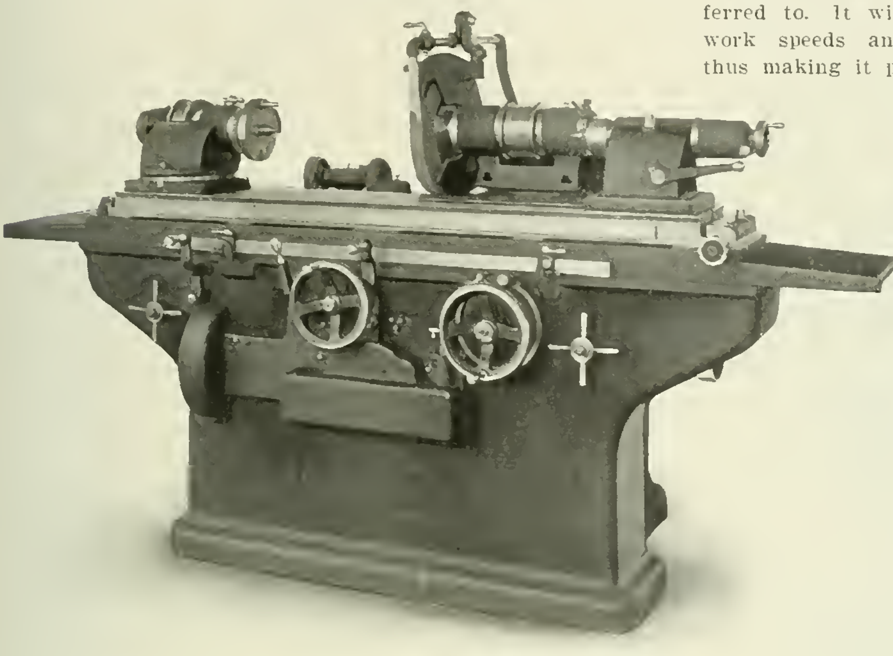


Fig. 1. Universal Grinder built by the Cincinnati Grinder Co.

This grinder is fitted with speed and feed boxes that enable the operator to obtain instantly, from a central position in front of the machine, any speed or feed with which the machine is provided, thus eliminating overhead cone pulleys and mechanical speed-changing devices. The entire overhead works required for driving this machine consists of a drum and a single shaft carrying four pulleys; the headstock has only one pulley for both live- and dead-center grinding. The table has a variable tarry at points of reversal, and the wheel is provided with an automatic cross-feed and a positive stop for use in the production of duplicate diameters.

The feeds and speeds of the table and work-spindle are regulated by the two speed change boxes shown attached to the rear of the machine in Fig. 2, the one to the right being for the table feed, while the one to the left regulates the work speed. The drive is through the upper pulley to the right, which is mounted on a shaft that transmits power to both speed boxes. The different feed and speed changes are controlled by the small pilot wheels shown at the right and left sides of the machine in Fig. 1. These wheels are mounted on shafts which pass through the bed and on the ends of which are pinions meshing with rack teeth cut in the sliding members to which the diving keys of the change gears are attached. One of these connecting shafts is clearly shown in Fig. 2, while Fig. 3 shows a sectional view of the speed-change box through which the overhead drum for the headstock spindle is driven. This illustration shows clearly how the speed changes are obtained by shifting the diving key by means of the rack-and-pinion movement referred to. It will be seen that by this arrangement, the work speeds and table feeds are entirely independent, thus making it possible to use the correct table feed for a given work speed. A single lever, convenient to the operator, furnishes means for instantly starting or stopping the rotation of the work and the travel of the table in conjunction with each other.

The wheel-stand slide, which is mounted upon long and wide ways, is so arranged as to preclude the possibility of any jumping or sticking action or of lifting under heavy cuts. This slide swivels and it has a graduated base. The transverse movement is controlled and adjusted by a handwheel on the front of the machine, which is graduated to read in thousandths of an inch on the diameter of the work. A finer hand-feed, graduated to read in quarter thousandths on the work diameter, is available by locking the automatic cross-feed and turning the thumb-wheel to obtain the adjustment required. The wheel-stand is amply proportioned to resist the most severe service, and it is rigidly supported by a pedestal which is cast integral with the base and extends to the floor. The wheel spindle runs in phosphor-bronze boxes that are provided with means of compensating for wear. It is made of carbon steel and is hardened, ground and lapped.

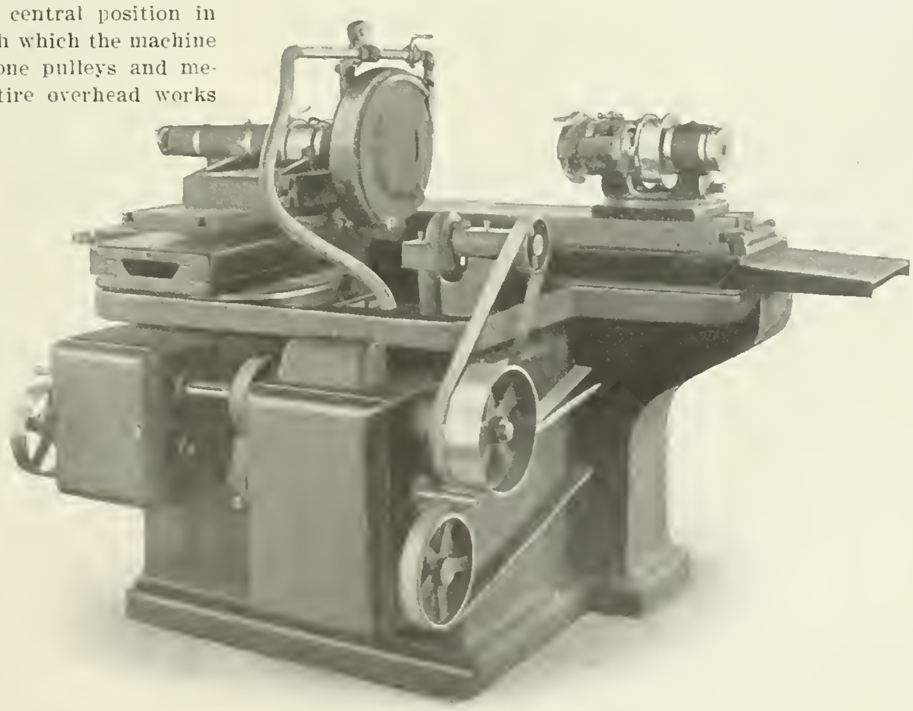


Fig. 2. Rear View of Grinder showing the Feed and Speed Boxes

The automatic cross-feed covers a range varying from 0.00025 inch to 0.005 inch at each reversal of the table, thus giving feed changes fine enough for producing a high finish on delicate work and coarse enough for the rapid removal of stock

on heavier parts. This feed can be set, of course, to automatically disengage when the work has been reduced to the required size, and it is regulated by the simple turning of a thumb-wheel that is conveniently located.

The table has a reciprocating motion on the ways of the main base casting that is controlled by adjustable dogs operating against a reversing lever which actuates a clutch of the load-and-fire type contained in the automatic feed-plate. The latter is a complete unit that is bolted to the front of the machine so as to be readily removed at any time. As before stated the table travel is entirely independent of the work speeds or the speed of the wheel, which permits traversing the work at each revolution a distance equal to the full width of the wheel face—a desirable feature when removing stock rapidly. The swivel table, which is mounted on the sliding table, pivots on a large, hardened and ground central stud. The swivel table can be set at an angle with the ways when grinding tapering work. It is graduated to read in degrees and taper in inches per foot. The adjustment is made by rack and pinion at the right end of the table, and the direct reading scales indicate its position. When it is necessary to move the table through a greater distance than that covered by the graduation marks, no special disconnection is necessary as the adjusting device is so designed that it leaves the table free to swivel through an arc limited only by the wheel-slide.

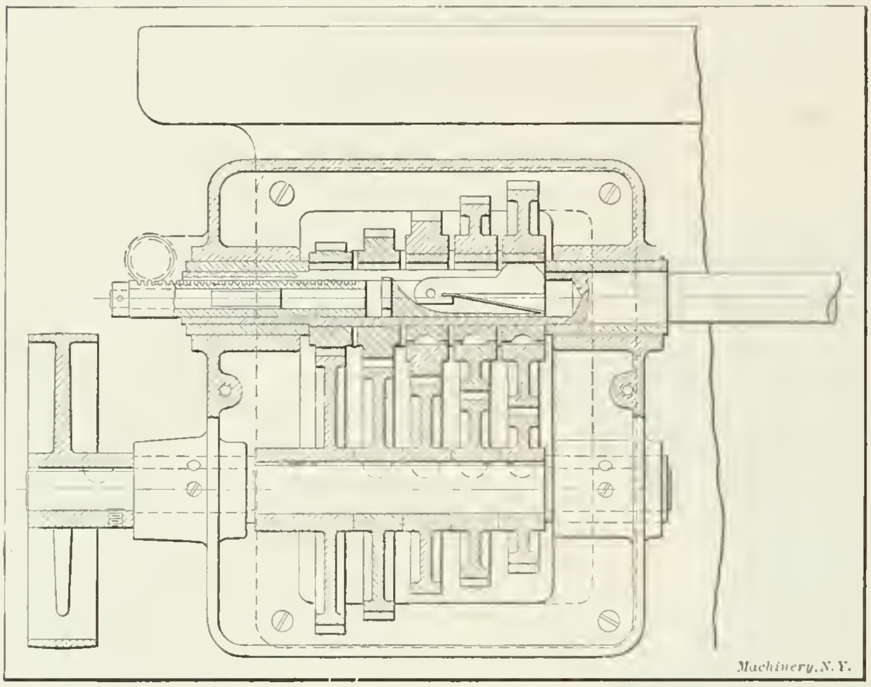


Fig. 3. Sectional View of One of the Speed Boxes

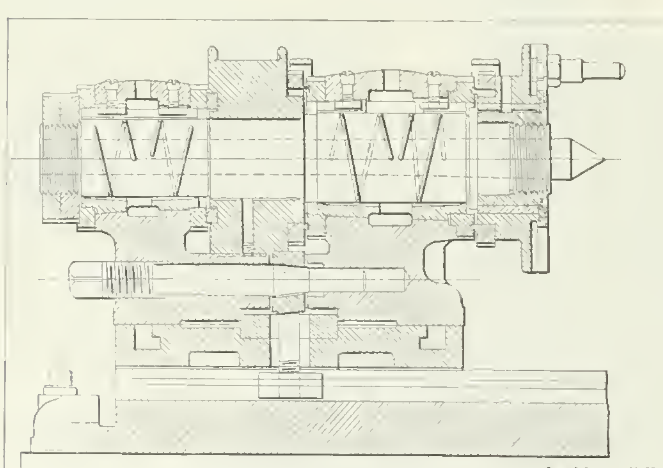


Fig. 4. Sectional View of the Headstock

The headstock, a sectional view of which is shown in Fig. 4, swivels, has a graduated base, and is locked to the swivel table by means of a large stud-bolt sliding in a T-slot. This bolt and the conically-ended screw by which it is tightened, are clearly shown in the engraving referred to. The spindle is hollow, hardened, ground and lapped and runs in bronze boxes which are provided with means for taking up wear. The work is revolved through gearing when grinding on dead centers, which transmits motion from the single pulley to the faceplate. When it is desired to grind on live centers, the pulley is locked to the spindle. The headstock is kept in alignment by the use of an inverted V of the lathe type, which is depressed so that it does not project above the table surface and thus interfere with the clamping of attachments.

The footstock, which is shown in Fig. 5, is kept in alignment on the table in a manner identical to that of the headstock, and it is also clamped in position by a stud-bolt which slides in a T-slot in the table. A diamond holder which may be used for truing the wheel without removing the work, is attached to the end of the footstock spindle as shown. The spindle is hollow and it is bored to the same taper as the spindle of the headstock. It is so designed as to be operated by a handwheel or quick-acting spring, controlled by a lever.

The base of this grinder has a three-point bearing in order to compensate for any uneveness in the flooring and to maintain perfect alignment. It is of box section, thoroughly ribbed and braced so as to offer resistance to torsional strains. The back-rests furnished with these machines for supporting slender work, take up the reduction in grinding, are rigid, capable of delicate adjustments, and are universal in their movements. The construction of one of these rests is shown in Fig. 6. The pump, the drive for which is clearly shown in Fig. 2, is of the well-known centrifugal type which revolves horizontally in a case immersed at all times, thus obviating the necessity of priming.

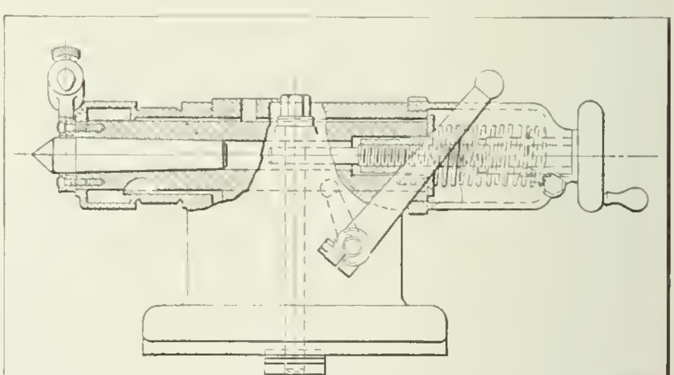


Fig. 5. The Footstock

The water tank is cast integral with the base, the arrangement being such that the pump bearings do not come in contact with the water. Water guards are provided which catch the spray and waste water when wet grinding, and return it to the settling tank and pump.

These machines are built in four sizes, the principal dimensions of the No. 1 or smallest, and the No. 4 or largest, being respectively, as follows: Swing over table, $10\frac{3}{4}$ and 13 inches; maximum distance between headstock and footstock centers, overhung, 34 and 68 inches; number of work speeds, 10; range of work speeds, 25 to 288, and 21 to 242 revolutions per minute; number of table feeds, 10 and 12; range of table feeds, 6 to 66 inches and 6 to 90 inches; horsepower required for driving, from 2 to 4 and from 5 to 8; floor space required, 41 by 96 and 49 by 164 inches.

These grinders are manufactured on the unit system of construction, which eliminates to an appreciable extent, individual fitting and assembling and insures interchangeability of parts. Plain bearings are scraped to master surface-plates and straightedges; shaft bearings are ground and fitted with re-

movable bushings which may be replaced when worn without disturbing the alignment of the shafts, and all sliding surfaces and revolving parts are provided with liberal and efficient means of lubrication. The equipment includes one in-

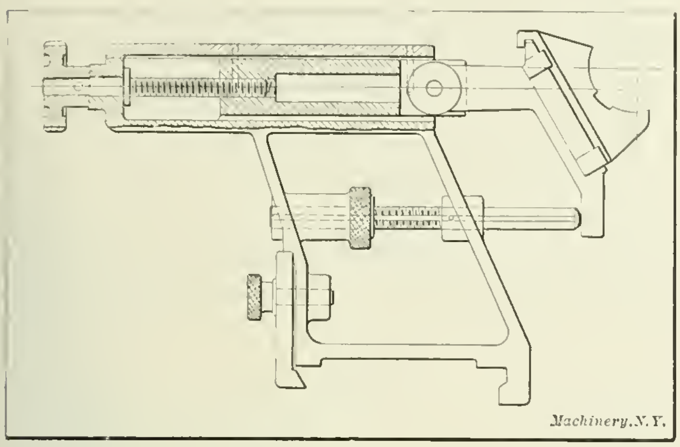


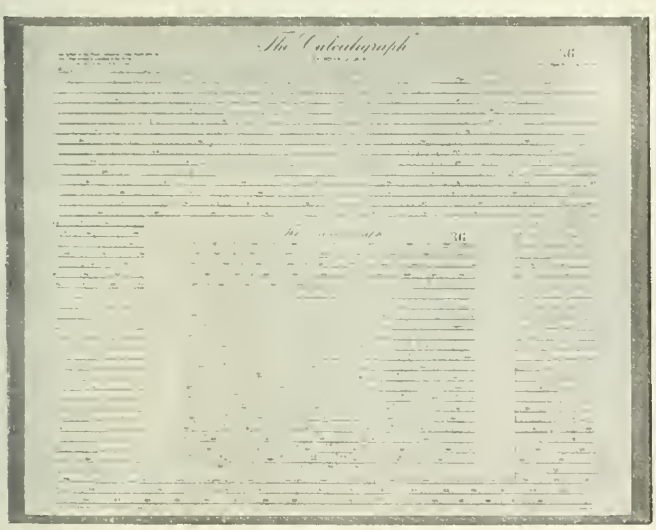
Fig. 6. The Back-rest

ternal grinding fixture, draw-in collet, one three-jawed combination chuck, faceplate, two combination plain and universal back-rests, center-rest, tooth-rest, two grinding wheels, a set of dogs, water guards, and the necessary adjusting wrenches.

THE CALCULIGRAPH OR COLYER-NOYES SLIDE-RULE

The device illustrated herewith is known as the "Calculigraph," and is intended to facilitate the tedious and time-consuming details in connection with mathematical work. This instrument, like similar calculating devices, is based on the well-known properties of logarithms. It consists of two parts, namely a plate 12 by $9\frac{1}{2}$ inches, containing the necessary graduations, and a "bridge" which is shown on the plate in the illustration. This bridge is also graduated and has a series of parallel slots through which results are read directly from the plate. Owing to the large size of the plate, and, consequently, the coarseness of the graduations, a high degree of accuracy in the results is obtained.

When using the "Calculigraph," the upper left-hand corner of the bridge marked with number "10," is always kept in the



Colyer-Noyes 36-inch Slide-rule

upper left-hand quarter-section of the plate, and the slots in the bridge are kept parallel with the lines on the plate. By observing these simple precautions, the operations of division, multiplication and proportion may be readily effected with this instrument.

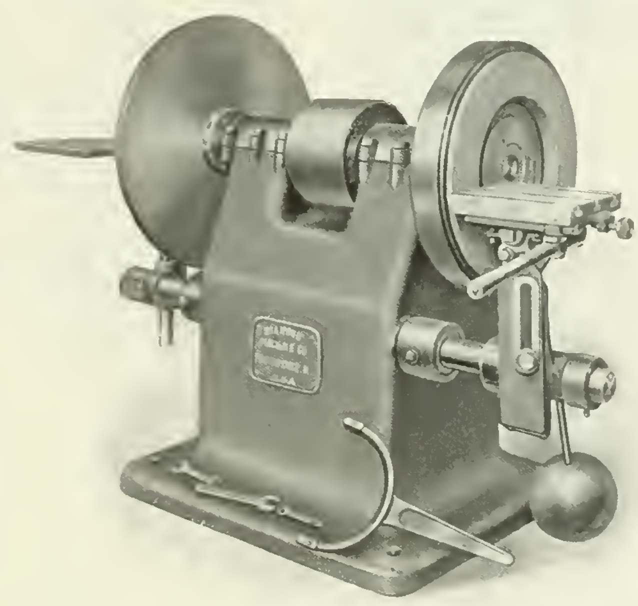
When it is desired to multiply two numbers, the bridge is moved on the plate to such a position that the multiplier lies in the slot immediately above the number "10" on the upper left hand corner of the bridge; the number to be multiplied is then found on the bridge, and immediately above it on the plate will be the result of the multiplication.

For division the bridge is set so that the number upon it corresponding to the divisor, lies immediately below the number "10" in the center of the plate; the number representing the dividend is then found on the bridge, and in the slot immediately above it will be the quotient. As in all similar instruments, the position of the decimal point is not shown by the "Calculigraph," but it is independently determined.

This instrument may be obtained from Kolesch & Co., 138 Fulton St., New York City.

DIAMOND HEAVY DISK GRINDER

The disk grinder shown herewith is particularly adapted for grinding large and heavy work, such as automobile cases, feet of motor frames, etc. This machine has a steel-bound chuck and abrasive ring on one end of the spindle, and a steel disk for emery disks on the other, so that it is adapted to heavy grinding where considerable stock has to be removed, and also for that class of work which can be finished to advantage with a disk. The table on the side of the machine



Diamond Machine Co.'s Disk Grinder

which has the disk, is an ordinary plain table, as this side is not used for such heavy work as the other, and, therefore, a man can hold the work against the disk without excessive fatigue. The other side which has the large abrasive ring wheel, is intended to remove the greater amount of stock and do it more rapidly than the other. Therefore this side of the machine has been equipped with a sliding table operated by a hand lever. The work can be held in any jig, which can be bolted to the T-slots in the sliding table. The sliding table is provided with a micrometer stop for the production of duplicate parts. It is operated by a hand lever which is not only used to bring the work up against the wheel, but also to rock it back and forth over the face of the wheel, thus using the entire surface. The wheel can be dressed quickly and economically by fastening a wheel dresser on the sliding table-top and then rocking the table back and forth over the face of the wheel. The table is balanced by a proper size weight which hangs out of the way below the table-supporting stud. The entire construction of this machine is extremely massive and heavy. The spindle bearings are babbitted and ring oiling. The studs which support the tables are of extra large diameter. All the necessary wrenches, a cement press, and a countershaft are provided with the machine.

The height from the base to the center of the spindle is 36 inches; diameter of the spindle in the bearings, 3 inches; diameter of the disk, 30 inches; size of the emery ring, 22 by 17 by $2\frac{1}{2}$ inches; size of plain table, 14 by $30\frac{3}{4}$ inches; size of the sliding table, $8\frac{1}{2}$ by 12 inches; weight, crated for shipment, 1500 pounds. This grinder is manufactured by the Diamond Machine Co., Providence, R. I.

COMPOUND TABLE FOR COLBURN HEAVY-DUTY DRILL PRESSES

In the department of New Machinery and Tools for July, 1910, we illustrated and described a heavy-duty drill press built by the Colburn Machine Tool Co., of Franklin, Pa. This company has just brought out a new attachment for this machine, in the shape of a compound table which has both

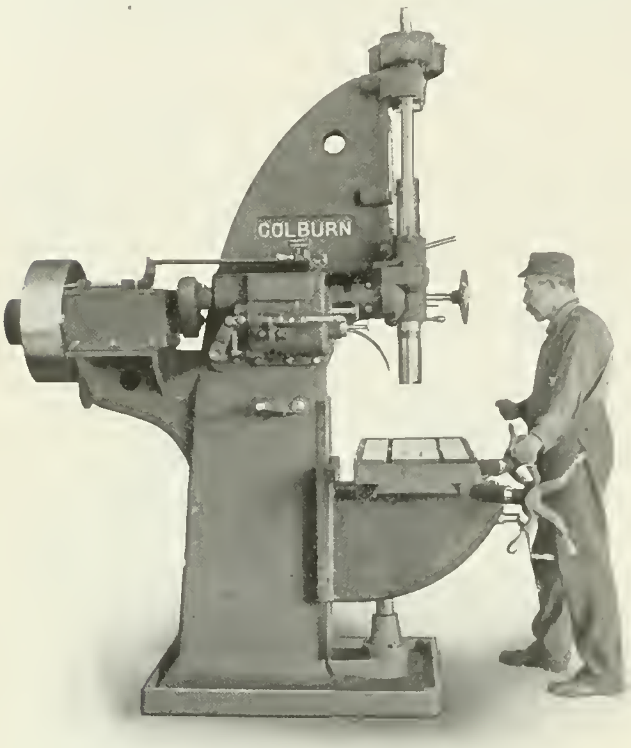


Fig. 1. Colburn Heavy-duty Drill Press with Compound Table

cross and longitudinal movements, controlled by conveniently located pilot wheels.

This table has a rapid movement, through a worm and rack, of 20 inches longitudinally and 8 inches crosswise. The operator, when standing directly in front of the table as shown in Fig. 1, can adjust it in either direction without moving out of his position It should be explained that this is not an at-

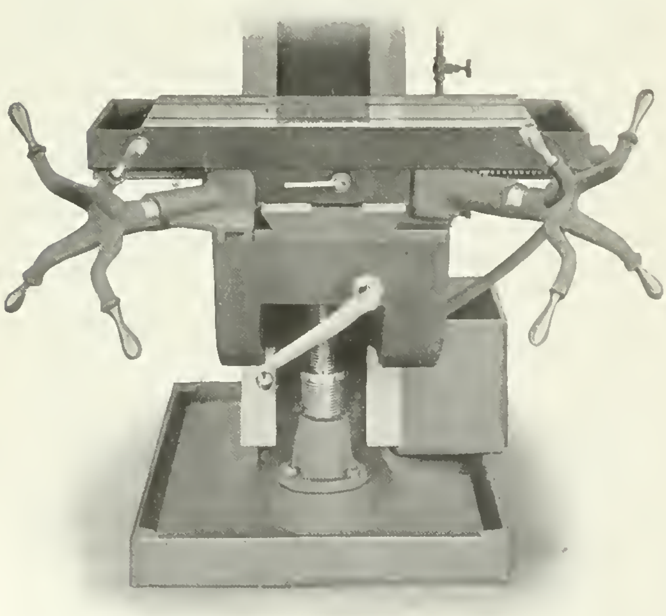


Fig. 2. Front View of the Compound Table

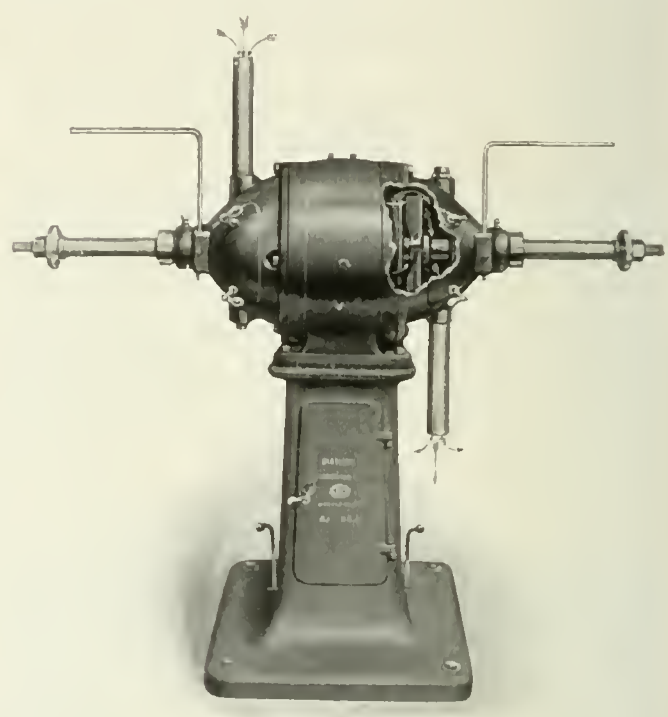
tachment to the regular table, but a special knee and table that is furnished only when so ordered.

The platen of the compound table has a working surface, inside the oil grooves, of 16 by 30 inches, and it contains two large T-slots for the clamping of work. A large chip pan is provided at each end and oil grooves run lengthwise at each side. The design is such that all lubricant running into the pan at the left end is drained back by means of a cored opening through the table, to the chip pan nearest the tank. From this pan the lubricant is conveyed, by means of a hose and suitable connections, to a tank at the side of the machine so that no matter how large a stream of lubricant is used, it all drains back to the supply tank.

In Fig. 2 a detailed view of the table as it appears from the front, is shown. It is evident from the illustrations that it would be impossible for this table to spring, owing to the heavy bracket or knee underneath and the additional support received from the elevating screw. When the compound table is used, the maximum distance between its top and the end of the spindle is 28 inches, which is 6 inches less than when the regular table is employed.

DIAMOND NO. 3 MOTOR-DRIVEN POLISHER

The Diamond Machine Co., Providence, R. I., has recently redesigned its No. 3 motor-driven polisher, shown in the accompanying engraving, with reference to the following points:



Motor-driven Polisher with Cooling Arrangement for the Motor

First, to make the machine self-cooling, and second, to allow it to be operated without opening the door in the column. The first feature has been obtained by placing a fan on the spindle of the machine close to the armature on the outer side of the commutator, and by placing inlets and outlets on the ends of the motor frame. By this means, when the machine is in motion, the fan is constantly drawing cool air through the parts of the motor which ordinarily heat up, and discharging it outside of the machine. The inlet may be connected with the outside air or any place from which clean air can be obtained. The discharge may be carried to a dust collector or discharged any place where the dust is not objectionable.

An electrically-driven polisher or grinder requires that the products of grinding or polishing be kept from the electrical parts as much as possible. In order to do this it is necessary to use an enclosed motor. When the motor is developing a good deal of power, the entire machine necessarily becomes very hot. This undesirable condition is entirely prevented by this arrangement of the fan, together with the inlet and outlet device. This machine is rated at 10 horsepower, and under actual service, for short intervals, it has produced double this

power; as the motor is kept cool it will develop as much power as a like motor entirely open. In previous machines it has been necessary to get inside the column to throw the switch and also to get at the regulator. In this machine a lever projects on each side which can be thrown by the operator's foot thus throwing off the switch. A lever is also provided (not shown in the engraving) for operating the controller. The machine is equipped with bronze ring-oiling bearings each 5 3/4 inches long.

RAHN-CARPENTER EXTENSION-BED GAP LATHE

An extension-bed gap lathe that is designed to meet the requirements of repair and jobbing shops, where a large range and variety of work has to be done at a minimum expenditure for equipment, has been developed by the Rahn-Carpenter Co., of Cincinnati, O.

The top bed of this lathe slides along the lower one and can

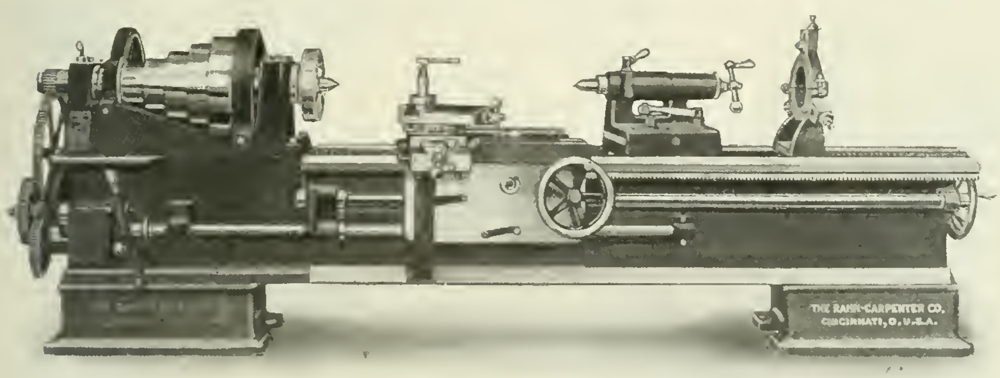


Fig. 1. Rahn-Carpenter 24- and 43-inch Extension-bed Gap Lathe

be adjusted to any width of gap required within the range of the machine. By moving the upper bed, the distance between centers can, of course, also be considerably increased. Both the main bed and sliding member are heavily and substantially constructed and firmly braced throughout their entire length with box girders so that vibration from the heaviest cut is absorbed. The sliding bed is accurately planed and fitted into the lower one, and as the carriage and tailstock are moved along with it, perfect alignment with the head spindle is assured in all positions. The upper bed is moved by means of a coarse pitch screw and handwheel which is located at the end of the lathe.

This machine has a wide range of both longitudinal and cross-feeds, any of which may be instantly obtained by shifting the vertical lever shown connected with the feed box. The positive geared type of drive is employed, and the feeds are so arranged that no two of them can be thrown into operation at the same time. A patented safe-

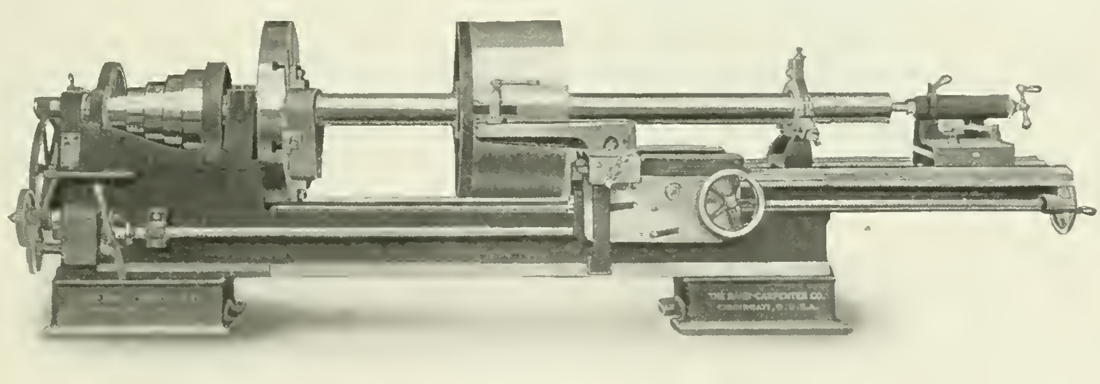


Fig. 2. Gap Lathe with the Gap Open Full Width for Turning Pulley

ty device prevents the breaking of gears in the feed box or in the apron through any unavoidable accident or carelessness on the part of the operator. The compound rests and cross-feed screws have graduated micrometer disks for indicating the feeds.

The headstock of this machine is well ribbed and firmly bolted to the lower bed. The spindle is hollow, is made of a special carbon steel and is finished by grinding. The boxes are made of the best gun metal and are provided with means for taking up any wear which may occur. The driving cone is of extra large diameter, powerfully back-geared and capable of using a broad belt. This lathe can also be equipped with a three-step cone and double back-gear when this is desired. As the engravings show, the tailstock is of the offset type, which allows the compound rest to be swung around parallel to the bed.

The compound rest is rigid and has a long broad bearing on the carriage. The swiveling base is graduated, and gibs are provided for taking up all wear. The carriage is gibbed to the bed both front and back, and provides a broad bearing for the rest. It has a long bearing on the bed and can be firmly locked to the latter for cross-feed work. The construction is such that the tool-rest can be brought close to the gap when required. The front of the carriage is extended and firmly braced, thus allowing extra travel for the compound rest in order that the tool may be operated on the largest diameter that can be swung in the gap. The apron is simple in its design, and the various controlling levers are conveniently placed. The rack and all gears are made of steel, and the stud-pins are hardened and ground.

The countershaft has double-friction clutch pulleys of powerful design. Ample oiling facilities are provided and the shaft runs in self-oiling boxes. The equipment regularly supplied with this lathe consists of a countershaft, steady-rest, follow-rest, and large and small faceplates, wrenches, and a full set of change gears. If desired, a taper attachment, extension turning rest, turret on the carriage, chucks, chuck-plates, turning tools, faceplate chuck or any special tool-rest can be furnished extra.

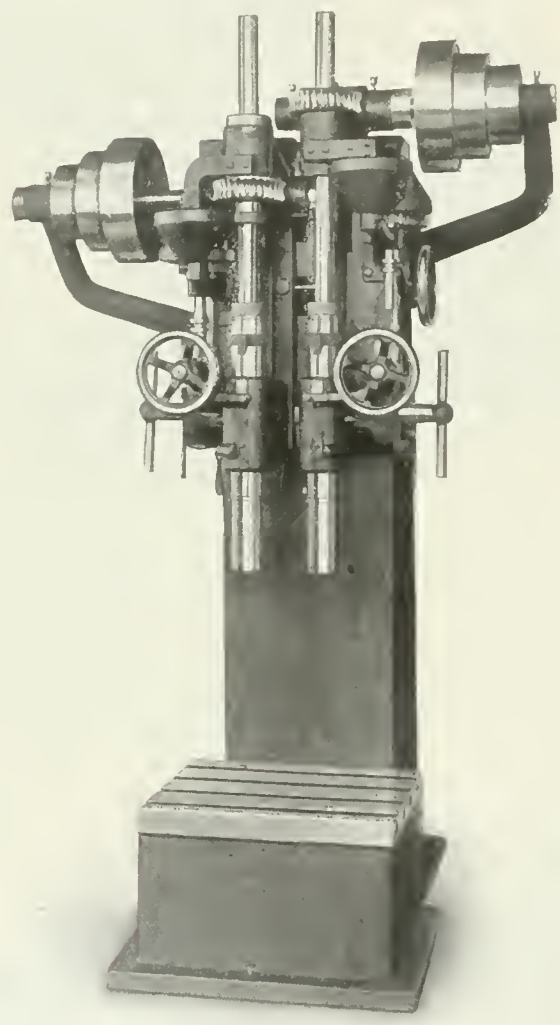
This lathe swings over the gap, 48 inches; over the V's, 27 inches; over the carriage, 19¼ inches, and over the rest, 17¾ inches. The extreme width of the gap with a 10-foot bed is 3 feet. The floor space required for the 10-foot machine is 10 feet by 2 feet and the weight 7000 pounds. There is a feed range of from 0.01 to 0.27 inch and a thread-cutting capacity of from 2 to 20 threads per inch.

HOEFER DRILLING, BORING, FACING AND TAPPING MACHINE

The machine shown in the accompanying engraving is another addition to that line of special machinery that has been brought out to meet the demand of automobile manufacturers and others for tools particularly adapted to a certain class of work, in order to secure rapidity of production and accuracy. This machine is built by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill., and it has been specially designed for drilling, boring, counterboring and accurately tapping the inlets of automobile engines. These inlets have heretofore been machined on stock tools which, not being particularly adapted for the purpose, were necessarily slow as they lacked the convenience of manipulation found in a special machine. Furthermore, when tapping the inlets on stock machines which are fed by the lead of the tap, the threads are

liable to be stripped unless precaution is taken. With this special machine the tap is fed positively so that there is no stripping of the thread.

The column of this machine is of the box type to which a stationary base is attached. On the upper end of the column a gibbed cross-rail is attached, to which the two spindle heads are gibbed. The spindle head to the right is permanently fastened on the cross-rail, while the one to the left may be adjusted horizontally on the rail by means of a screw so that centers of various distances may be obtained. The spindles are driven by three-step cones through steel worms and bronze worm-gears. The worms are supplied with ball bearing end-thrusts and run in an oil bath. The spindles are made of the best crucible spindle steel and run in bronze-bushed bearings. As before stated, they are fed by a positive geared feed, and are automatically tripped at any predetermined point. For tapping, the necessary change gears for giving the spindles a feeding movement equal to the tap lead, will be supplied. Each spindle is driven, and is also fed, independently of the other, and each has a hand-feed and quick-return lever. The feed gears have four independent changes that are obtained by a lever, convenient to the operator, which swings against an index-plate giving the desired feeds in thousandths. One of the commendable features of this machine is that it requires only 30 to 45 inches floor space, as all the belting is overhead. While this tool is especially designed for the purposes mentioned in the foregoing, it can, of course, be employed to advantage on many other parts where boring, drilling and tapping is required, within the capacity of the machine.



Hoefer Drilling, Boring, Facing and Tapping Machine

The minimum distance from center to center of the spindles is 4⅝ inches, and the maximum distance, 8 inches. The minimum distance from the spindles to the table is 12 inches, and the maximum distance, 28 inches. The vertical feed of the spindles is 16 inches, and the distance from their centers to the column, 12 inches. The feed of the spindles per revolution, is 0.008, 0.016, 0.0315 and 0.0625 inch, but this range can be changed to any feed desired. The spindle is fitted with a No. 5 Morse taper, and its diameter is 2 1/16 inches. The size of the table is 18 by 24 inches, and the greatest height from the floor to the top of the machine is 81 inches.

HOYSRADT & CASE WET TOOL GRINDER

The aim in the construction of the wet tool grinder shown in the accompanying engraving, has been to build, at a moderate price, a simple and efficient tool in which an even and steady flow of water could be maintained upon the wheel without the use of a pump. The water in this grinder is contained in the hollow head (the wheel running in a separate trough) and through a hollow bronze connection, water to any desired amount can be supplied to the wheel. In fact, these grinders can be used either wet or dry by simply shifting the lever seen beneath the bowl at the front. Self-oiling and dirt-proof bearings are employed on the grinder and also on the countershaft. It is claimed that three or four oilings a year will keep these bearings running perfectly. The countershaft is also supplied with a patented self-oiling loose pulley. These grinders are built in two sizes, having 16- and 24-inch wheels, respectively, and the builders are Hoysradt & Case of Kingston, N. Y.

Hoysradt & Case Wet Tool Grinder

PEASE MOTOR-DRIVEN CUTTING AND TRIMMING TABLE

A motor-driven cutting and trimming table that will be found of great convenience and utility for the trimming of blueprints and also for cutting tracing paper or cloth, detail paper, etc., is shown in the accompanying halftone. This table is provided with a parallel clamp, operated by a foot-treadle, which holds the paper, tracing cloth or print securely, while the revolving cutting knife is being used. The device is rapid and convenient in its operation, and it will trim a very narrow strip from the paper or print. As the engraving shows, the revolving cutting knife is motor-driven, the rotation being positive by mechanical means. The thinnest paper may be cut perfectly with this table, and from five to ten sheets may be severed simultaneously. The knife is electrically operated in either direction at will, and it is stopped or started by a specially-designed wrist-controlled switch, which leaves both hands of the operator free for handling the paper or prints.

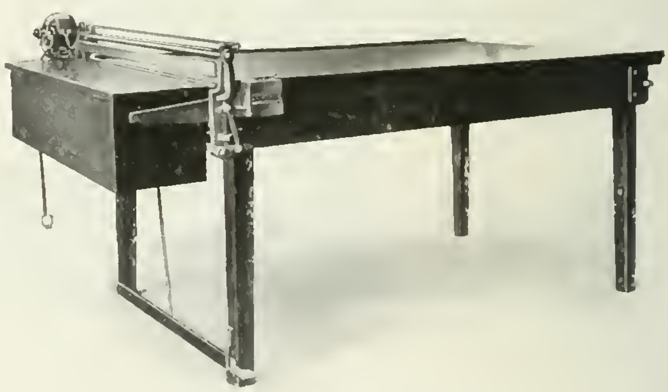


Table for Cutting or Trimming Blueprints, Tracing Cloth, etc.

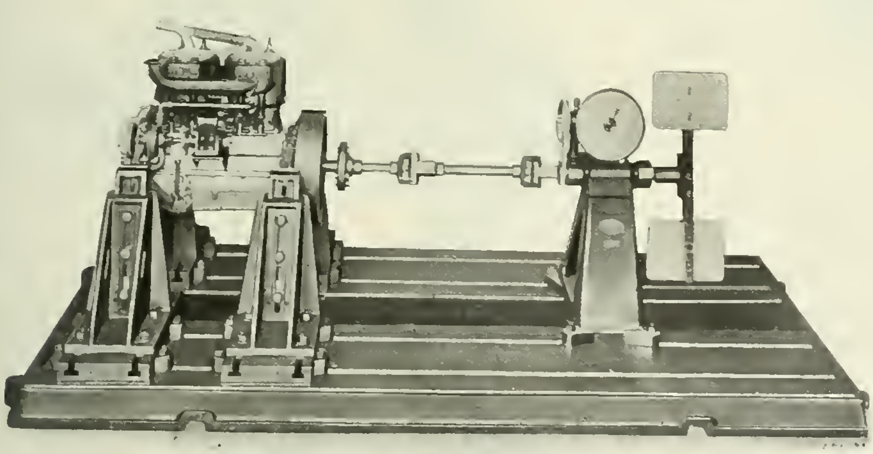
The table is constructed of hard wood with metal trimmings, and it is arranged to be easily "knocked down" for shipment. The electrical arrangement is such that the current for the motor may be obtained from any incandescent light socket by simple connections. A light-proof box for blueprint paper is attached to the end of the table, as shown. The top of the table is scored in inches and is provided with figures along the front edge, so that sheets can be instantly cut to any size. A sizing diagram can also be provided for the top of the table, which shows at a glance the size of any tracing or print and the square foot measurement, no calculation being necessary.

These tables are also furnished with a basket on the end, instead of a light-proof box, that is especially designed for prints after they have been run through an automatic continuous printing, washing and drying equipment. These tables, as regularly supplied, are 4 feet wide by 6 feet long, but any width up to and including 8 feet can be furnished. (They are also furnished in widths up to 42 inches, with a cutting knife arranged for operation by hand). The cutting machinery is all self-contained and it can be supplied separately if desired, so as to be bolted to any table of appropriate width. This table is the product of the C. F. Pease Co., 167 Adams St., Chicago, Ill.

TESTING BASE FOR GASOLINE MOTORS

The accompanying half-tone shows a testing outfit for gasoline engines that has been put on the market by Joseph Tracy, 116 West 39th St., New York. This outfit consists of a cast-iron bed plate and universal supports for carrying the motor, which may be connected to a dynamometer or prony brake. As the engraving shows, the four supports for the motor are mounted on small base-plates which contain cross slots, thus permitting the supports to be adjusted laterally as well as longitudinally. A vertical adjustment is also provided by means of sliding members on the supports, which may be raised or lowered by suitable screws and locked by the bolts shown.

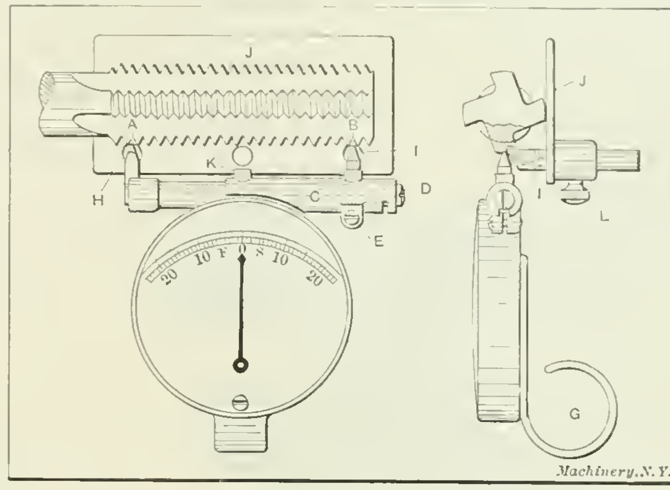
This bed-plate forms a substantial foundation for any motor-testing operations, and by means of the easily adjustable supports, any style or size of motor can be securely seated and lined up in a few minutes. The device has been designed to supply a reliable substitute for the make-shift methods usually employed for testing, which result often in a great waste of time in preparation for a test, and are often so unsubstantial that trouble is caused by the motor and dynamometer getting out of alignment while testing. All the contact surfaces of the bed-plate and motor supports are planed true.



Testing Base with Motor Supports having Universal Adjustment

THE WOLFE THREAD TEST INDICATOR

An indicator that is especially adapted for the rapid and accurate testing of threads on taps, dies, screws, etc., has been brought out by Joseph L. Wolfe, 859 Stratford Ave., Bridgeport, Conn. This indicator can be used for testing any tap or screw having a length of one inch or longer, and an inaccuracy of 0.0002 inch is said to be easily discernible. The dial of the indicator is graduated to read thousandths of an inch, and it has a range of 0.024 on either side of the zero mark. This instrument has two ball points, *A* and *B*, which are brought into contact with the thread to be tested. Point *A* is movable and point *B* is stationary. The latter can be unscrewed from its socket and screwed into the socket *K* when a testing range of 1 inch is desired. The sleeve *C*, which holds stationary ball point *B*, can be adjusted by screw *D*, the sleeve being held in its adjusted position by the clamp-screw *E*. The loop or handle *G* is used for holding the indicator when testing a thread.



Gage for Testing the Threads of Taps, etc.

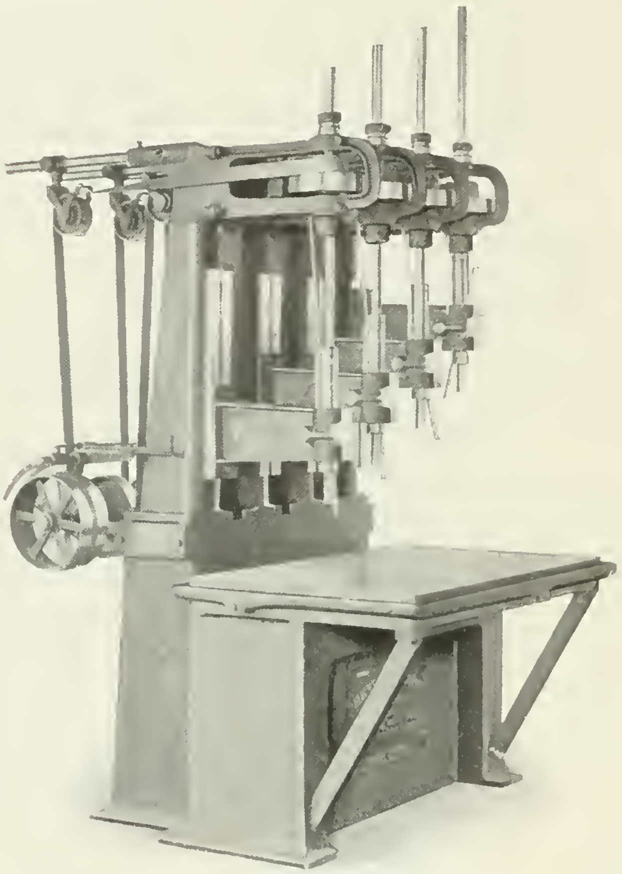
In addition to the indicator proper there is a centering gage which provides a means for enabling taps, screws, etc., to be tested on the center line, thereby insuring accuracy. This centering gage can be used on taper as well as straight taps, and it has a capacity for diameters ranging from ¼ to 1½ inch. The adjustable points *H* and *I* on the centering gage are graduated in thirty-seconds of an inch, and they may be held in any position by knurled thumb-screws *L*. As the engraving indicates, this centering gage also has a base-plate *J* against which the piece being tested is held. The engraving shows the gage being used for testing the threads of a tap, with the points *A* and *B* set to the two-inch range. When using the centering gage, the graduated points *H* and *I* are set out from the plate *J* a distance equal to the radius of the tap or screw that is to be tested. Knurled thumb screws *L* are than tightened, thus holding points *H* and *I* in the adjusted position. The tap or screw is next placed on the centering gage and held down on plate *J* and against the points *H* and *I*. The indicator itself is held in the hand with the thumb and first finger on opposite sides of the case, and with the second finger through the loop *G*. The indicator is then brought against the tap which is held on the centering gage with the other hand so that the stationary ball point *B* enters the thread and rests on the flat end of point *I*, and the movable point *A* also enters the thread and rests on the flat part of point *H*. The indicator will then show whether the thread is "fast" or "slow" in thousandths of an inch. If the thread is accurate, the pointer on the indicator will remain at zero. If it is "fast," the pointer will move in the direction of *F*; and if "slow" the pointer moves, of course, in the opposite direction.

HENRY & WRIGHT CABINET BASE DRILLING MACHINE

Another development in the line of high-speed ball bearing drilling machinery manufactured by The Henry & Wright Mfg. Co., of Hartford, Conn., is shown by the accompanying illustration. The table of this machine is not adjustable but it is firmly fastened to the cabinet base in a way that makes

it absolutely rigid and immovable in service. It may, however, be taken off if this should be necessary for redressing to renew its accuracy, by removing four bolts. The heavy design of drilling heads used in the automobile manufacturers' drilling machine described in the September number, are used on this type, and the combination is extremely rigid and unyielding.

The table is ribbed on the under side like a standard surface-plate and it is made extra heavy to provide for redressing. Four oil ducts fitted with strainers convey lubricant from the table to a tank inside the base. The machine will drive high-speed steel drills up to 1 1/8 inch in diameter, but its most



Henry & Wright Drilling Machine

efficient field of operation is the drilling of holes 7/8 inch in diameter and under; the extra power being intended to drill an occasional larger hole which may occur in a piece of work containing a number of smaller ones. This arrangement, of course, effects a considerable increase in the working range of the machine, as a large number of parts that would either have to be drilled, tapped, counterbored or reamed in two or more machines can frequently be done in one machine without removing the part from the jig, which tends toward greater interchangeability, accuracy and rapidity in manufacturing.

The hole in the spindle is a No. 2 Morse taper, so that it is necessary to reduce the taper of the largest drills in order to make them fit the spindle. The No. 4 machine, which is the size illustrated herewith, is the first one of this type to be produced, but it is the intention of the builders to make a wider variety ultimately. This machine will be furnished with a plain table or with full oiling equipment, including a tank, pump, piping, flexible tubing and faucets, as ordered. The No. 4 size weighs with an 8-inch overhang 3200 pounds; with a 12-inch overhang 3500 pounds; and with a 15-inch overhang 3800 pounds.

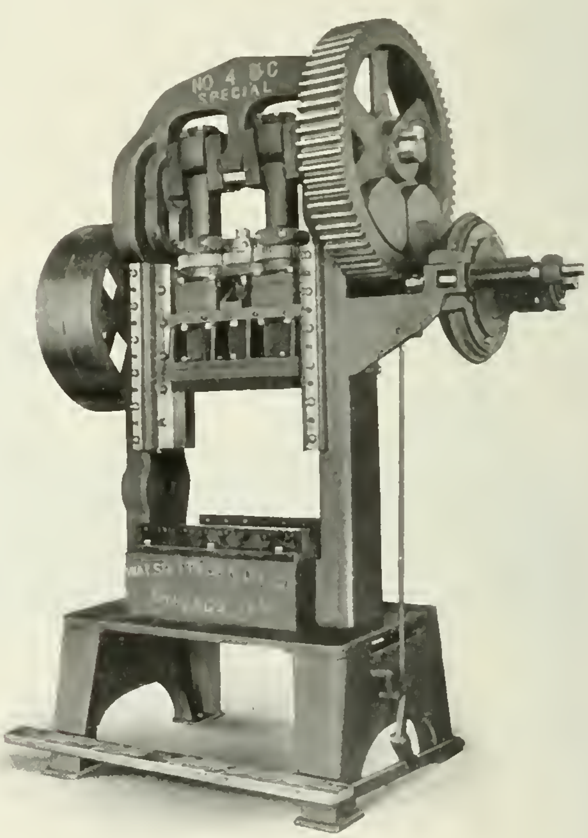
BESLY DISK WHEEL CEMENTING PRESS

Charles H. Besly & Co., Chicago, Ill., the well-known makers of disk grinders, have brought out an improved disk wheel cementing press, illustrated herewith. This press is so constructed that the top plate may be swung out of the way, as shown in the illustration, while the disk wheel is being glued, and swung back into position when pressure is to be applied. The press accommodates disk wheels 26 inches in diameter and smaller. The disk wheel is raised off the face of the press by a central shouldered shaft, which is actuated by a cam movement connected with the lever shown at the left. In raising, the cam is thrown slightly over the center and against a bumper-pin. This holds the disk suspended of its own weight. In lowering, the disk is raised slightly by means of the lever to permit the cam to come over the center, when it is lowered until the disk wheel rests on the pedestal casting. When pressure is to be applied, the yoke is swung into engagement with a stud set in the pedestal. No lock is necessary, as the pressure holds the yoke in position. The mechanical means for raising and lowering the disk is a desirable feature, as the large disk wheels are heavy and hard to handle, a 26-inch Besly disk wheel weighing 125 pounds.

Besly Disk Press

WALSH STRAIGHT-SIDED DOUBLE-CRANK PRESS

The accompanying illustration shows a special straight-sided double-crank press which is so designed that it will stop at any angle of its stroke by simply removing the foot from the foot-treadle, the latter controlling the transmission of power to the slide absolutely. This machine is driven by a friction clutch which is fitted with a brake-band on its rim. This clutch and the brake are clearly shown in the illustration. When the treadle is compressed, the friction clutch engages and the brake-band is released. As soon as the treadle is released, the compression spring shown disengages the clutch, and the rod upon which the compression spring is mounted—being connected with the brake-band—compresses the latter which instantly stops the machine.



Press built by the Walsh Press & Die Co.

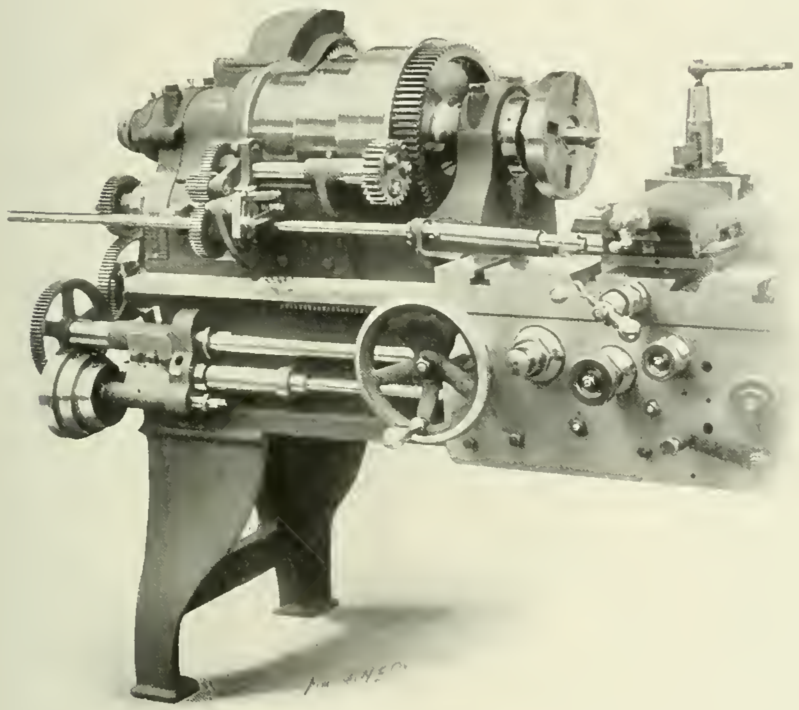
This press was designed by Mr. H. C. H. Walsh, and was built by the Walsh Press & Die Co., 4709-11 West Kinzie St., Chicago, Ill., to meet the requirements of a manufacturer who will use it in the production of horseshoe magnets.

BRADFORD RELIEVING ATTACHMENT

The relieving attachment here illustrated is made by the Bradford Machine Tool Co., Cincinnati, O., and it can be applied to this company's 14-, 16-, 18-, 18- heavy pattern, 20-, and 22-inch lathes or to other sizes if ordered. It may be used for backing off the teeth of reamers, taps, hobs, mills, etc., and it will relieve either straight or taper work having any number of flutes from 2 to 24, inclusive.

The attachment consists of a substantial bracket that is built as a unit with all the parts self-contained, thus insuring permanent alignment and smooth working of the parts. This bracket, with its mechanism, is mounted on the front of the headstock, as clearly shown in the illustration. This position is easily accessible, it being unnecessary to go to the rear of the lathe for making adjustments or for changing the gears.

As the illustration shows, the drive is from the face gear instead of the spindle gear. The advantage of this construction is that the attachment is speeded down and up in the same degree, thus avoiding abnormal gear ratios and small driven pinions or a multiplicity of gear centers to provide for the 2 to 24 movements per revolution of the spindle. This feature has heretofore been entirely overlooked and has resulted, on the one hand, in an exceedingly heavy and clumsy attachment, or, on the other hand, in an attachment unfit for the unnecessarily severe and excessive stresses imposed.



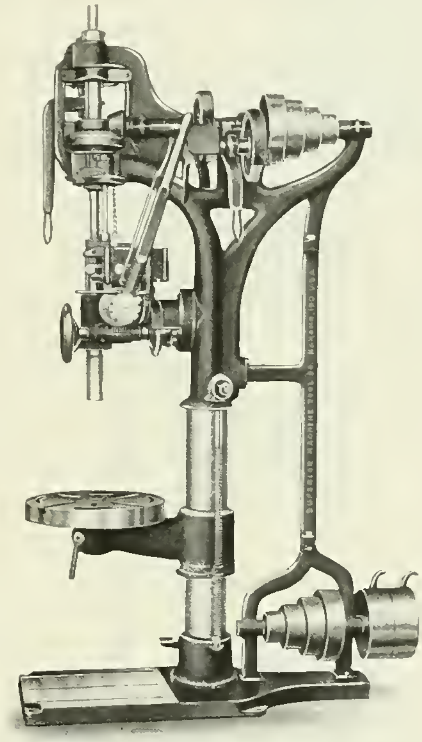
Lathe equipped with Bradford Relieving Attachment

A single fixed cam only is required and it is mounted on a shaft of large diameter and close to the shaft bearing, thus providing that rigidity which is so essential to a device of this kind. This cam actuates one arm of a lever through a roller on a tool-steel stud. The roller is fixed in position on the lever, and receives a true and correct movement at all times. In this attachment the amount of relief is obtained in the following manner: The derived motion of the roller is transmitted through the rocking lever and connecting-rod to a rock-shaft, which transmits the movement to the compound rest as will be explained later. One end of the connecting-rod is attached to a sliding block capable of adjustment towards and away from the center of the rocking lever. This adjustment controls the amount of motion to be transmitted to the rock shaft, and is obtained by means of a screw and knurled knob so placed that it is within easy reach of the operator. It is evident that the amount of relief is quickly and precisely adjusted from as fine to as coarse as may be required, and the whole range is at the operator's command without even stopping the lathe.

A bracket on the carriage carries one end of the rock-shaft, the movement of which is transmitted through a telescopic sleeve, shaft and knuckle joints, to a set of spur gears in the compound rest. On the side of one of these gears there is an eccentric hub which engages the bronze nut in the compound rest through which, in turn, passes the top slide screw. Now it is plain that the derived movement of the rock-shaft is transmitted through the telescopic sleeve, shaft, knuckles and eccentric gear and screw to the top slide of the compound rest, and it will be readily seen that a rocking movement will result in the compound rest top slide. A set of change gears and an index plate are furnished providing for from 2 to 24 such movements per revolution of the spindle.

The gear which meshes into the face gear, is adjustably fixed to a flange which is keyed to the shaft, thus providing an adjustment between the tool and the work when first setting up, without disconnecting.

The carriage of the lathe has full traverse between centers and the movements of the compound rest are always available. The attachment need not be removed when doing ordinary work, as simply locking the small quadrant up or down, respectively, disengages or engages the attachment. The practical value of this feature is readily apparent.



Superior 21-inch Upright Drill Press

The cam used in this attachment has the proper shape to give a uniform movement to the tool which is quickly withdrawn from the work by a strong spring capable of ready adjustment with nut and washer.

One of the novel features of this attachment is found in the connecting means between the connecting-rod and the rock-shaft, which facilitates the easy lengthwise movement of the rock-shaft even on coarse pitch taps, etc., and heavy cuts. The crank is fast to an inner sleeve and is driven by an outer bush. The sleeve drives the rock-shaft through a key, but is capable of an automatic limited movement lengthwise with the rock-shaft, independent of its driving connection, a strong spring returning it to the original position after each cut. This construction effectively overcomes any tendency of sticking or binding of the rock-shaft.

Gear guards are placed over all exposed gears and are arranged so that they can be readily removed when necessary.

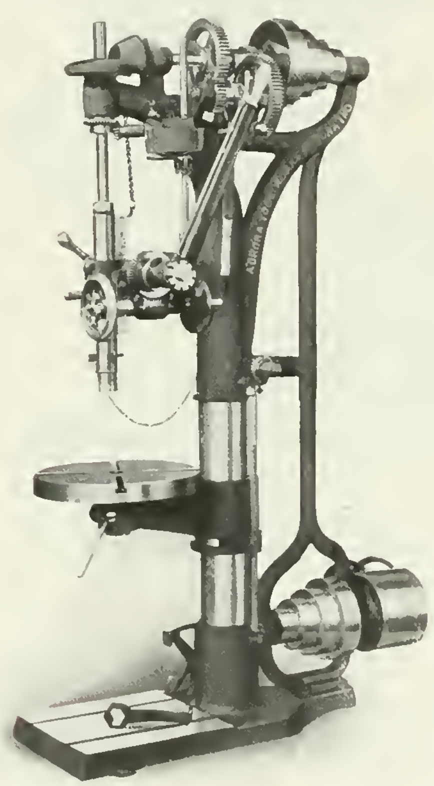
SUPERIOR 21-INCH UPRIGHT DRILL PRESS

The Superior Machine Tool Co., Kokomo, Ind., has brought out the design of upright drill press illustrated herewith. This machine, which is the 21-inch size, is built with back-

gears, positive geared feed and tapping attachment. The feeding mechanism is mounted on the head, which is stationary, and it is enclosed by a gear box. The drive to the feed mechanism is by a vertical shaft, which is driven from the spindle quill by spur gears. Four changes of feed are available, ranging from 0.006 to 0.016 inch per revolution of the spindle. These changes are effected by simply shifting conveniently located handles attached to the gear box. The tapping attachment, which was illustrated and described in the department of New Machinery and Tools for July, 1909, is equipped with friction gears which are enclosed with gear covers or guards. It will also be noted that the other gears are covered by suitable guards for the protection of the workman. This machine will drill to the center of a 21-inch circle. The maximum distances between the table and spindle and the base and spindle are 20 and 37 inches, respectively. The traverse of the spindle is 8 inches, while that of the table is 16 inches. The spindle is bored to receive a No. 3 Morse taper.

AURORA UPRIGHT DRILL PRESS

The design of drill press shown in the accompanying halftone has been brought out by the Aurora Tool Works, Aurora, Ind. This machine, which is of the stationary head type, is equipped with positive geared feed, the feed change mechanism being enclosed in a case attached to the column. Power is transmitted to the feed-box from the spindle driving quill through bevel gears and a horizontal shaft, and connection is made with the worm-shaft on the head by a vertical shaft and bevel gears as shown. The base is heavy and well-ribbed and the columns are of large diameter with the metal well distributed to insure strength. This machine, in common with the others built by this company, is provided with a back brace to avoid the possibility of springing the column. The yoke is made a part of the column to insure a substantial support for the top shaft, spindle, feed shaft and pulleys. The table arm has long bearings and it is carefully machined to fit the column. The table is also heavy, well ribbed and rests on a large circular bearing on the arm. All bevel gears are planed theoretically correct and run in babbitt metal bearings. If desired, this machine, which is built in 20- and 21-inch sizes, can be equipped with a tapping attachment.



Upright Drill Press built by the Aurora Tool Works

GRANT ADJUSTABLE TOOL-HOLDER

In Fig. 1 is shown an adjustable boring-tool holder that is intended for use principally on milling machines in connection with the boring of jigs, dies, etc. This tool-holder has a shank in which an adjustable slide carrying the boring tool is mounted. By turning the adjusting screw shown, the tool-carrying slide is positively moved in or out and the amount of movement is determined by graduations on the screw-head, which reads to thousandths of an inch. The slide has a movement of about 1 inch, and it is rigidly fitted in the head of the holder.

In Figs. 2 to 5 inclusive, some of the uses to which this tool may be put are shown. Fig. 2 shows it in position for boring bushing holes in a drill jig. These holes are first drilled slightly smaller than the required size, the drill being held by a chuck in the milling machine spindle. After the hole is drilled, the boring tool is put in the spindle of the machine and is used to bore the holes to the required size. The spacing between the centers of the holes can be read directly from the feed-

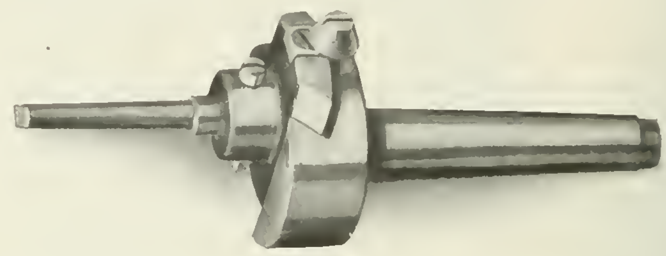
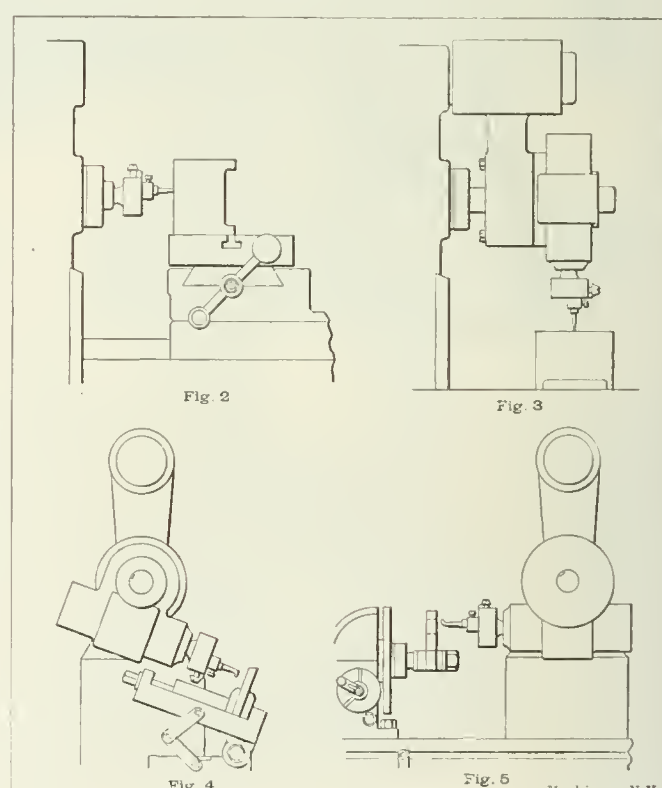


Fig. 1. Adjustable Boring-tool Holder for Milling Machine Work

screw dials or from verniers when the machine is so equipped.

In Fig. 3 the tool is shown held in a vertical attachment and at work on the top of a jig. In Fig. 4 it is being used for generating a form tool. The tool blank, after being roughed out, is held in a universal vise that is inclined to an angle of about 22 degrees to give the proper clearance. The vertical attachment is set to the same angle, so that the point of the tool, while revolving, describes circles in planes parallel to the face of the tool blank. The tool is then fed through the blank by moving the platen longitudinally.

In Fig. 5 the method of using the tool on work mounted in the dividing head is shown. Jigs, the bushing holes of which have a circular lay-out, can be bored to advantage in this manner by clamping them to the faceplate of the dividing head.



Figs. 2 to 5. Examples of Work done with Grant Adjustable Holder

The foregoing show a few of the uses to which this tool may be put and are given as examples of its adaptability to general tool-room and machine shop work. The particular tool-holder shown in the illustration is fitted with a No. 7 Brown & Sharpe taper shank, and it is adapted for boring all sizes of holes up to 2 inches in diameter. Larger and smaller sized holders with shanks of any required taper may also be obtained. A smaller size, having a No. 4 Brown & Sharpe taper shank is recommended as the most economical for small jig

work and should be used in connection with a high speed attachment. It is adapted for boring holes up to one-half inch in diameter. This tool-holder is made by the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn.

MASSILLON STEAM HAMMER

The 1500-pound steam hammer shown in Fig. 1 represents the latest type of hammer manufactured by the Massillon Foundry & Machine Co., of Massillon, O.

In building single-frame hammers some makers use two bolts which pass through the main frame and into the slides, and depend upon these bolts, together with the thin and narrow wedges often used, to hold and back up the slides and guides. Other manufacturers eliminate the bolts entirely and place their slides and guides in a cavity which is provided in the cheek of the main frame, with adjusting bolts passing from the outside of the frame cheeks into the back of the slides and guides. In the construction of the hammer shown in Fig. 1, both of these ideas are employed: Two bolts pass through each slide and back through the main frame, thus throwing the strains of the ram back onto the frame of the hammer where they belong, rather than on the cheeks. This construction is clearly shown in the sectional view Fig. 2. This illustration also shows the swell or enlargement of the main frame which extends back of and partly to the front of the wedges and slides, thus forming a pocket or a partial cavity into which the slides and wedges fit. The advantageous feature of this construction is that the cheeks of the main frame behind the slides, back up and support the bolts which pass through the main frame, while, on the other hand, the use of the bolts passing through the main frame, supports and protects the cheeks on the frame casting. The result is a construction which is practically unbreakable.

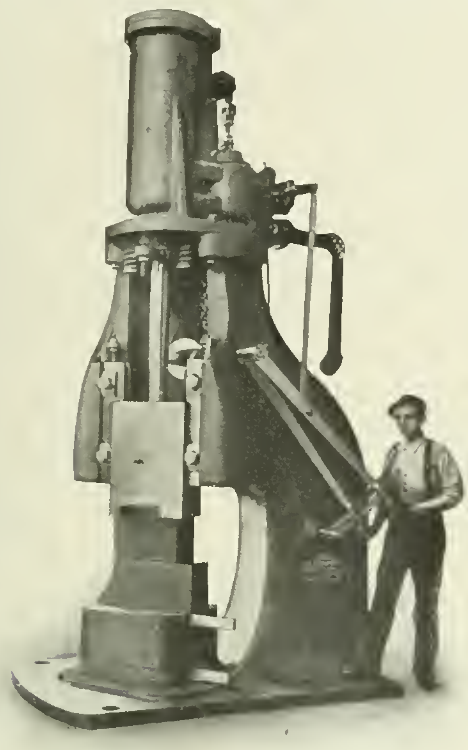


Fig. 1. Massillon 1500-pound Steam Hammer

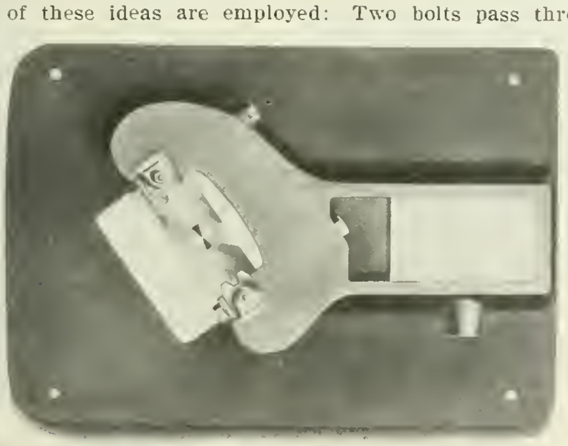


Fig. 2. Sectional View showing Construction of Guides

The slide wedges used in this hammer are made of the best quality of forged steel, and they extend the full width of the base or back of the slides. The cheeks of the main frame furnish a strong base or bearing for these parts. The construction is further strengthened by projections on the cheeks which extend out beyond the wedges and cover part of the front side of the slides, thus making a pocket or cavity for the latter.

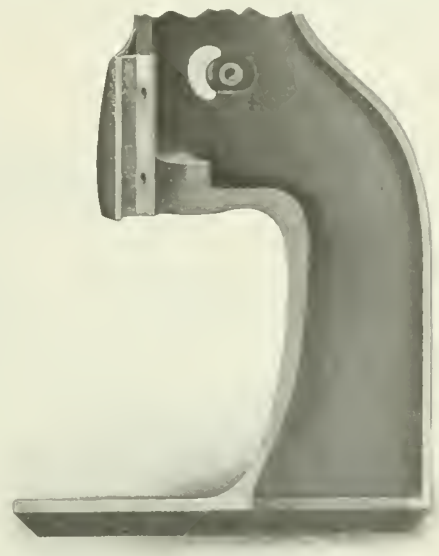
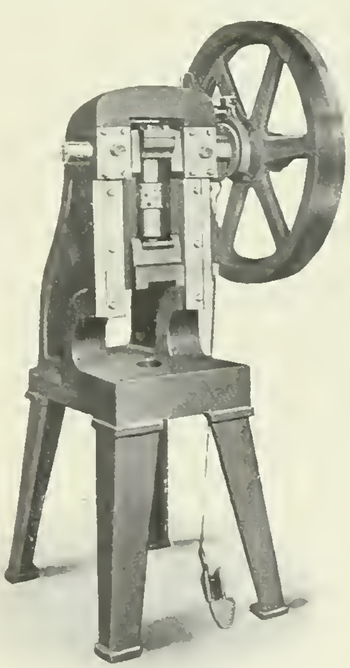


Fig. 3. Section through Lower Part of Column

Fig. 3 further illustrates the construction of the main frame, showing in particular the thickness of the metal in the frame casting behind the ram at a point where strength is most needed. By this plan all lugs or ribs have been eliminated. This hammer has recently been patented, the claim allowed covering the construction of the main frame at that point where the slides and wedges are located.

LA SALLE NO. 4 SINGLE-ACTION OPEN-BACK POWER PRESS

The power press shown in the accompanying halftone is the product of the La Salle Machine & Tool Co., La Salle, Ill. In the construction of this machine, no radical departure has been made from former designs, the aim of the manufacturers having been to produce a well built and rigid tool. The adjustment of the slide is by means of a sleeve connection which is made by fitting a large steel nut, or internally threaded sleeve, to the lower member of the connection, and connecting the upper and lower members by a right- and left-hand screw. This screw is turned by means of a collar through which the screw is fitted. The adjusting screw and collar are casehardened. This makes a very strong adjustment and one that will not loosen from shock or strain of the press. An adjustable brake is provided to prevent the press from running over when the clutch is released. The members of the clutch are made of hardened tool steel, and the sliding dog which engages the flywheel, strikes on a hardened steel plug inserted

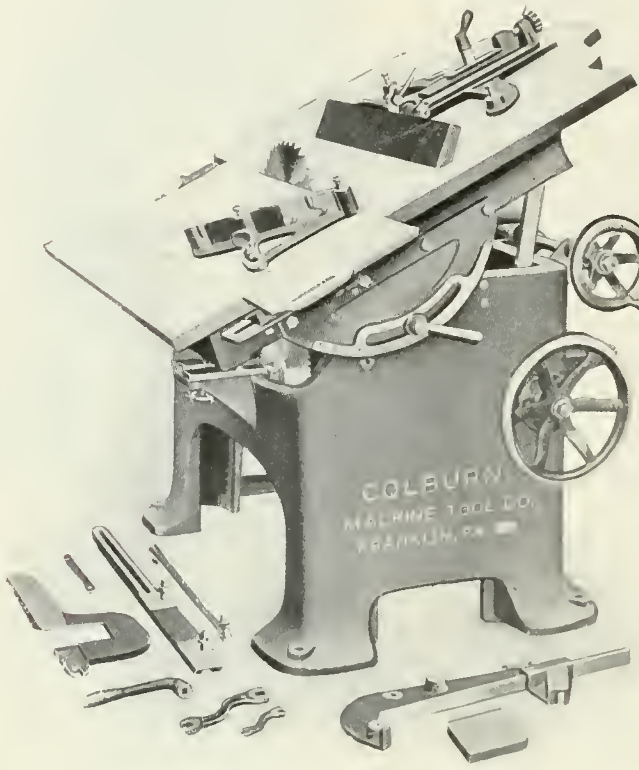


La Salle Open-back Press

in the slot of the flywheel, thus preventing excessive wear. The flywheel is bushed with phosphor-bronze and all bearings are scraped and are adjustable for wear.

COLBURN UNIVERSAL SAW-TABLE

An improved design of universal saw-table for pattern shops and other wood-working establishments, has been brought out by the Colburn Machine Tool Co., Franklin, Pa. A number of improvements are incorporated in the design of this tool, among which may be mentioned the mechanical tilting device for the main table, the micrometer adjusting splitting fence, and the extension to the table which allows wider stock to be cut.



Colburn Universal Saw-table and Attachments

The column or main frame is a one-piece, heavily-ribbed casting that is symmetrical in design and has a large arched opening on the side to allow the inner mechanism to be easily inspected. The table, which is 42 inches long by 40 inches wide, is divided into three sections, namely, the main table located at the right of the saw, the sliding table, and the shelf or section at the left of the sliding table. One of the important advantages of this construction is that the sliding table may be quickly and easily operated as it is but 12 inches wide and does not have the weight of the wider and more cumbersome tables. It is mounted on dustproof roller bearings and travels in carefully scraped and fitted trackways for which proper lubrication is provided. These ways are located in an intermediate track which is adapted to move toward or away from the saw, thus giving ample room for dado heads up to 2 inches wide. The outer portion of this track is extended out to the left and upward, level with the sliding table, thus making a shelf for the support of long work. The entire table can be tilted through the various angles up to 45 degrees, by means of a handwheel which operates a cut-steel pinion that meshes with a steel rack. This mechanism gives a quick adjustment, and as the table is balanced, the handwheel is turned with little effort. The angle to which the table is set is shown by a pointer and graduations on the side of the column.

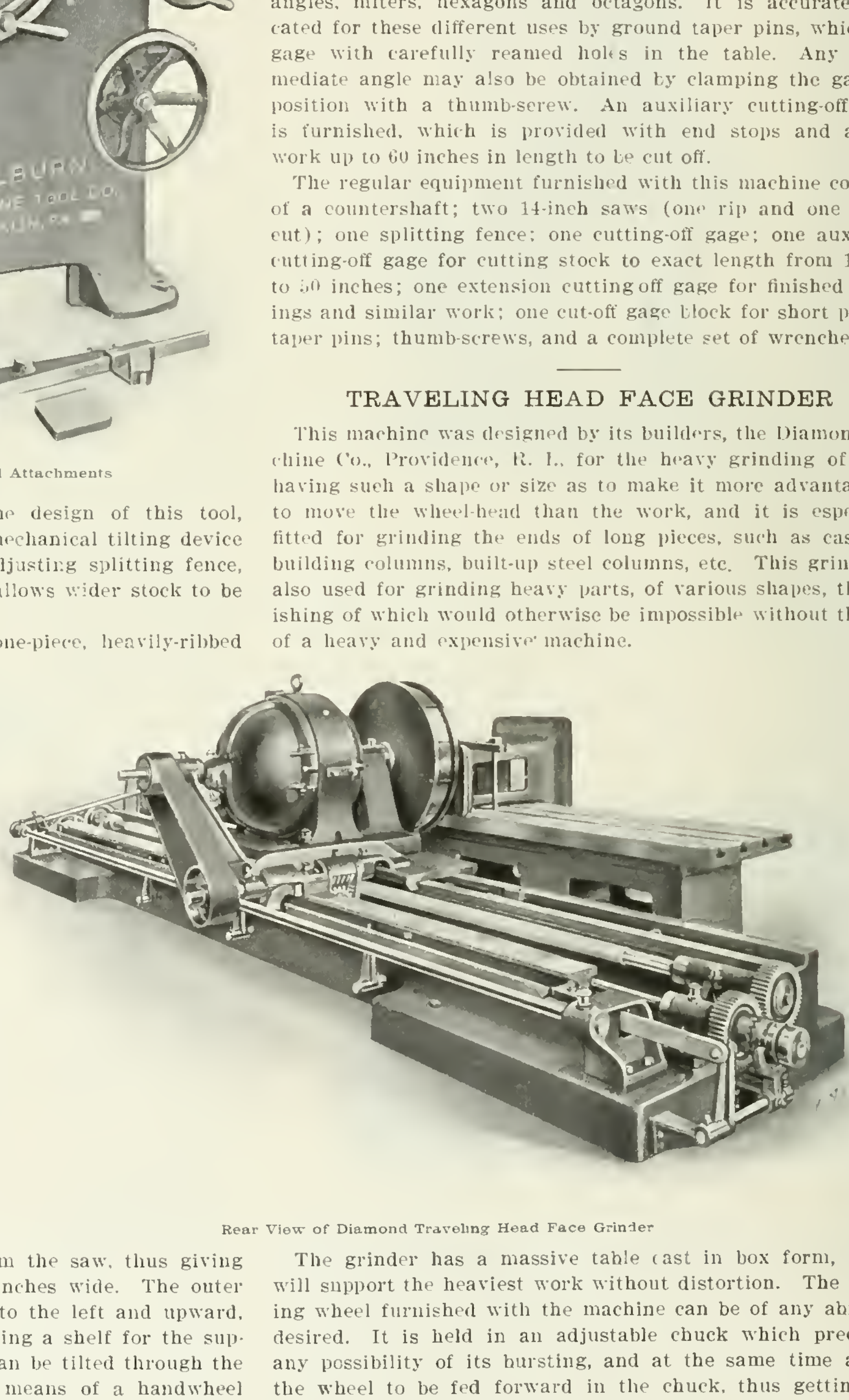
The ripping gage of this machine may be set to rip stock up to 21 inches in width, and it may be used either on the stationary or sliding table. When ripping is to be done with the table tilted, the gage is always placed on the left-hand or lower side, as the stock then has a firm support and heavy material is held by its own weight against the gage. When sawing out core-boxes or other hollows, the gage may be set diagonally to the saw. This gage tilts to an angle of 45 degrees with the table and it is provided with a small square block which may be attached to its face and used as a gage for cutting off short pieces. The use of this block prevents the pieces from wedging between the saw and the gage after they are severed.

The cutting-off gage may be set on the sliding table in two positions, one being for wide work and the other for average widths. This gage can be instantly set for cutting triangles, miters, hexagons and octagons. It is accurately located for these different uses by ground taper pins, which engage with carefully reamed holes in the table. Any intermediate angle may also be obtained by clamping the gage in position with a thumb-screw. An auxiliary cutting-off gage is furnished, which is provided with end stops and allows work up to 60 inches in length to be cut off.

The regular equipment furnished with this machine consists of a countershaft; two 14-inch saws (one rip and one crosscut); one splitting fence; one cutting-off gage; one auxiliary cutting-off gage for cutting stock to exact length from 1 inch to 60 inches; one extension cutting off gage for finished moldings and similar work; one cut-off gage block for short pieces; taper pins; thumb-screws, and a complete set of wrenches.

TRAVELING HEAD FACE GRINDER

This machine was designed by its builders, the Diamond Machine Co., Providence, R. I., for the heavy grinding of work having such a shape or size as to make it more advantageous to move the wheel-head than the work, and it is especially fitted for grinding the ends of long pieces, such as cast-iron building columns, built-up steel columns, etc. This grinder is also used for grinding heavy parts, of various shapes, the finishing of which would otherwise be impossible without the use of a heavy and expensive machine.



Rear View of Diamond Traveling Head Face Grinder

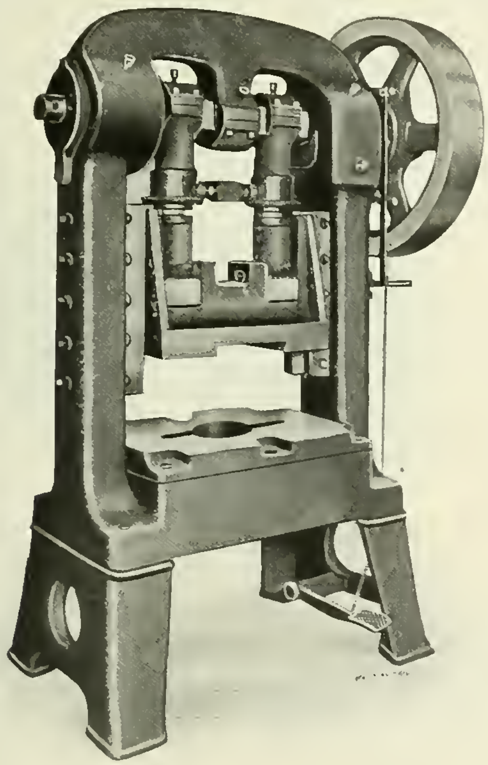
The grinder has a massive table cast in box form, which will support the heaviest work without distortion. The grinding wheel furnished with the machine can be of any abrasive desired. It is held in an adjustable chuck which precludes any possibility of its bursting, and at the same time allows the wheel to be fed forward in the chuck, thus getting the maximum amount of wear from it. The motor is mounted

upon the grinding wheel spindle and has sufficient power for the heaviest work. The front bearing of the wheel-spindle is a ring-oiling bronze held in a massive support that is cast solid with the traveling head. The longitudinal feed of the wheel-head is obtained from the rear end of the wheel-spindle through a belt and gearing, as shown in the engraving; the belt acts as a safety clutch, and slips in case the wheel is brought up against any obstruction. The automatic feed of the wheel to and from the work is obtained from the same source. The longitudinal feed is automatic, its direction being changed either automatically or by a hand-lever conveniently placed. The operator has all necessary control from one position. In the design of this machine the details have been carefully considered. A liberal means of oiling all bearings, both cylindrical and sliding, has been provided. All gears are cut and are of suitable material for the work required.

The principal dimensions of this grinder are as follows: Total travel of head, 144 inches; cross-feed of head, 4 inches; length of slide bearings, 60 inches; size of table, 25 by 144 inches; height of table from floor, 24 inches; length of main ways, 216 inches; distance across the ways, 32 inches; height to center of spindle, 34 inches; length of spindle bearings, 10 inches; and diameter of spindle in the bearings, 3½ inches. The table length can be changed to suit individual requirements.

STANDARD DOUBLE-CRANK PRESS

The double-crank press illustrated herewith is a modification of the regular line of "J" presses built by the Standard Machinery Co., 7 Beverly St., Providence, R. I. This machine is fitted with an instantaneous Horton roller friction clutch



Standard Machinery Co.'s Double-crank Press

that permits less than 1/32 inch travel of the periphery of the wheel after it is engaged. The driving wheel on the plain press is 60 inches in diameter and weighs a ton in the rim, whereas on the back-geared press it is 42 inches in diameter and weighs 1400 pounds. The slide of the machine is made extra wide to accommodate blanking dies of a large area. The thrust blocks in the ram are of bronze and the connections are of high-grade iron and steel. Both connections are adjusted simultaneously by turning the squared shaft down with a wrench, the movement being imparted to the adjusting screws through bevel gears. This method makes it comparatively easy to adjust the ram. The ram without any attachments, weighs 1000 pounds and with boxes, lower connection, attachments, etc., it will weigh between 1800 and 2200 pounds. Notwithstanding this weight, however, it can be adjusted with comparative ease by using a 14-inch wrench.

The dimensions of this machine, which is made in both geared and plain types, are as follows: Distance between uprights, 44 inches; length of bed front to back, 28 inches, right to left, 52 inches; distance from ram to bed (stroke down), 13 inches; length of stroke, 3 inches; adjustment, 1½ inches; over-all height of machine, 112 inches; and floor space, 60 by 75 inches.

ROBEY-SMITH BEVEL GEAR PLANER

The accompanying halftone shows the Robey-Smith automatic bevel gear planer. This machine is an improved de-

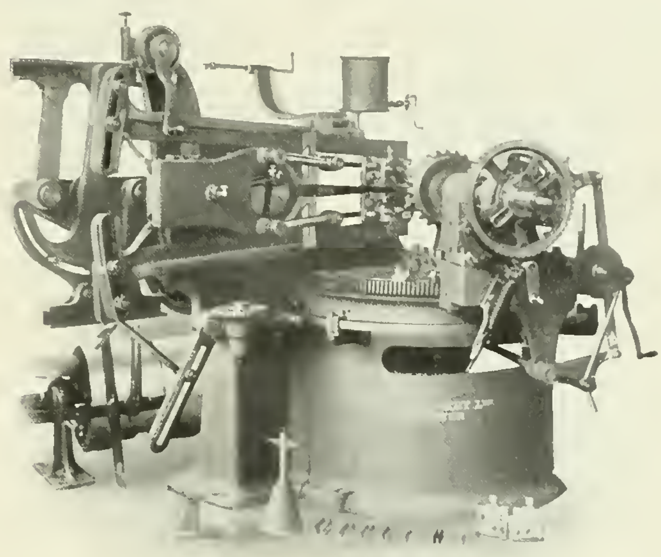


Fig. 1. Robey-Smith Bevel Gear Planer with Improved Indexing Mechanism

sign, the American rights for which have recently been acquired by Schuchardt & Schütte, Cedar and West Sts., New York. In the old model, the operation of the machine was accompanied by considerable noise in connection with the indexing mechanism, the movement of which was effected by a cam and a number of levers. In the new model, these levers have been replaced by a positive chain drive, which has overcome the objectionable feature mentioned. This chain, which is located at the rear, transmits power from the driving cone to a sprocket which is secured to a shaft that runs through the base to the front of the machine. This shaft, which is offset to an angle of 12 degrees by means of a universal joint, transmits motion to a pair of bevel gears. To one of these gears is secured the link motion operating the pawl that advances the indexing plate on the spindle carrying the gear blank.

In the operation of this machine, two planing tools are used, one on each side of the tooth. These tools are attached to slides that are mounted on pivoted arms which converge on a center intersecting the apex of the pitch cone of the blank being cut. The tools move backwards and forwards on the pivoted arms, and, at the same time these arms are gradually opened and closed so that the distance between the tools is varied and curves are formed on the teeth being cut. The saddle carrying the blank to be cut has a rotary motion about a center that is directly under the apex of the pitch cone of the blank, and it is this rotary motion which feeds the blank

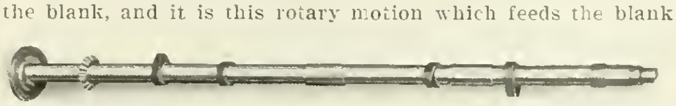


Fig. 2. Gear-cutting Operation performed in Robey-Smith Machine

to the tools, the movement being automatically stopped when the proper tooth depth has been cut. As the illustration shows, the saddle is connected with the pivoted arms carrying the slides and cutting tools, by a circular bar having teeth cut in it at one end. Meshing with these teeth there is a quadrant, which, through a pair of bevel gears, a slotted

lever and a connecting-rod, controls the swinging parallel motion which, in turn, controls the pivoted arms. The blank is rotated a distance equal to the pitch for each stroke of the tools. See MACHINERY, August, 1908.

In Fig. 2, a gear-cutting operation that is performed on this machine, and one that will doubtless interest automobile manufacturers, is shown. The piece illustrated is a gas engine cam-shaft, and the bevel gear seen near the flanged end forms an integral part of the shaft. When cutting the teeth of the gear, the flanged end is held by a chuck in the work-spindle, and the outer end is supported by a rest. The advantage in having the gear integral with its shaft is, of course, obvious. The equipment furnished with this machine includes three gages for setting the tools and one for setting the blanks in position; eight pairs of high-speed steel cutting tools; complete overhead driving apparatus, and the necessary wrenches.

BANTAM BALL-BEARING PILLOW-BLOCK

A type of ball-bearing pillow-block that is manufactured by the Bantam Anti-Friction Co., Bantam, Conn., is shown in Figs. 1 and 2. These bearings are intended for excessive or high speeds. Fig. 1 shows the bearing assembled, while Fig. 2 is a view of it partially disarranged, the plates being removed so as to show the ball races, method of oiling, and the clamping arrangement of the inner spool. This clamping is effected by a conical sleeve that is fitted to the tapering bore of the inner race. The shaft passes through the bore of this sleeve and the latter, which is split to allow the necessary contraction, is tightened on this shaft by being drawn into the inner race by a collar that is screwed on the threaded end of the sleeve and against the race. This simple method of clamping the inner race—

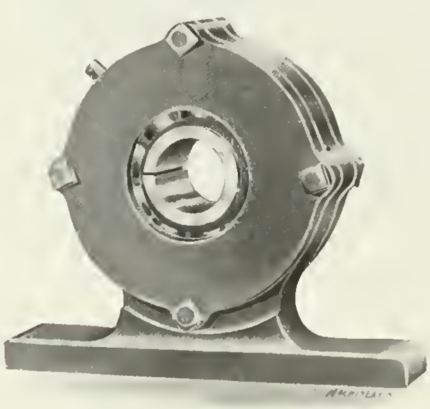


Fig. 1 Ball-bearing Pillow-block for High Speeds

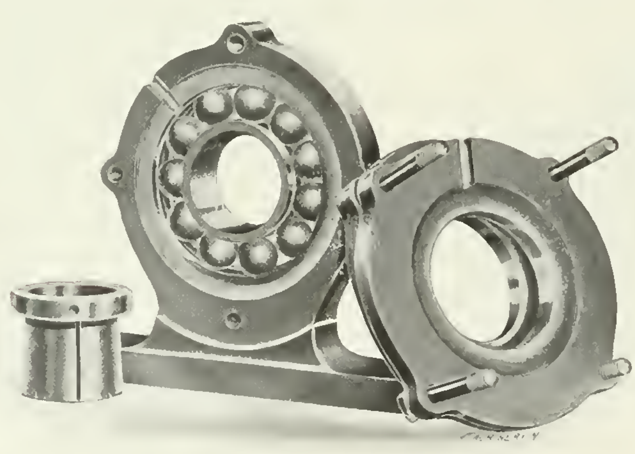


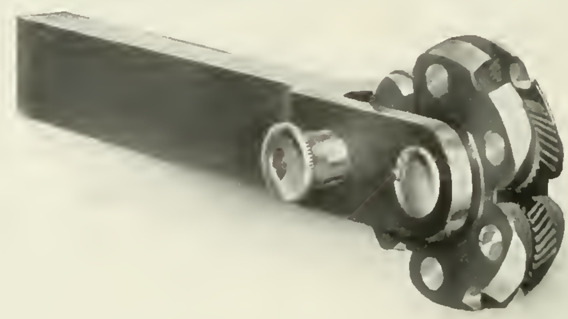
Fig. 2. Pillow-block with Side Plates removed

known as the "adapter" method—makes it possible to quickly attach or remove one of these bearings from its shaft.

This type of bearing has been employed with successful results in connection with hat machinery and similar lines. The races are not made of so called "tool steels," but of high-grade close-fiber machinery steels, that are carefully and well casehardened.

MILLER TOOL CO.'S KNURLING TOOL

The knurling tool shown herewith is known as the "six-in-one," the name being derived from the fact that there are six knurls available that may be used either in pairs or singly. The knurls are arranged in pairs of the same pitch, so that three grades of cross and a similar number of single knurls may be obtained. When a single knurl is being used, the screw shown at the side of the tool is used for locking the turret. The knurls are all machine-cut, and they are mounted

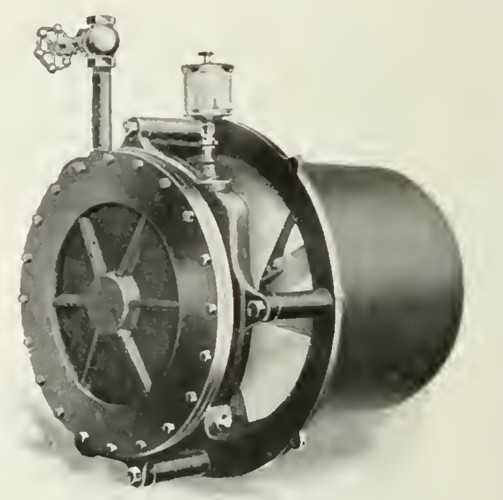


Knurling Tool with Three Sets of Knurls

on hardened pins of tool steel. The holder and turret are of pack-hardened machine steel, and all working parts are accurate and true. This tool is suitable for use on engine lathes, turret lathes and screw machines and for both heavy and light work. It is made by the Miller Tool Co., New Britain, Conn.

STURTEVANT TURBO-UNDERGRATE BLOWER

The B. F. Sturtevant Co., Hyde Park, Mass., has recently placed on the market a compact design of turbo-undergrate forced draft set that is intended particularly for electric power plants that need increased draft during the peak of the load,



Blower with Propeller-type Fan driven by Direct-connected Turbine

and for plants that have outgrown their stack capacity, heating systems, etc.

The construction of this blower set is simple and durable. It consists of a single-stage impulse steam turbine that is direct connected to a propeller-type fan. The bucket wheel of the turbine is a solid steel forging carefully machined, the steam buckets being milled in the periphery of the bucket wheel. The steam nozzles are made of Tobin bronze and they are held in place by composition draw-up nuts. The construction of the steam case gives accessibility to the steam nozzles for inserting, removing or cleaning them.

An ample dust-proof phosphor-bronze bearing and thrust washers are provided with oil cup lubrication. The bearing is so constructed that it can be renewed at a small cost.

The fan is built up and consists of six polished sheet aluminum blades rigidly fastened with hard drawn copper rivets into a bronze hub, which is finished all over to secure the proper balance necessary for the high rotative speed of these sets. The materials used in the construction of the fan insure mechanical strength and also corrosive resisting power. The stationary members of the blower set are constructed of cast-iron parts of ample strength and rigidity.

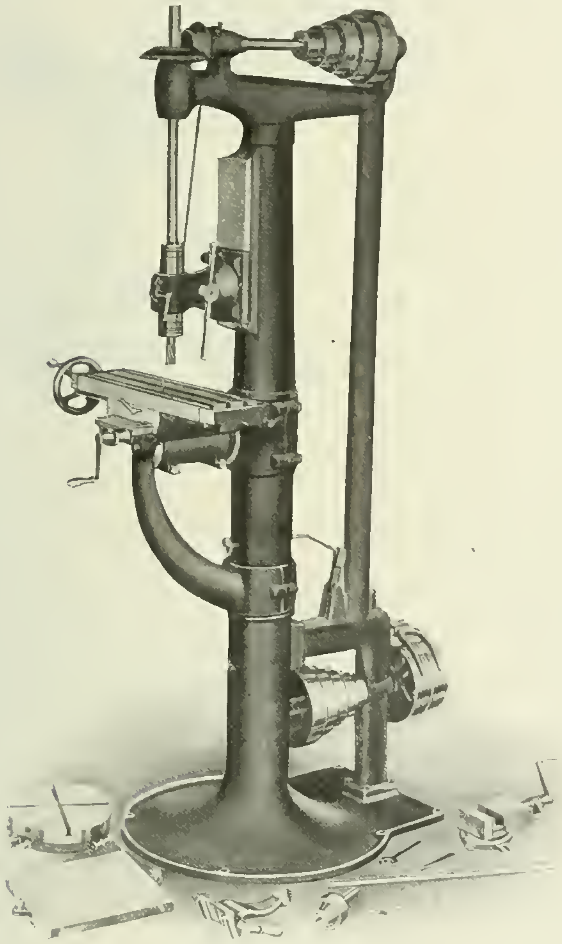
This blower is practically silent in operation, and it requires a minimum amount of attention as it can be controlled by a hand damper regulation or by regulating valves operated by the boiler steam pressure.

As the exhaust steam from the turbine contains no oil, it may be used to advantage for any work to which exhaust steam may be put, as in feed-water heaters, heating, etc.

KNIGHT NO. 1 DRILLING AND MILLING MACHINE

The W. B. Knight Machinery Co., 2019-25 Lucas Ave., St. Louis, Mo., has just placed upon the market the improved type of combined drilling and milling machine shown in the accompanying engraving. This machine is said to have nearly three times the cutting power of the No. 1 size formerly manufactured by this company, and it is much more rigid in its construction. Among the changes may be mentioned the improved form of drive, the addition of a back-supporting brace to the column, and a different design of table-supporting arm.

This machine is designed for performing a variety of both drill press and vertical miller work. The table is so mounted on its supporting bracket that it may be tilted to any desired angle, and its angular position is indicated by suitable graduations. It may also be swung about the column and it is provided with longitudinal and cross-feed movements. Both



Combination Drilling and Milling Machine

feed-screws are equipped with graduated set collars, which may be used to advantage for laying out accurate work.

A drill plate is furnished with the machine, which may be bolted on the slotted table and used for plain drilling. The circular attachment shown at the left of the base, will be found useful for milling out dies, cams, and circular pieces having special shapes, the latter being accomplished by using special cutters. The equipment also includes a swivel graduated vise, a chuck, and a drill guide. The latter attachment, which is seen in front of the base, is fastened when in use, to the column just below the sliding head, and the projecting arm is used to steady the drill which passes through it. This device may be employed to advantage when laying off and drilling holes in dies, jigs, templets, or for other work where accuracy as to the distance between the holes is required. It is also useful for drilling holes in a surface which is not at right angles with the drill, as the guide prevents the latter from running to one side. These attachments, together with the universal adjustment of the table, adapt the machine to a large variety of work.

MOTOR DRIVE FOR SENECA FALLS SPEED AND WOOD-TURNING LATHES

In the accompanying engraving is shown an electric motor drive for 10-inch speed and wood-turning lathes as applied by

Wood-turning Lathe with Motor Drive

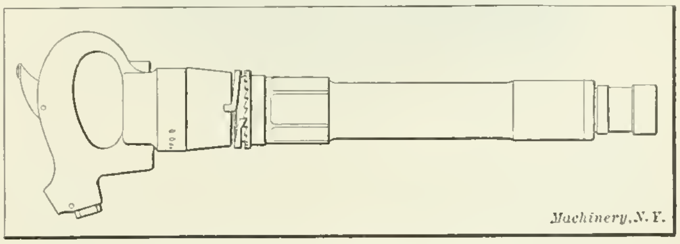
The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y. It is similar to the motor drive this company has been using for some time on their screw-cutting engine lathes.

The upright countershaft frame is hinged on a bracket that is attached to a leg; and the cone belt is tightened by turning the hand-crank shown on the bracket. The belt from the motor is tightened by a hand nut, and both belts can be kept at the proper tension without shortening them, until worn out. The bearings of the countershaft have oil rings the same as the head spindle bearings of the lathe.

An important advantage of this type of drive is that any constant-speed motor may be used, and preferably a small motor 1/2 or 3/4 horsepower of high speed, as they cost less than slower speed motors. Many motor-drive attachments are confined to one or two kinds of motors and therefore cannot be used on all kinds of current. Variable-speed motors can be used if desired, and will be found desirable on some classes of work.

MONARCH PNEUMATIC RIVETER

The Monarch pneumatic riveter manufactured by the Standard Railway Equipment Co., of St. Louis, Mo., has been fitted with an improved self-tightening spring-locking device which makes it impossible for the barrel and handle to become loose



Pneumatic Riveter with Spring Locking Device

in service. As the engraving indicates, this device consists of a spring which engages a slot in the handle casting on one side and the teeth of a locking collar on the barrel. When it is desired to remove the handle, the barrel is gripped in a vise

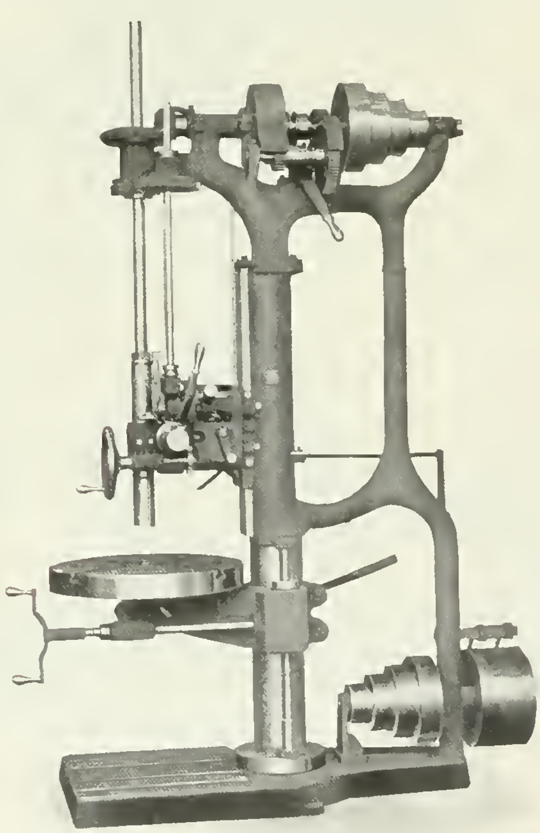
with the handle up and the tooth part of the spring is then disengaged from the collar by means of a screw-driver or small chisel. In order to keep the spring from engaging the collar teeth while unscrewing the handle, a piece of sheet metal should be placed between the spring and the collar for the former to slide upon. A bar is then placed through the grip hole of the handle which is unscrewed the same as an ordinary nut.

The riveter itself is simple in construction and high-grade materials are used throughout. The barrel is made of special vanadium steel, and the valves, valve-block and piston are of tool steel. These hammers are fitted with a safety device when specially ordered to prevent the accidental shooting out of the piston or rivet set.

KERN IMPROVED UPRIGHT DRILLING MACHINE

The machine illustrated herewith is one of the new line of standard upright drills built by the Kern Machine Tool Co., Cincinnati, O., for general manufacturing purposes. The principal improvement in this machine over this company's standard construction is in the effective device used to obtain the eight positive feeds furnished with this line. As will be noted, the feed box is placed on the sliding head, utilizing the space back of the quick approach and return lever. When located at this point, it does not interfere with the full traverse of the sliding-head in either direction and permits the box to be of sufficient size to allow the feed gears and shafts to be of ample size and coarse pitch. This gives an easy torque to the shafts with a consequent high efficiency and long life to the mechanism.

The feeds provided range from 0.006 to 0.048 inch per revolution of the spindle. All changes are made without stopping



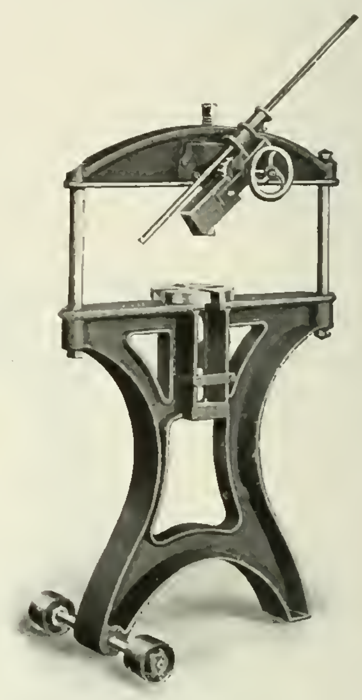
Kern Upright Drilling Machine

the machine, and the principle embodied in the box is the well approved tumbler and sliding-gear design.

Another feature worthy of mention is the improved automatic trip to the feed mechanism. This is located directly on the feed shaft in the form of a saw-tooth clutch, and is operated either by hand or by a suitable trip-dog located on the sleeve rack, and adjustable to any depth within the range of the spindle. This does away with the gravity or drop worm box, and permits a constant full contact between the worm and worm-wheel at all times. A suitable "shearing-pin" is placed in the feed shaft to protect the feed box against accidents. The machine is fully gear-guarded, and has eight changes of speed. It drills to the center of a 25-inch circle and has a spindle traverse of $9\frac{1}{4}$ inches. The spindle is bored to receive a No. 4 Morse taper. The back gears have a ratio of 6.5 to 1, and a bevel gear ratio of $2\frac{1}{4}$ to 1. The traverse of the sliding head is 17 inches, and the traverse of the table arm on the column, 15 inches. The net weight of the machine is 1600 pounds.

GREENERD EXTRA-CAPACITY ARBOR PRESS

A new design of arbor press has just been brought out by Edwin E. Bartlett, 326 A St., Boston, Mass. These presses are to be built in three sizes, known as Nos. 13, 14 and 15. They will correspond in power to the Nos. 3, 4 and 5 Greenerd presses, but the capacity for diameters is increased, the No. 13 press taking 30 inches, while the two larger sizes have a capacity for diameters up to 36 inches. The distance over the plate can be easily increased by making the side-rods longer. As the accompanying illustration of the smallest, or No. 13 size, shows, these extra-capacity presses are mounted upon wheels which makes it easy to move them about the shop—an advantage which many will appreciate. In connection with the forcing mechanism, there is a ratchet and pawl which makes it always possible to use the lever in the most efficient position, the ratchet being keyed fast to the pinion while the pawl is held in the casting through which the lever passes. The lever is counterbalanced, as shown, so that it will automatically come to a vertical position; the pawl is then disengaged and the ram is free to be moved by means of the hand-wheel shown. The lever is free to slide in its casting so that the leverage employed can be varied as more or less power is required, there being an advantage, of course, in shortening the lever for light work. A soft metal bottom pocket for retaining the arbors or mandrels is provided, and is a feature which experience has proved to be advantageous.



Greenerd Arbor Press

FARWELL GEAR TESTER

The Farwell gear-testing machine shown in Figs. 1 and 2 has been designed by the Adams Co., 714 White St., Dubuque, Iowa, for testing spur gears ranging in size up to 30 inches between centers. Any inaccuracy in the diameter or depth of the teeth is shown by this device, and skew teeth or gears cut eccentric with the bore may be detected. The clearance and the running of a pair of gears on correct center distances may also be tested.

Mounted on the cross-rail of this gear tester, there are two heads—one stationary and one movable—in which are inserted the arbors that hold the gears while they are being tested. The sliding head is moved and set by means of a screw, and a ratchet relief is provided in the crank handle as a safety device to prevent injury to parts by the careless jamming of the gage or gears.

The screw controlling the movement of the sliding head is cut with great care and accuracy, and a 12-inch adjustable micrometer gage is furnished for checking up the setting of

the micrometer disk on the end of the screw. When using the 12-inch gage for checking the adjustment, it is set to 11½ inches when one-half-inch arbors are used, or to 11 inches when 1-inch arbors are employed. The top of the upper rail has a scale graduated to read in inches and tenths of an inch. The finer measurements are obtained from the large mi-

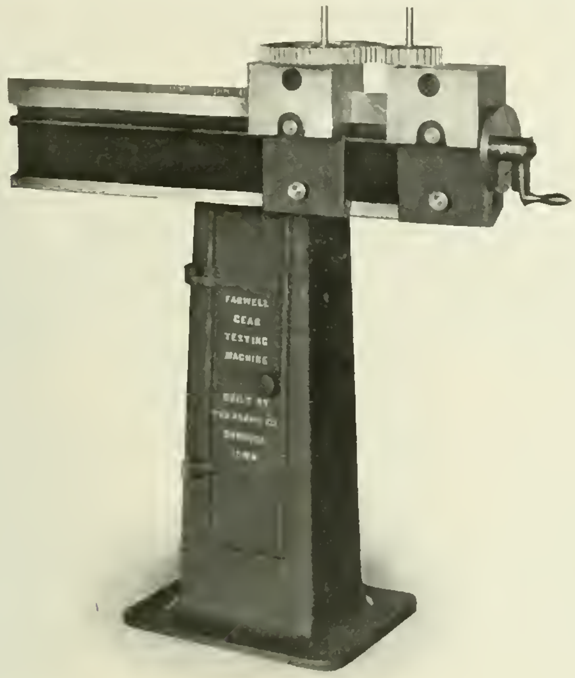


Fig. 1. Farwell Gear Testing Machine

crometer disk at the right end of the screw, which is graduated to read in thousandths, while a block on the head gives readings of quarter thousandths. This micrometer disk is more clearly shown in the detailed view, Fig. 2.

The screw for moving the outer head is supported in the stationary head by a series of collars having angular sides that run—as does the Acme-threaded screw—in split babbitt nuts. The lower thumb-nut in the heads enables the nuts on the screw and collars to be kept as tight and free from lost motion as is consistent with the free working of the screw. A gib,

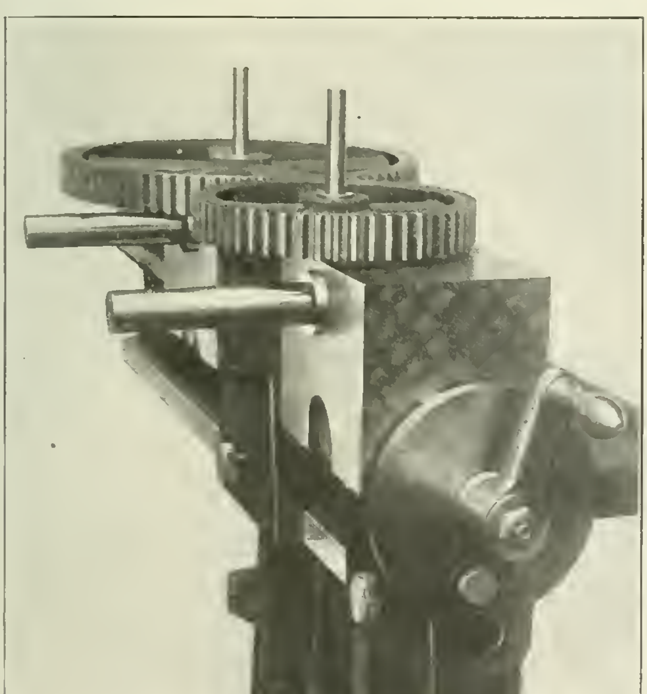


Fig 2. Detail View of Gear Tester showing Gears on the Vertical Arbors, and Micrometer Disk for Fine Measurements

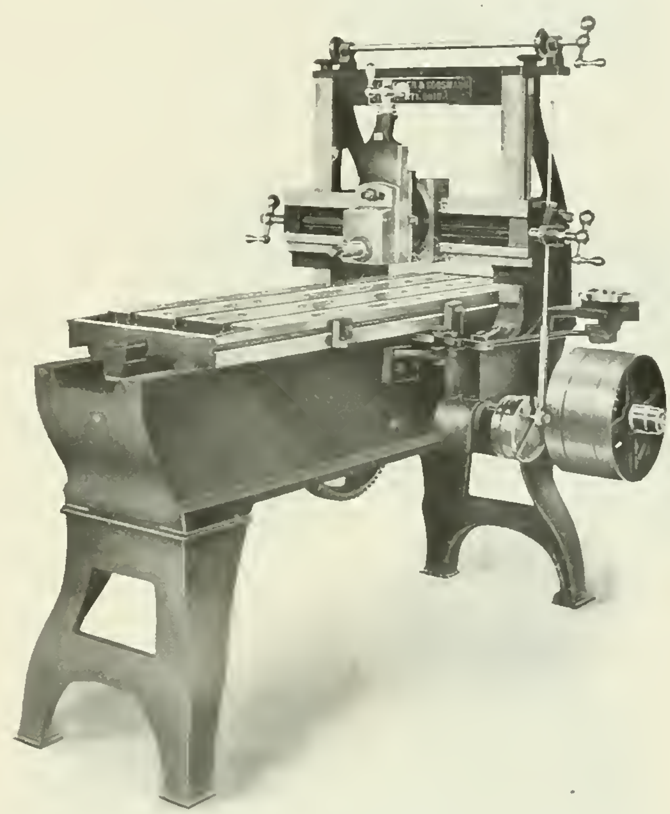
adjusted by a thumb-screw, prevents any lost motion between the sliding head and the rail.

The arbors are inserted in the vertical holes for testing center distances, the gears being placed in the position illustrated. A practical test for noise may be made by placing the arbors in a horizontal position and adjusting the gears to the center distance where they run best. During this test the gears may be driven by a belt.

The equipment furnished with this machine includes two ½-inch arbors, two one-inch arbors, and one 12-inch micrometer checking gage. A shelf, which runs the entire length of the bed, may be used to hold gages, arbors, bushings, etc., when the machine is in use, and the cabinet in the column provides room for storing these parts.

SCHNEIDER & GOOSMANN PLANER

The Schneider & Goosmann Machine Co., 1929 Race St., Cincinnati, O., is now building the design of 16-inch by 16-inch by 3-foot planer shown in the illustration. The various parts of this machine have been carefully proportioned and those which are subject to strain are substantially reinforced. The bed is deep and well-ribbed. The shafts are made of high-grade machinery steel, and all shaft bearings are long. The pulley shaft and also the intermediate shaft run in interchangeable bushings. The table measures three feet inside the scrap pockets, and it has a steel rack four feet long so



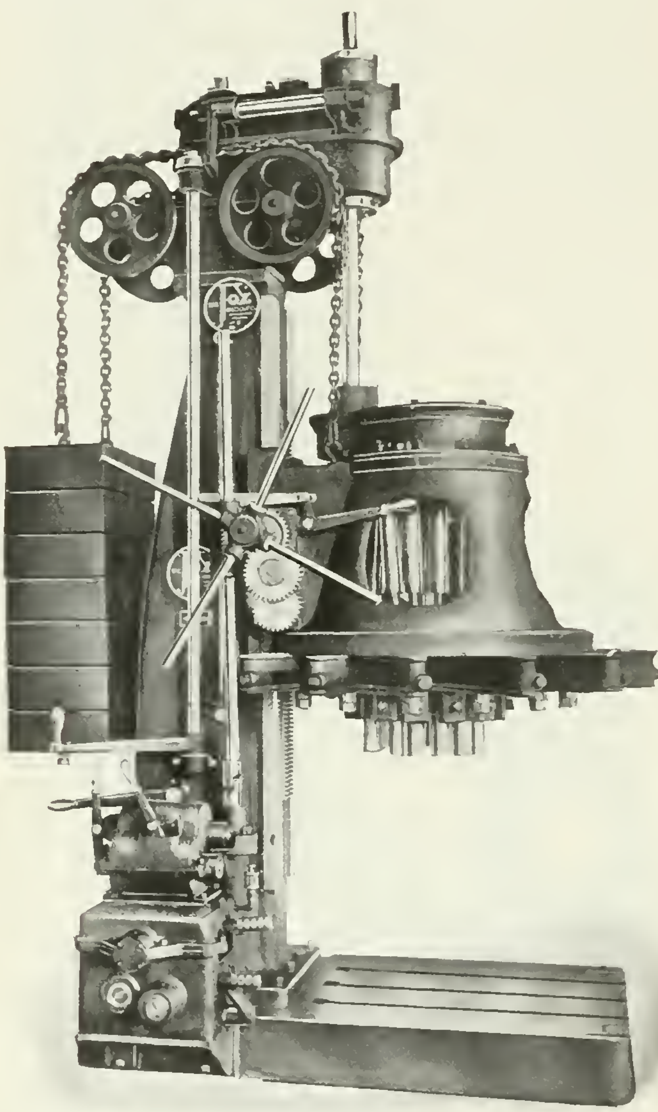
Schneider & Goosmann 16-inch by 16-inch by 3-foot Planer

that work three feet in length may be planed if necessary. A clamping device has been provided to prevent the table from lifting when extreme lengths are being planed. These clamps are located on the inside of the bed at the center and bear upon grooves cut in the table just above the V's.

The belt-shifting mechanism moves one belt entirely off the tight pulley before beginning to move the other on. A safety plunger is provided that prevents the accidental starting of the planer when the driving belts are running on the loose pulleys. The ratio of the belt speed to the cutting speed is 32 to 1, and the width of the belts is 1¼ inch. The head and cross-rail, as well as the housings, are strong and have wide bearing surfaces, which are carefully scraped. The saddle is graduated, and the tool-slide, which has an exceptionally long range, is equipped with a micrometer dial on the feed-screw. The cross-feed is automatic in both directions. The countershaft has tight and loose pulleys 6 inches in diameter by 2 5/8-inch face; the flywheel is 11 inches in diameter and acts as a reversing pulley, and the other pulley is 5 inches in diameter. The net weight of the planer, complete with the countershaft and wrenches, is about 1150 pounds.

FOX MACHINE CO.'S DRILLING MACHINE

The Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich., has recently placed on the market a new multiple-spindle drilling machine. This machine, which is illustrated herewith, is known as the No. 5 drill, and it is intended for the drilling of gas engine frames, cylinder parts, automobile transmissions, pump flanges and work of a similar character. The machine is designed for either belt or motor drive. When a belt drive is furnished, a single constant-speed pulley is used, which is of large diameter and has a broad face. All changes of speeds and feeds are obtained through gear boxes, and the transmission is of the selective sliding gear type. All driving gears run in oil baths, and all main bearings are self-oiling and are of special bronze metal. The principal gears of the machine are of 3½ per cent nickel steel, and the gear teeth are generated upon a gear-hobbing machine. This machine has a capacity for drills up to 1½ inch in diameter, and eight drills of this size can be used at one time.



Fox No 5 Drilling Machine

A friction tapping device, located on top of the column, can be furnished with these machines. The clutches are of the expanding ring type, provision being made for their adjustment, as necessary. All levers are within easy reach of the operator, and provision is made so that the drills may be stopped without shifting the belt. These machines are built to drill to any rectangular lay-out up to 16 by 30 inches or to any circular lay-out up to 24 inches in diameter. The drill spindle bearings and supporting arms are of an improved type upon which patents are pending at this time. The main feature of the drill spindles is the exceptionally strong construction of the spindle bearings and supporting arms, which greatly reduces the drilling strain. Another feature of the spindle construction is that the drills, when set at very close centers, may be raised or lowered, as necessitated by varying lengths of drills.

There are six changes of spindle speeds varying from 200 to 675 revolutions per minute, and 6 changes of head feeds, which vary from 0.787 inch to 6.92 inches feed per minute. A single lever is used for engaging and disengaging the feed mechanism, and there is an adjustable stop for automatically releasing the feed. Special attention has been given to the covering of all gears so as to comply with the requirements of state laws.

This company is using a universal joint of its own design which has all the friction surfaces hardened so as to reduce the wear upon the joint parts. This feature, together with the small number of parts in the joints, gives them an exceptionally long life. The drill illustrated is equipped with a circular head which can be set to drill a lay-out of 24 inches maximum distance between drill centers. The machine weighs 10,000 pounds, and the weight is so distributed that the modern high-speed drills can be driven without straining any part of the machine.

MANVILLE WIRE-FORMING MACHINE

The Manville Bros. Co., 27 Benedict St., Waterbury, Conn., has recently brought out a new design of four-slide wire-forming machine. In the construction of this machine, which is shown herewith, particular attention has been paid to convenience in handling all adjustable parts, the parts having been so arranged that the operator can stand at the front of the machine and reach the clutch lever and the various adjustments for the straightener, feed, cut-off, former, tools and stripper.

The wire straightener on this machine is of the well-known double roll type and it is so placed that the operator can see the wire at all points as it passes between the rolls. The wire feed on the original Manville machine of 1854, was operated from a crank-plate on the end of the side shaft, through rocker-arms and connections to the feed slide. This mechanism has proved so efficient that it has been used in this late model, with such modifications as the present requirements demand.

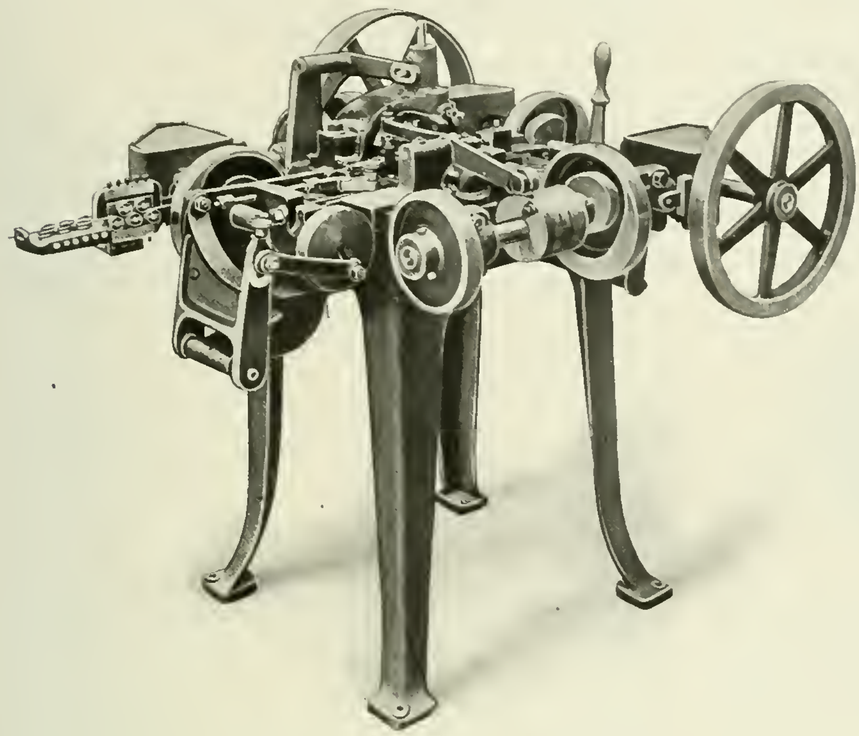
Two adjustments are provided for the feed: A main adjustment at the crank-plate consisting of a binding nut on the crankpin and a knurled adjusting screw for moving the crankpin to and from the center, and an auxiliary adjustment at the top of the rocker-arm (seen to the left) which raises or lowers the end of the main connection. The first is used for rougher adjustments, and the auxiliary for obtaining refinements in the feed not available heretofore. These adjustments in connection with the positive feed stop, eliminate all inaccuracy in feeding and result in perfect work.

The feed grip, which is operated by an independent cam and cross-slide, is so arranged that it will handle either wire or flat band metal. The grip-lever is so pivoted as to make the grip, in a way, self-tightening; that is, the greater the resistance to feeding, the tighter the grip. This grip-lever may be thrown in to or out of action, without stopping the machine, by a knurled handle on top of the lever. The customary slide friction, with its tendency to heat and cut, is not used, thus eliminating a source of much trouble experienced with the old-style feeds. With this feed it is not necessary to adjust the binder cam.

In machines of the older types, it has been customary to loosen two cap-screws, and drive the cut-off bracket to as near the correct position as possible, for the length of wire required. As this method would be out of place when used in combination with the refinements of feed adjustment on this machine, the cut-off bracket is arranged to be adjusted with a screw and miter wheels. With this arrangement, the operator, with one wrench, may loosen the clamp bolt and turn the screw adjustment until the cut-off is in the correct position, giving a degree of accuracy corresponding with that of the feed.

The slides, which are well fitted and scraped to a bearing, are supported by projecting shelves that extend from the edge of the bed, thus supporting them against the downward pressure at the cam rolls.

There has been much objection in older machines to the weak and springy nature of the bracket carrying the former, and, in attempts to overcome this weakness, the bracket has been enlarged until it has cut off the operator's view of the tools and the work. In the later machines built by this company, the bracket is in the form of an arch, and provides such a degree of rigidity that it can be cut away over the tools so as to leave a clear opening for observation of the work. These



Manville Four-slide Wire-forming Machine

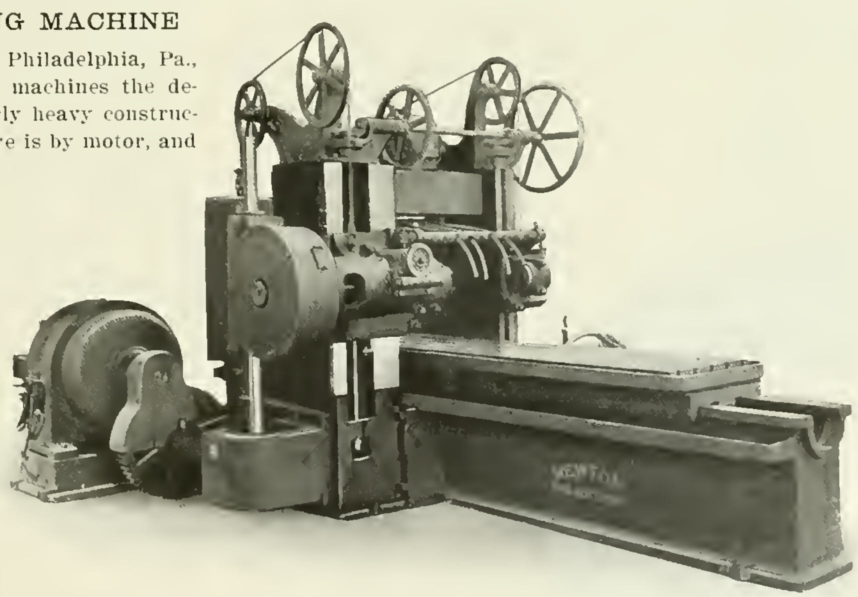
holders are fitted to take either round or rectangular shanks. The stripper lever is carried on an independent bracket bolted to the rear of the bed, and requires no re-adjustment when the form-holder is adjusted.

In place of the old-style tight and loose pulleys, the well-known Johnson clutch has been substituted. The use of a single pulley does away with the necessity for a countershaft, as the machine may be belted direct from the main line.

NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tools Works, Inc., Philadelphia, Pa., has added to its line of horizontal milling machines the design shown herewith, which is of particularly heavy construction. As the engraving shows, the main drive is by motor, and there is also a small auxiliary motor for elevating the saddle and outboard bearing. The work-table has a spiral gear and rack drive with a fast reversing traverse and three changes of geared feed.

The spindle is driven by a sleeve worm-wheel (23 9/16 inches in diameter), having a bronze ring with teeth of steep lead. The sleeve of the worm-wheel is 7 inches in diameter, and revolves in a bronze-bushed capped bearing, the main part of which is cast solid with the saddle. The driving worm is of hardened steel and it is fitted with roller thrust bearings, which are encased, thus giving continuous lubrication.



Motor-driven Horizontal Milling Machine built by the Newton Machine Tool Works

The face of the main upright upon which the saddle is mounted is 20 inches wide, and the length of the saddle bearing on the upright is 24 inches. Provision is made for elevating the outer end of the arbor support and the saddle in unison, to maintain alignment. The diameter of the spindle in the driving sleeve is 5 inches and in the main bearing 6 inches. There is a double taper bearing at the nose of the spindle, the large ends of which are 7¾ inches in diameter. The bearings in which the spindle revolves are bronze-bushed. The drive to the cutter arbor is by means of a broad-faced key. The spindle is fitted with a No. 7 Morse taper and it is arranged to hold the cutter arbor in place by means of a through bolt. The spindle sleeve is 9¾ inches in diameter and the bearing is 21¾ inches long. This sleeve has an in-and-out hand adjustment by means of a rack which engages a pinion connecting with the worm-gearing shown. The spindle sleeve is securely held in position by this adjusting mechanism and it is additionally locked by clamping the bearing, which is split.

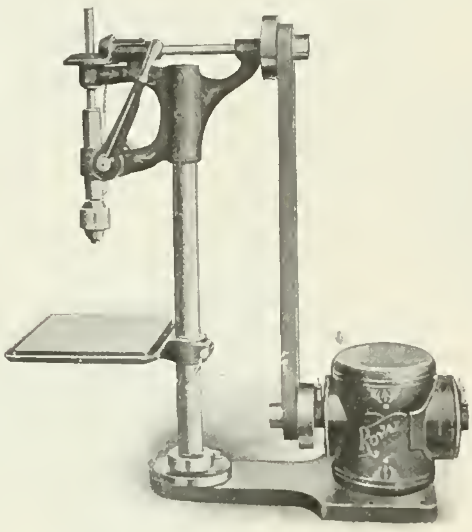
This machine will admit work 30 inches in width between the end of the spindle and the inner side of the outboard bearing, and work 32½ inches high will pass beneath the cross-slide at the top. The distance between the uprights is 34 inches, and the work-table is 27 inches wide by 10 feet 6 inches long over the working surface. This table is of the box-type construction and is entirely surrounded by an oil pan. It has square, lock gibbed bearings on the bed, and is 6½ inches deep above the shears. The bed is also of the box-type construction and is stiffened by special double ribs.

The outboard bearing has a horizontal adjustment in its support, which is also obtained by means of a rack and pinion movement. The bearing for the cutter-bar is capped and bronze-bushed and is fitted for a 3½-inch arbor. A handwheel is provided for elevating the saddle and outboard bearing, and the table may also be adjusted by a handwheel located on the operating side of the machine. All the operating levers are conveniently located to permit of their control from one position.

ROYAL ELECTRICALLY-DRIVEN SENSITIVE DRILL PRESS

The electrically-driven sensitive drill press shown in the accompanying engraving is made by the A. J. Deer Co., Hornell, N. Y. This machine is designed for automobile factories, garages, general repair shops and, in fact, wherever a light portable tool is needed. The current may be either alternating with a voltage of from 110 to 220, and a frequency of 60 cycles, or direct with from 110 to 220 volts. Three changes of speed may be obtained by means of the three-step driving cones. The spindle of this drill is counterbalanced

and the table has a vertical adjustment and can be swung about the column. The spindle is fitted with a chuck and has a lever feed. The principal dimensions of this drill are as follows: Greatest distance from the chuck to the table, 15½ inches; vertical movement of the spindle, 4 inches; vertical adjustment of the table, 15½ inches; distance from the center of the spindle to the column, 6 inches; size of the table, 10 by



Electrically-driven 12-inch Drill Press

12 inches; drill capacity, 1/2 inch; and net weight, 210 pounds.

The Royal sensitive drills are also made in two other styles, one being a 10-inch machine of the bench type, and the other a 12-inch size similar to the one shown in the illustration but with the addition of a column or pedestal for floor use. The motor for driving the 10-inch drill forms the base, and the drive to the spindle is by a round belt. Five changes of speed are provided on the smaller size and its dimensions are as follows: The greatest distance from the chuck to the table, 8¾ inches; distance from center of spindle to column, 5¼ inches; vertical movement of spindle, 2¼ inches; vertical adjustment of table, 8¾ inches; size of table, 8¼ by 10¼ inches; drill capacity, 1/4 inch; and net weight, 120 pounds.

CLEVELAND ARBOR PRESS

The accompanying engraving illustrates a new and unusually heavy arbor press recently put on the market by The Cleveland Machine Specialty Co., 202 204 St. Clair Ave., N. E., Cleveland, Ohio.

Cleveland Arbor Press

The frame is of box construction with a base 5 1/2 inches high and heavily ribbed to the full depth of the frame. The lever is counterweighted as shown, so that when released, it rises to the vertical position, at which point the pawl is automatically raised from the ratchet wheel so that the ram can be quickly adjusted to or from the work by means of the handwheel.

This press will take work up to 20 inches diameter by 15 inches high. It will force a 3-inch arbor into place and is capable of exerting a pressure of six tons. The machine weighs 430 pounds net, and it is designed to withstand the abuse to which these machines are so often subjected.

NEW MACHINERY AND TOOLS NOTES

Cabbaging Machine: Famous Mfg. Co., East Chicago, Ind. Machine for compressing all kinds of scrap metal, worked by hand, producing bales or "cabbages" suitable for re-melting. The machine is intended for the use of brass founders, scrap metal dealers, and manufacturers having much bulky scrap to dispose of.

Motor-driven Polishing and Grinding Stand: Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Portable motor and stand that can be arranged to operate small buffing, polishing and grinding wheels, ventilating blowers, etc. The motor is light and can be easily carried by means of a handle attached to the top of the frame.

Large Shear: Long & Allstatter Co., Hamilton, O. Large shear intended for shearing plates. The heaviest stock that can be cut at one stroke of the slide is 12 feet long and 1 inch thick. The stroke of the shear is 8 inches and the ratio of the gearing is 14 to 1. This machine is entirely self-contained and is equipped with a motor drive.

Wheel-lathe Tool Block: Putnam Machine Co., Fitchburg, Mass. Tool block for driving wheel-lathes, in which the tool is powerfully clamped by a cam-like projection formed on the end of the clamping lever which is raised by a screw that bears on the end of the tool shank, the tool being clamped at the front by the cam and at the rear by the screw.

Change Gear Boxes: New Haven Mfg. Co., New Haven, Conn. Complete quick-change gear-box in which thirty-two gradations of feed for turning or threading may be obtained by the manipulation of two levers. Also change feed box giving three changes which is operated by a single lever. These quick-change boxes are applied to the lathes built by this company.

Tap Wrenches: J. E. Poorman Co., Inc., 1825 Bristol St., Philadelphia, Pa. Tap wrenches furnished in three sizes (Nos. 4, 5 and 6) for taking taps, ranging from 1/16 to 3/16 inch, 1/8 to 1/4 inch, and 3/16 to 7/16 inch, respectively. The shanks have a knurled extension, which is very convenient for backing the tap out at high speed with the thumb and forefinger.

Bench and Toolpost Grinder: New York Electric Tool Co., 136 Liberty St., New York City. Electrically-driven combined bench and toolpost grinder. It can be held in the lathe toolpost for grinding centers, etc., and a rectangular base, which may be readily attached, converts it into a small bench grinder. The weight is 8 pounds and the diameter of the wheel, 3 inches.

Turbine Blower: Buffalo Forge Co., 490 Broadway, Buffalo, N. Y. Two-stage turbine blower which, because of the comparatively low speed required, can be directly driven by motor. Small capacities at high pressures are easily obtained at moderate speeds, for by using two or three stages, the speed can be reduced to that corresponding to one-half or one-third, respectively, of the total pressure.

Combination Rule: E. P. Johnson Rule Mfg. Co., 553 Monroe St., Chicago, Ill. Combination six-inch rule, protractor, tri-square, bevel and caliper. It consists of two parts which are pivoted together to form a protractor, and a sliding piece in one section, which is used as a caliper. The protractor has a vernier reading to one-half degree, and the tool, which is of German silver, is accurately graduated.

Die Casting Machine: Soss Mfg. Co., 435 Atlantic Ave., Brooklyn, New York. Machine for casting parts in metal molds under pressure, using an alloy of low melting temperature and high tensile strength. The metal is melted by gas and a large variety of castings can be made with it, individual molds being required, of course, for each piece. It is claimed that two men can operate it and turn out 4000 pieces per day.

Die Grinder: F. L. Schmidt, 21st St. and 11th Ave., New York City. Die grinder, the spindle of which can be placed either in a horizontal or a vertical position, as required, or at any intermediate position. Wheels are mounted on both ends of the spindle, and the latter may be adjusted while the machine is in motion. The drive is by a quarter-turn belt which connects the countershaft at the rear with the spindle, by passing over idlers at the top of the column.

Transferring Punch: E. C. Bliss Mfg. Co., Providence, R. I. Transferring prick-punch intended particularly for toolmakers' use. It consists of a base-plate and overhanging arm, both of which contain punches in exact alignment. When it is required to transfer a punch mark from one side of a piece to the other, the upper punch is brought down to coincide with one mark, and the second mark is made by pulling down and releasing the lower punch which is actuated by a spring.

Molding Machine: Henry E. Pridmore, Chicago, Ill. Heavy double-shaft stripping plate machines in both round and square types and intended to be operated as roll-overs with the service of a crane and hoist. The operation of making a mold on this machine consists in putting the flask in place, ramming

it up and clamping it to the bottom board of the machine; the entire equipment is then turned over and the pattern drawn from the mold, after which the machine is lifted and returned to the floor for making the next mold.

Four-spindle Indexing Attachment: Garvin Machine Co., Spring and Varick Sts., New York City. Attachment for holding spark plugs while the hexagons are being milled. Four plugs are held at a time and all are indexed simultaneously. The milling operation is performed before the plugs are threaded so that they are held by the smooth ends in double-tapered collets that are tightened by a wrench. When the work is completed, the collets are loosened, and the return of the table operates ejecting levers which force the pieces from the fixture.

Mechanigraph: Topping Bros., 122 Chambers St., New York City. Machine for making opaque drawing paper, on which a drawing has been made in pencil, sufficiently transparent for the production of blueprints. The drawing to be treated is passed between a pair of rolls which carry it through a bath that renders the paper translucent. It is then conveyed along a series of moving tapes to the drying rolls. This machine, with the exception of certain improvements, is similar to the "transparentizer" illustrated and described in the April, 1907, number of MACHINERY.

Tooth-rounding Machine: Schuchardt & Schütte, New York City. Automatic tooth-rounding machine for chamfering teeth of gears used in sliding transmissions, etc. The machine employs a profiling cutter mounted in a spindle, that may be swiveled to angles suitable for any gear tooth. The arbor on which the gears are mounted is indexed by a mechanism that is entirely automatic, thus making the operation continuous. Either a single gear or several may be operated on simultaneously, and the teeth can be rounded on both sides at the same setting. This machine has a capacity for gears up to 12 inches in diameter.

Shear: Cleveland Punch & Shear Works, Cleveland, O. Large shear built for cutting test pieces from plates, I-beams, channels, etc. The main frame is a solid steel casting, which weighs 35,000 pounds. All gears are of steel with machine-cut teeth, and the main driving gear is 7 feet 4 inches in diameter, with a 10-inch face. The flywheel is 6 feet in diameter and weighs 6700 pounds. The shear is provided with a clutch of the 8-jawed type, which is operated by foot-treadle or hand-lever in the usual manner. The drive is by 30 horse-power motor which is connected to the flywheel by a 10-inch belt. The complete machine, exclusive of the motor, weighs 70,000 pounds.

Floating Reamer: Kelly Reamer Co., Cleveland, Ohio. A recent improvement in the Kelly floating reamer, which insures both accuracy and finish without grinding, in cylinders from one inch to twelve inches diameter, and is being used with success for both turret lathe and cylinder work. The improvement consists of an adjustable rigid high-speed boring blade set immediately ahead of the reamer proper, its purpose being to take a final boring cut of about 0.01 inch leaving but 0.003 inch for the reamer to remove, and thus reducing the work done by the reamer blades. Reamers of this type have in the automatic machines at the plant of Timken Roller Bearing Co., Canton, Ohio.

Upright Drill: Mechanics Machine Co., Rockford, Ill. This machine is a recent addition to the line of upright drills manufactured by this company. The size is 28 inches, and the design is similar to the No. 32 machine illustrated in the April number of MACHINERY. There are eight changes of feed available, ranging from 0.004 to 0.051 inch per revolution of the spindle. All feed gears are milled from solid stock, and the drill is equipped with a geared tapping attachment if required. The head is adjustable on the column, and the maximum distance from the spindle to the base is 56 inches. The vertical feed is 13 inches, and the distance from the column to the center of the table is 14½ inches. The diameter of the column is 8 inches, while the spindle diameter in the sleeve is 1 15/16 inch.

Single-stroke Open-die Header: E. J. Manville Machine Co., Waterbury, Conn. Improved type single-stroke open-die header intended for heading long rivets, wood-screw blanks, bolts, etc., which are subsequently shaved to remove surplus stock and the fin under the head caused by the joint in the gripping and heading dies. This machine can also be employed for cutting and heading wire, where the fin marks are not objectionable. It is built in six sizes; the smallest size has a capacity for diameters up to 1/8 and a length of 1½ inch, and the largest, for diameters of ⅝ inch and lengths of 7 inches. This type lends itself to greater speed than a solid die, as the feeding of the stock ejects the finished piece without loss of time, and also because the blank is brought quickly in line with the heading punch.

Micrometer Caliper: Gilbert, Harris & Co., Chicago, Ill. Universal micrometer caliper which may be used for inside or outside measurements within its range. It has a range of 4 inches inside the frame, and the adjustments may be locked when set. The frame is drop forged and contains a sliding rod in one end for quick adjustment and a micrometer screw in the other for fine measurements and adjustment. This caliper can also be used for taking inside measurements, the sliding rod on one end and the micrometer head on the other being pointed for this purpose. There is also provided an attachment in the shape of two drop-forged arms which fit the sliding rod, so that the caliper may be set to two measurements at one time. These arms may also be used independently for a variety of purposes.

Piston Ring Grinder: Bay State Grinder Co., Worcester, Mass. Improved design of piston ring and surface grinder, having ample weight and stiffness to meet the requirements of any work within its capacity. The machine has a Walker magnetic chuck that is attached to a vertical spindle, which, in turn, is driven by spiral gears from the cone shaft, the gears running in an oil bath. This chuck is elevated by a graduated handwheel. The head on which the emery wheel is mounted is adjustable so that saws, cutters, etc., may be ground convex or concave if desired. This head is provided with three feeds. The spindles and shafts are ground, and have adjustable bushings that are thoroughly protected from dust. The pedal clutch-operating device is a noteworthy feature, as it enables the operator to start and stop the rotation of the chuck with his foot, so that the hands are left free. This same pedal also connects and disconnects the circuit which supplies the current for the chuck, though this can be operated by hand. The machine can be equipped with a vertical spindle and cup-wheel, if desired, and it can be arranged for either wet or dry grinding. A valve face grinding attachment for grinding single cams can also be supplied. A countershaft is not necessary as the drive is direct from the main shaft.

* * *

CORRECTION TO CARTER & HAKES BENCH MILLING MACHINE DESCRIPTION

In the article descriptive of the bench milling machine manufactured by the Carter & Hakes Machine Co., of Winsted, Conn., which appeared in the September number, the statement was made that the machine is built in two styles, one being a hand milling machine, with or without a vertical attachment, and the other a machine with both hand and power feeds for the table. This is erroneous, as the bench machine is not made with power feed or with a vertical attachment. The No. 3 hand milling machine built by the company can, however, be furnished with or without a vertical attachment, and also with both hand and power feeds for the table.

* * *

FLUX FOR BRASS FOUNDRY WASHINGS

In the melting of washings from brass foundry ashes, a flux must be used unless they are washed very clean. Even with clean washings a flux is advisable. The same applies to grindings, skimmings and similar waste materials. Unless a flux is used when they are melted, a union of the particles of metals is prevented by the presence of so much foreign matter, and instead of the full amount of fluid metal there is usually obtained a small quantity in the bottom of the crucible and a large mass of pasty material fritted together. When a flux is used the foreign matter is dissolved and clean metal is left. For a flux in melting brass, bronze or composition washings, grindings, skimmings and other material, I have found nothing better than plaster-of-paris. It is cheap and excellent for this purpose. It possesses the property of dissolving what foreign matter may be present in the shape of sand, slag or oxide, and it has practically no action on the crucible; any desired quantity can be used. It melts readily and forms a thin slag. To melt washings or grindings with plaster-of-paris, mix about 5 pounds of it with the washings when they are placed in the crucible. Then melt in the usual manner. If the slag at the conclusion of the melt is not sufficiently fluid, more should be added. When the metal is completely melted pour the entire contents of the crucible into ingot molds. Do not attempt to skim it. The slag will run into the molds with the metal and rise to the top. Allow the mass to cool and then dump the ingot molds. The slag of plaster-of-paris can be readily detached by a blow from a hammer, or it usually will fall off.—*Edwin S. Sperry in paper read before American Brass Founders' Association convention.*

ADDITION TO THE RYERSON PLANT

Joseph T. Ryerson & Son of Chicago have in course of erection additions to their already large plant, which will give them an increase of floor space, of approximately 85,000 square feet, making a total building floor area of over 800,000 square feet.

The new buildings are two in number—one is to be devoted to machinery warehousing and display and demonstration rooms, and the other to the storage of structural shapes and specialties. Both new buildings follow out the same general engineering and architectural design adopted throughout the plant. The addition to the machinery demonstration and display rooms is located north of the present machinery warehouse on Rockwell St., extending north to 14th St. This building is 350 feet long and 75 feet wide, of steel and brick construction with tile and glass roof. The floor is 3-inch planking crossed with matched hard maple over concrete. This building will be served by a 15-ton crane, spanning the full width of the building, the runways of which will extend over double switch tracks and a wagon runway at the south end of the building.

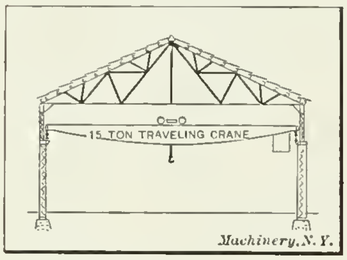


Fig. 1. End Elevation, Machinery Demonstrating Building, Joseph T. Ryerson & Son, Chicago

The building will be piped for compressed air, steam, gas and water, and both alternating and direct electric current will be available in all parts, which with lineshafting and belting will enable the company to test or practically operate any kind of machine. The building is of fireproof construction throughout, and when completed will be the largest machinery display and demonstration room devoted to an individual concern.

The structural specialty building is immediately south and adjacent to the present structural warehouse and extends 500 feet from Rockwell St., east to the Pennsylvania tracks. The building is 100 feet wide and of steel construction throughout. This building will be served by two cranes, each of 5 tons capacity and with 100 foot span. Double switch tracks extend across the east end, while in the west end there is a wagon runway.

These extensive additions to the Ryerson plant, coming at this period of general dullness and unsettled business conditions, are significant as representing the progress which that company has made in the "steel department store" idea and as further exemplifying the success which has attended such concerns as are in position to cater to the entire wants of the steel users.

* * *

At a recent meeting of the National Association of Cotton Manufacturers, Mr. Jos. Hope, of Rouen, France, exhibited a sample of a substitute of cotton made from spruce wood pulp. Cloth woven from the fiber is said to stand bleaching, dyeing and finishing as well as cotton, and to have a more brilliant luster. It is stated that it can be produced at a smaller cost than the market price of cotton, and that arrangements are made abroad for its manufacture on a large scale.

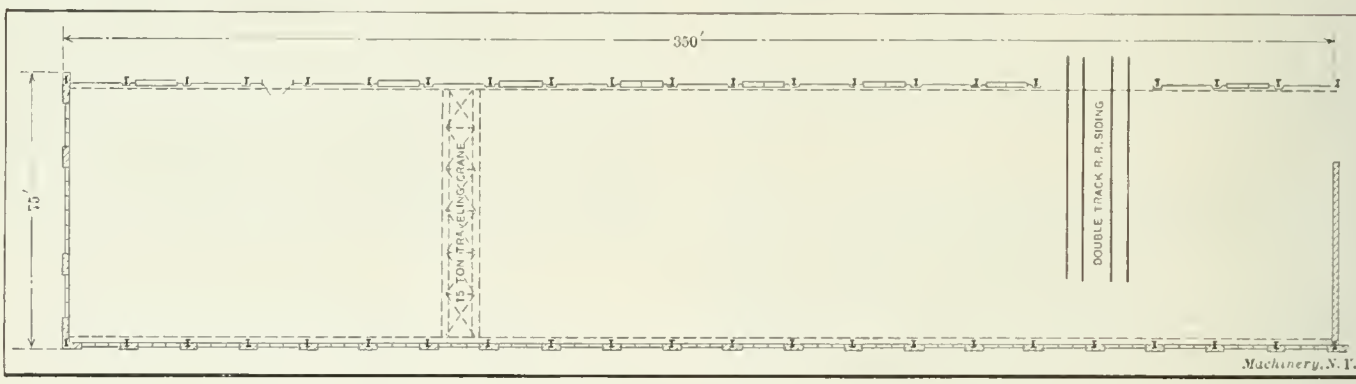


Fig. 2. Plan of Machinery Demonstrating and Display Building, Joseph T. Ryerson & Son, Chicago

DON'TS FOR ELECTRICIANS*

By H. E. WOOD†

Don't run wires crooked.
Don't use unenclosed fuses.
Don't put in wiring loosely.
Don't put up cleats with nails.
Don't use acid in soldering joints.
Don't nick a wire when skinning it.
Don't allow contacts to become dirty.
Don't read a meter from left to right.
Don't leave bad joints in the molding.
Don't put up any circuit without a fuse.
Don't let a switchboard get out of repair.
Don't leave any conduit pipe ungrounded.
Don't forget that mica is a good insulator.
Don't use the edge of a knife to clean wire.
Don't put too much tension on a drop light.
Don't work on inside wiring, with current on.
Don't leave conduit pipe improperly supported.
Don't leave a piece of work without testing it.
Don't forget that all joints should be soldered.
Don't throw a switch lever in or out too slowly.
Don't leave any binding bolts or contacts loose.
Don't put up rosettes without their proper fuse.
Don't leave litter or rubbish around a generator.
Don't use emery cloth or paper on a commutator.
Don't put fuse plugs where water can get at them.
Don't use pliers unless the handles are insulated.
Don't put in iron bolts where brass ones should go.
Don't be wasteful of wire or tape; they cost money.
Don't let the commutator get dirty or gummed up.
Don't let wires sag; they present a bad appearance.
Don't put any pulling strain on a portable lamp cord.
Don't make a splice without having the wires clean.
Don't try to replace fuses without pulling the switch.
Don't let a switch blade arc when throwing it in or out.
Don't put a motor or generator on a shaky foundation.
Don't overload a motor or generator for too long a time.
Don't believe that a wire is "dead" because others say so.
Don't slant holes downward where wires enter a building.
Don't leave loose bolts or nuts near a motor or generator.
Don't install a motor or generator in a damp or wet place.
Don't throw a switch before you know how it is connected.
Don't burn the insulation on wires while soldering a splice.
Don't splice a small wire and a large one together in a line.
Don't put in a lighting circuit without having it well fused.
Don't enclose a motor or generator so that it cannot get air.
Don't forget the lugs on switches for wire larger than No. 8.
Don't use dry batteries where a constant current is desired.
Don't leave dirty waste lying on a switchboard or rheostat.
Don't attempt to trim an arc light with "juice" on the wires.
Don't leave an open keg of nails near a generator or motor.
Don't leave the end of a conduit pipe without a bushing on it.
Don't put your hands on a generator when it is not necessary.
Don't shift the brushes when a motor is running at full speed.

* For "Don'ts" previously published in MACHINERY, see "Don'ts for Draftsmen" and "Don'ts for the Prevention of Accidents in the Machine Shop," July, 1910; "Don'ts for Planer Men," June, 1910; and "Don'ts for Machinists," March, 1910, with accompanying references.
† Address: 182 N. 4th St., Newark, N. J.

Don't forget that electricity is like the wind; it can't be seen.

Don't use a screwdriver unless the handle is properly insulated.

Don't put in a new brush without fitting it to the commutator.

Don't forget that rosin makes a good flux for soldering splices.

Don't think that all adults can stand the same amount of current.

Don't depend upon your head entirely to remember a wiring diagram.

Don't let a motor or generator run when it is sparking excessively.

Don't work on a running generator or motor with steel or iron tools.

Don't disconnect wires without tagging them, if they are to go back.

Don't fail to place switches where they will be handy in case of fire.

Don't carry steel tools in your pocket when working around a generator.

Don't get into the habit of twisting wires both ways in making splices.

Don't forget that platinum makes the most satisfactory sparking points.

Don't overload a circuit beyond the carrying capacity of the conductors.

Don't put your fingers on a commutator, as the oily effect is bad for it.

Don't splice an insulated wire and leave it without winding it with tape.

Don't put wires in dangerous places without protecting them thoroughly.

Don't throw the rheostat lever up too quickly, but give it the proper time.

Don't sweep the floor or raise dust near a generator when it is running.

Don't forget that pure coin silver makes a very satisfactory contact point.

Don't start up a new motor or generator without a thorough examination.

Don't use anything but authorized fuse in places where fuse wire is to go.

Don't put two solid carbons, or two cored carbons in an alternating current arc lamp.

Don't put wires near together crosswise, without bushings or circular loom work between.

Don't leave a key in a socket switch unless you are willing to have it tampered with in your absence.

Don't solder a joint up close to a wall or woodwork without asbestos protection between it and the wires.

Don't forget that dental cement will fill the crevices where mica is broken out of a commutator, and that it is a very efficient insulator.

Don't wind a large wad of tape over a splice, as it is sufficient to have the wire covered; the splice need not be much larger than the wire in other places.

Don't forget that both a generator and a motor should have a good blowout with a strong blast of air occasionally, to get rid of all the dust which accumulates there.

* * *

The exhibit of the commissary department of the United States Navy at the Domestic Science and Pure Food Exposition, Madison Square Garden, New York, September 17-24, gave visitors some idea of the extent to which machinery and apparatus is used on United States naval vessels for the preparation of food. The exhibit was of interest from an engineering standpoint, showing, as it did, advanced types of machinery for bread mixing, potato peeling, etc., and electrical apparatus for roasting, broiling and general cooking. Electrical ranges have the advantage of requiring only about three-fourths the space of coal ranges of equal capacity—a very important consideration in the equipment of a battleship, on account of the limitations of space.

INSPECTION OF YALE & TOWNE MANUFACTURING METHODS

The hoist sales department of the Yale & Towne Mfg. Co., New York, represented by Messrs. R. T. Hodgkins, manager of the hoist department, and H. C. Spaulding, New York district manager, entertained about thirty salesmen of the leading concerns selling Yale & Towne hoists, and others, on the afternoon and evening of September 16. The party inspected the factory at Stamford, Conn., and were then given a shore dinner at the Stamford Yacht Club House on Shippan Point. The object of the "get-together" was to impress on the salesmen the high quality of Yale & Towne products by showing them the processes of manufacture and methods of inspection, and to give them a forecast of the company's selling policy. The party evinced great interest in the manufacturing practice followed in making locks, builders' hardware, hoist chain, hoists, etc. The event is one that will be long remembered with pleasure by those whose good fortune it was to participate.

* * *

A brilliant example of the remarkable progress of aviation in 1910 is the achievement of George Chavez, a Peruvian, who flew over the Alps from Brigue, Switzerland, to Domodossola, Italy, September 23. Chavez made the flight in an attempt to win the prize of $20,000 offered by the Italian Aviation Society for a flight from Brigue to Milan, Italy, a distance of seventy-five miles. He followed the general route of Napoleon's famous road over the Alps through the Simplon Pass, and rose to a height of between 8000 and 9000 feet, thus probably breaking his own altitude record of 8271 feet, made September 3. Unfortunately Chavez lost control of his monoplane at that great height through the benumbing effect of cold and practically fell with the machine thousands of feet until near the ground where he recovered partial control and the fall was broken, but the daring aviator was so badly hurt that he died four days after.

* * *

A government report from Washington indicates that bicycling as a pastime is rapidly decreasing in popularity both abroad as well as in America. Statistics show a great falling off in exports of bicycles from the United States. In 1897, when bicycling was at the zenith of its popularity, $7,005,323 worth were exported; in 1900, the exports amounted to $3,553,149; and during the last fiscal year the exports totalled only $620,760.

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PERSONALS

Clifford Talbot, formerly with James Cunningham, Son & Co., Rochester, N. Y., has been made superintendent of the Selden Motor Vehicle Co. of Rochester.

Chester B. Hosford, for many years superintendent of the Haydenville Co., Haydenville, Mass., has taken the position of superintendent of the Bay State Brass Co., of Haydenville.

J. B. Canfield, master mechanic for the Boston & Albany R. R. at the Allston, Mass., shops, has been promoted to division master mechanic at the West Springfield, Mass., shops.

John B. Milliken has resigned the position of comptroller of the Crocker-Wheeler Co., Ampere, N. J., and taken the position of treasurer of the Yale & Towne Mfg. Co., Stamford, Conn. Mr. Milliken's headquarters will be in New York.

A. J. Fries, division master mechanic of the Boston & Albany R. R. at the West Springfield, Mass., shops, has been promoted to the position of division superintendent of motive power for the New York Central & Hudson River R. R., Buffalo, N. Y.

William H. Amidon, of Millers Falls, Mass., the only survivor of the original fifty workmen who started with the Millers Falls Co. forty-one years ago, was recently given a surprise party on his seventy-sixth birthday by over one hundred of his fellow workmen.

William M. Chamberlin, formerly secretary and treasurer of the Adcraft Club, Detroit, Mich., and general promotion manager of the Detroit Lubricator Co., Wright Mfg. Co., and the Austin Separator Co., has been appointed manager of the bureau of general promotion of the American Supply & Machinery Dealers Association, of Detroit.

Critchley Parker, publisher of the *Australian Mining Standard*, Melbourne, Australia, made a brief visit to the United States in September in the interests of the Australian com-

monwealth, his mission being to awaken in American manufacturers and business men an appreciation of the great opportunities for the development of industrial enterprises in Australia and its large potential market for machine tools, machinery of all kinds, etc.

Charles F. Kenworthy, a furnace engineer until recently with the engineering department of the American Brass Co., and formerly of the Kenworthy Engineering Co., has been engaged by the Rockwell Furnace Co., 26 Cortlandt St., New York, to represent it in the New England states and Canada. Mr. Kenworthy has devoted his entire time for the past eighteen years to the design and construction of furnaces and fuel apparatus and brings with him a large acquaintance among the builders and users of this line.

James Sherwood, a well-known steel salesman, has been appointed Canadian agent for Thomas Firth & Sons, Ltd., Sheffield, England. Mr. Sherwood took full charge of the Canadian trade October 1, with headquarters in Montreal. For five years past Mr. Sherwood has filled a responsible position in the sales organization of E. S. Jackman & Co., Chicago, Ill., agents for the Firth-Sterling Steel Co. Prior to that engagement he was the railroad representative in Canada of the Ewald Iron Co. He was closely associated in the development of the Firth-Sterling business in Chicago, and, also having had valuable experience as assistant manager and salesman in the old Chicago staff of Howe-Brown & Co., and Park Bros. & Co., is well qualified for his present position.

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OBITUARIES

George M. Gerry, for over fifty years a manufacturing machinist at Athol, Mass., died August 31, aged seventy-three years.

Aaron W. C. Williams, treasurer and manager, and one of the founders of the Capewell Horse Nail Co., Hartford, Conn., died August 4.

M. M. Joslyn, of Springfield, Mass., died recently in Yokohama, Japan, aged thirty-nine years. Mr. Joslyn was a skilled draftsman and toolmaker, and had held several important positions. He went to Japan about a year ago as manager of the American Graphophone Record Co. of New York. He formerly was superintendent of the American Record Co. which was absorbed by the trust three or four years ago.

John W. Russell, president of the John W. Russell & Sons Co., Springfield, Mass., died at his home August 31, aged eighty-seven years. Mr. Russell began his apprenticeship to the machinist trade seventy-two years ago with Zelotus Lombard, and with the exception of a short run of "California gold fever" in '49 and '50, had been continually in the machinists' trade and manufacturing. Mr. Russell established the business, now conducted by his sons and which has been a continuous and successful enterprise, in 1865.

George Henry Baush died at Northfield, Mass., September 12 with an abscess on the lungs, aged forty years. Mr. Baush, born in Holyoke, Mass., was the son of C. H. Baush, the founder of the present Baush Machine Tool Co., of Springfield, Mass. He and his brothers formed a partnership with their father under the firm name of C. H. Baush & Sons, and moved to Springfield where the business is now located. Later the firm name was changed to Baush & Harris Machine Tool Co., and still later to the present name. Mr. Baush was superintendent of the concern for several years, leaving it a few years ago and taking up the selling of machinery. He gave up the position of sales manager of the Fay Machine Tool Co., Philadelphia, Pa., last spring on account of ill health.

CHARLES T. PORTER

Charles T. Porter, the famous engineer, inventor, author, "father of the high-speed steam engine," and promoter of many improvements in steam engineering practice and design, died at the home of his son, Mr. L. M. Porter, New York, August 29, in his eighty-fifth year. Mr. Porter was educated to be a lawyer, and practiced law with indifferent success for a few years. Then, becoming interested in the invention of a stone-dressing machine made by one of his clients, he abandoned law to promote it and thus became interested in engineering. The original invention was worthless and considerable money was sunk by Mr. Porter and his friends in its development. In the struggle to make the machine work he conceived an improved machine which was built and worked successfully. The operation of this machine required much power, and great trouble was met with in regulating the engine, which was of the old-style, long-stroke, fly-ball governor type. This trouble led to the invention of the Porter governor in 1858, and made him acquainted with the general defects of the common type of slow-operating steam engines then in use. The Porter-Allen steam engine, in which the governing function was effected through controlling the action of the slide valve instead of throttling the steam pipe, was the work of Mr. Porter and James F. Allen with whom he became acquainted in 1860-61. The two were closely associated for ten

Charles T. Porter

years. The development of the Porter-Allen high-speed engines, which ran with such steadiness under extreme fluctuations of load as to make electric lighting practicable, and made direct-connected engines and dynamos possible in 1880, was, it might be said, the direct result of Mr. Porter's experience with the stone-dressing machine. The development of the high-speed steam engine led to many improvements in machine design and manufacturing practice, and it would be difficult to estimate the great influence of his work on engineering practice in general. Mr. Porter's conception of a high-speed engine of much greater power for a given unit of weight than the slow-speed engine has had a profound effect on prime mover design. The multiple-cylinder high-power gas engine weighing, say ten pounds or less per horsepower in the case of the automobile and three pounds or less for the aeroplane, is the logical result of his pioneer work. The story of his life fills a large volume entitled "Engineering Reminiscences," published in 1908, and is a remarkable record of engineering progress made in the fulfilment of an idea. Mr. Porter's work in England and America brought him into contact with most of the leading engineers of the age, and the book is replete with incidents that occurred in his intercourse with them. He was a remarkable mechanical genius, but unfortunate in many of his business affiliations and his life was somewhat embittered by the dishonesty and treachery of trusted associates. On the other hand, the hearty recognition accorded him by the engineering world was most gratifying. He was an honorary member of the American Society of Mechanical Engineers, and in 1909 was presented with the John Fritz medal which is conferred by the four national engineering societies, *viz.*, American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, and American Institute of Electrical Engineers, for notable industrial or scientific achievement. Mr. Porter was the fifth to receive the medal, the others being Lord Kelvin, Alexander Graham Bell, George Westinghouse, and Thomas A. Edison. Mr. Porter's home was in Montclair, N. J., where he had lived for several years. Following the death of his wife in July, he removed to New York to the home of his son.

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COMING EVENTS

October 9-12.—Second International Congress of Refrigeration, Vienna, Austria. For further information address Mr. F. W. Pilsbury, 1660 Monadnock Building, Chicago, Ill.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. H. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

October 25-6.—Annual convention of the National Machine Tool Builders' Association, New York. Hotel Astor headquarters. Charles E. Hildreth, secretary, Worcester, Mass.

October 27.—MACHINERY'S eighth annual outing.

November 17-19.—Fourth annual convention of the National Society for the Promotion of Industrial Education, Boston, Mass. A feature of this convention will be a lecture on "Continuation Schools," by Dr. George Kerschensteiner, superintendent of schools, Munich, Germany. James B. Monaghan, secretary, 20 West 44th St., New York.

December 12-15.—Convention of the National Gas and Gasoline Engine Trades Association, Racine, Wis. Albert Stritmatter, secretary, Cincinnati, Ohio.

SOCIETIES AND COLLEGES

BULLETIN OF THE ARMOUR INSTITUTE OF TECHNOLOGY. General information number containing catalogue of courses for the present school year. Frederick U. Smith, comptroller and secretary, Chicago, Ill.

Traveling Engineers Association. Committee reports and subjects for discussion, 18th Annual Meeting, Niagara Falls, Canada, August 16-19. W. O. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, N. Y.

National Association for the Promotion of Industrial Education. The Factory School of Rochester, by George M. Forbes. The National Importance of Education, by Dr. R. Rhees. Arthur L. Williston, secretary-treasurer, Pratt Institute, Brooklyn, New York.

NEW BOOKS AND PAMPHLETS

Vibrations of Systems Having One Degree of Freedom. By B. Hopkinson. 54 pages, 5½ x 8½ inches. Published in the United States by G. P. Putnam Sons, New York. Price 75 cents.

Model Balloons and Flying Machines. By J. H. Alexander. 127 pages, 5 x 7 inches, 45 illustrations, 5 inserted plates. Published by Norman W. Henley & Son, 132 Nassau St., New York, and Crosby Lockwood & Son, London. Price $1.50.

The success of the aeroplane has tremendously stimulated popular interest in balloons, dirigibles, and heavier-than-air flying machines of all kinds. It was the aim of the author to give the reader a history of the art up to date, and an idea of its present state as far as possible. It describes early balloon flights, the spherical balloon, the parachute, the dirigible balloon, fire balloons, how to inflate a model balloon with gas, a model airship, fundamental principles of flight, gliders, aeroplanes, Maxim's flying machine, biplane and monoplane flying machines, Farman, Voisin, Wright, Bleriot, and other biplanes. The concluding chapter gives a glossary of terms used in describing flying machines with suitable sketches to illustrate.

Power Gas and Gas Producers. By J. C. Miller. 184 pages, 5 x 8 inches. 18 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price $1.

It is freely predicted that the gas engine and gas producer will eventually replace steam engines and steam boilers for power purposes, especially in the larger plants. It is scarcely twenty years since gas producers were first introduced and in that short time the development of the gas producer plant has been most remarkable. This work treats of producer gas and its chemistry, heat values of various gases, gas producer fuels, types of gas producers, including Siemens, Wiley, Smith, Taylor, Loomis, Pettibone, and Morgan. Chapter VII is on gas producer operation. The efficiency of a producer plant is compared with that of a steam plant, and some causes of producer troubles are touched on. The concluding chapter is on gas producer installation, the erection of the plant, preliminary testing, water seals, gas holders, rules of the International Board of Fire Underwriters, etc.

Chemists' Pocket Manual. By Richard K. Meade. 443 pages, 4 x 6¼ inches. Published by the Chemical Publishing Co., Easton, Pa. Price $3.

This work is a practical hand-book containing tables, formulas, calculations, information, physical and analytical methods for the use of chemists, chemical engineers, assayers, metallurgists, manufacturers, and students. It has been the author's aim to present in as condensed form as possible such information as would seem to be of service to those interested. The work is one that can be highly commended. It is concise, compact and contains a large fund of valuable information, the contents being substantially as follows: metric and United States weights and measures, metric tables, mensuration, international atomic weights, stoichiometry, graphic methods of saving calculation, conversion tables, specific gravities of solids and liquids, weight and volume of substances, standard tables of the specific gravity of sulphuric acid, nitric acid, hydrochloric acid and ammonia, Lunge's and other tables of specific gravity of acids and alkalies, physical properties of gases, hygrometers, solubility, boiling point and melting point, standardizing weights, calibration of chemical glassware, temperature, heat, combustion, radiation, steam, electricity, mechanics, mineralogy, geology, volumetric solutions, standardized volumetric solutions, reagents used in quantitative and qualitative gas analysis, test papers, assaying, analysis of iron ores, analysis of coal, analysis of blast furnace slags, analysis of soap, etc.

High-Speed Steel. By O. M. Becker. 360 pages, 6 x 9 inches. 273 illustrations. Published by McGraw-Hill Book Co., New York. Price $4.

This work, is, we believe, the first comprehensive treatise on high-speed steel, its development, treatment and use, notwithstanding the fact that high-speed steel was first brought to the attention of the engineering world by Messrs. Taylor and White more than a decade ago. Space will permit us to give only a running review of the contents of this interesting and valuable book. It begins with a historical account of ancient steels and takes up the development of steels of the high-speed variety. Section II treats of the making of steel and tools, forging, hardening, tempering, annealing, grinding, etc. Section III is devoted to the use of high-speed steel tools treating of the range of usefulness and maximum effect, speeds, feeds, and related matters. Considerable space is given to the researches of Mr. Taylor, which were recorded in his paper "On the Art of Cutting Metals" presented before the American Society of Mechanical Engineers, December, 1906. In fact a considerable part of the work has been published elsewhere in the proceedings of engineering societies and the technical journals to which the author has contributed for several years. He has skillfully compiled these related articles and written new matter, thus producing a comprehensive treatise on the art of high-speed steel tool making and use that should be highly appreciated by works managers, superintendents, foremen and others concerned with obtaining the highest efficiency of metal-working tools.

CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, New York. Bulletin No. 4754 on mill type motors.

Newall Engineering Co., Walthamstow, London, E. Catalogue of gages, micrometers and measuring machines.

Ingersoll-Rand Co., 11 Broadway, New York. Form 4102 illustrating Sergeant rock drills, and component parts.

Sprague Electric Co., 527-531 West 34th St., New York. Bulletin No. 285 on motor-driven disk and propeller fans.

Kolesch & Co., 138 Fulton St., New York. Circular of Richter drawing instruments. Copies will be sent to any address on request.

Oswego Machine Works, Oswego, New York. Illustrated catalogue of cutting machines for cutting paper, books, boxes, board, cloth, tinfoil, leather, etc.

Goldschmidt Thermit Co., 90 West St., New York. Circular illustrating butt welded pipe joints for ammonia, steam, hydraulic, and compressed air plant installations.

Simplex Mfg. Co., 90 West St., New York. Circular of Simplex combination bench file and metal hack-saw, and price list of parallel files and hack-saws used therewith.

G. R. Lang Co., Meadville, Pa. Leaflet illustrating manufacturing tool-holders suitable for vertical boring mills, and a new design of tool-holder for lathe and shaper work.

National Brake & Electric Co., Milwaukee, Wis. Catalogue No. 391, illustrating and describing various types of National air compressors of self-contained and motor-driven types.

Golden-Anderson Valve Specialty Co., Fulton Building, Pittsburg, Pa. Circular of Golden-Anderson automatic cushion, non-return and triple action valves for steam and water service.

Rowbottom Machine Co., Waterville, Conn. Circular of the Rowbottom 18-inch double end ball bearing disk grinder which was illustrated and described in the September number of Machinery.

Liveright Bros., Philadelphia, Pa. Leaflet illustrating "Gold Medal" electric files, which represent a general departure in spacing, angle of pitch and teeth, resulting in rapid cutting and true, smooth surfaces.

Grant & Wood Mfg. Co., Detroit, Mich. Circular and price list of steel balls made by the company. The G. & W. balls are furnished in special steel, chrome steel, brass, bell metal, bronze, cast iron and special metals.

Colburn Machine Tool Co., Franklin, Pa. Catalogue C on the Colburn universal saw table which has recently been improved. The construction and attachments are illustrated in a most attractive manner, making an unusually interesting piece of trade literature.

General Electric Co., Schenectady, New York. Bulletin No. 4767 on large motors for steel mills. The bulletin illustrates a 6000-horsepower, 6600-volt, 75 R. P. M. induction motor built for the Indiana Steel Co., Gary, Ind., and other steel-mill electrical equipment.

Adams Co., 714 White St., Dubuque, Iowa. Booklet entitled "Gear Cutting Speeds" containing data showing the possibility of the hobbing process in cutting gears. Foremen and machine men of gear cutting departments will find the booklet interesting and instructive.

Buffalo Steam Pump Co., Buffalo, New York. Vacuum pump catalogue No. 228, illustrating vacuum pumps and condensers (with and without water seal in stuffing-box), combined air and circulating pumps, power pumps for wet and dry systems, jet condensers, surface condensers, barometric condensers, etc.

Elyria Gas Power Co., Elyria, Ohio. Circular of "Little Big" engines, illustrating and describing the construction of the improved type of gas engine built on the "split unit plan," the construction of which is on the lines of large gas engines having improved valve motion, water-cooled pistons and piston rods, in No. 3 and larger sizes, etc.

Fay & Scott, Dexter, Me. Catalogue No. 16 illustrating and describing extension gap engine lathes which are made in seven sizes, as follows: 16-32-inch; 18-36-inch; 20-42-inch; 24-46-inch; 28-52-inch; 32-56-inch, and 38-66-inch swing. The regular lathes are belt-driven, but the company is prepared to furnish them with individual motor drives, if desired.

Pawling & Harnischfeger Co., Milwaukee, Wis. Folder entitled "Four Laborers instead of Thirty," illustrating how a great saving in cost of handling material was effected in a foundry yard by the installation of Pawling & Harnischfeger traveling bridge crane for handling large quantities of scrap iron, pig, coke and limestone required for running three cupolas.

Bradley Stoughton, 165 Broadway, New York. Reprint illustrating and describing the Stoughton type converter similar to the Tropenas type for the manufacture of steel for castings. The Stoughton apparatus is adapted to making steel castings of any size from a fraction of a pound to three or four times the weight of one charge of the converter: that is, one ton of the converter can make a three-ton casting, etc.

Wheeler Condenser & Engineering Co., Carteret, N. J. Twenty-four page pamphlet entitled "Condensers for Small Central Stations," being a reprint of a lecture delivered before the Missouri Gas, Electric & Street Railway Association. It contains a number of useful tables, charts, and curves relating to the operation and economy of condensing machinery, and other valuable information for engineers concerned with power-plant economy.

Volcano Torch & Mfg. Co., Erie Pa. Circular illustrating the "Volcano" torch which generates its own pressure, without the use of an air-pump, and is said to be the most powerful gasoline blow-torch of its size on the market. The "Volcano" torch is made in several styles and weights and with extension burners it is adaptable for boiler repair work and other operations where it would be difficult to apply the burner of a regular torch.

National Sewing Machine Co., Belvidere, Ill. Catalogue of automatic screw machines with illustrations and descriptions of machines, tools, attachments and product. The machines listed include National automatic turret machine, No. 2; National automatic plain machine, No. 2; National automatic turret machine, No. 3; National automatic plain machine, No. 3; National automatic machine with magazine attachment No. 2; National hand shaver, etc.

Topping Bros., 122 Liberty St., New York. Pamphlet illustrating and describing the "Mechanigraph," a machine for making drawings transparent, and obviating the tracing of pencil drawings. Any opaque paper is rendered transparent by the process so that blue-prints may be made directly from drawings thereon without further treatment. The machine is useful also for restoring crumpled and disfigured tracings or drawings to their original smoothness and transparency.

Fosdick Machine Tool Co., Cincinnati, Ohio. Catalogue of radial drills and horizontal boring, drilling and milling machines. The catalogue illustrates and describes 2½-foot and 4-foot National radial drills, 3-foot standard and 5-foot standard radial drills, 5-foot universal radial drills with gear box and cone pulley drive, No. 0 and No. 1 A and B style horizontal boring, drilling and milling machine. Details of construction of drills and horizontal drilling and milling machines are included.

General Electric Co., Schenectady, New York. Bulletin No. 4755 entitled "The Electrification of the Cascade Tunnel on the Great Northern Railway." This interesting pamphlet illustrates the power house, generators, turbine water wheels, transmission lines, locomotives and scenes on the approaches to the tunnel. The tunnel is about 14,000 feet long and has a uniform grade of 1.7 per cent. It was electrified to overcome the great troubles caused by smoke and gases with steam locomotives handling heavy freight trains.

General Electric Co., Schenectady, New York. Bulletin No. 4749 on alternating current switchboard panels, three-phase and single-phase types. The panels illustrated are of the sectionalized type, and each section has a separate catalogue number. The panels are made in three sections and the pages of the bulletins are sectionalized so that the user can have before him a picture of the complete panel desired together with a full description of the equipment. The advantage of this ingenious arrangement will be appreciated by those who have to select switchboard equipment.

CONTENTS FOR OCTOBER

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition

H. H. Franklin Mfg. Co., 203 S. Geddes St., Syracuse, N. Y. Catalogue of Franklin die-cast finished parts, illustrating a multitude of die-cast parts for tabulating machines, magnetos, automobiles, telephone and electric work, gearing, computing machines, soda fountain pumps, etc. The Franklin die casting process was originated seventeen years ago and has been highly developed, it being practicable to produce complicated machine parts true to gage with all holes, flanges and threads perfect in every respect, leaving no machine work whatever to be done. The advantage of the process for interchangeable manufacturing of small machines made in large numbers is obvious.

Buffalo Steam Pump Co., Buffalo, N. Y. Catalogue No. 227 on single and duplex steam pumps, simple and compound types, center and outside packed, for all classes of service. A few of the pumps illustrated are: boiler-feed, waterworks, general service, underwriters' fire, tank, high-pressure (up to 2000 pounds per square inch), etc. Barometric and surface condensers, triplex pumps, centrifugal pumps, jet condensers, etc., are also shown, but the company's pump business has developed so broadly that it will issue five catalogues as follows: single and duplex steam pumps (the one here noted), jet, barometric and surface condensers, triplex power pumps, single stage centrifugal pumps and multi-stage centrifugal pumps (in press).

Hess & Son (successors to American Tinol Co.), 1215 Filbert St., Philadelphia, Pa. Circular of "Tinol" paste solder, rod solder, and wire solder, describing the characteristics of "Tinol" and method of use. "Tinol" is a soldering material made of tin and lead in the various proportions required, the same as ordinary solder, but instead of being simply melted together as an alloy and shaped into bars, rods and wires, the alloy is finely granulated, in the case of the paste form, and each grain is thoroughly coated with a flux, the result being that while the solder is in a melted state it is completely protected from the oxidizing influence of the air. The rod and wire forms are made hollow with the core filled with the same flux as that used with the paste.

Cincinnati Planer Co., Cincinnati, Ohio. Catalogue of Cincinnati planers, illustrating the company's new plant at Oakley, details of planer construction and the various sizes and styles of planers built. These include Cincinnati 22-inch standard planer, 24-inch, 26-inch, 28-inch, 30-inch, 33-inch, 36-inch (heavy forge), 42-inch, 42-inch (heavy forge), 48-inch, 56-inch, 62-inch, 72-inch, and 84-inch sizes, all standard except those noted. Also 34-inch x 24-inch, 30-inch x 36-inch, 42-inch x 36-inch, 48-inch x 30-inch, 56-inch x 42-inch, 60-inch x 48-inch, 72-inch x 48-inch, all of the widened type. The company's variable speed planers are also illustrated with belt and motor drives. The catalogue is a very handsome production measuring 9½ by 12½ inches and embellished with an illuminated cover showing a typical manufacturing district.

Norton Grinding Co., Worcester, Mass. Catalogue of Norton plain machines for cylindrical grinding, illustrating and describing 6-inch by 32-inch machine with overhead and electric drives; 10-inch by 36-inch machine with overhead and electric drives; 10-inch by 50-inch machine with overhead and electric drives: 10-inch by 72-inch machine, 10-inch by 96-inch machine, 10-inch by 120-inch machine, 14-inch by 50-inch machine, 14-inch by 72-inch machine and 14-inch by 96-inch machine, with overhead drives, 14-inch by 72-inch machine, with electric drive; 18-inch by 96-inch machine and 18-inch-30-inch by 96-inch machine, with overhead drives; 18-inch-30-inch by 96-inch machine, self-contained drive; 18-inch by 168-inch machine with overhead drive; 18-inch by 120-inch machine, self-contained drive; 20-inch by 96-inch machine, self-contained drive (for roll grinding); 20-inch and 32-inch by 168-inch machine, self-contained drive; 22-inch by 96-inch machine, special self-contained drive for roll grinding only. Rear and end views of machines are included, also illustrations of details, arrangements of steadyrests, cam-grinding attachments, foundations, etc., making a catalogue of unusual attractiveness and interest to the superintendent, foreman, and mechanic concerned with grinding practice.

TRADE NOTES

Leavitt Machine Co., Orange, Mass., is building an addition to its plant.

Crandon Mfg. Co., Bellows Falls, Vt., a new corporation, is installing machinery for the manufacture of the Crandon electric heat regulators.

American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa., is now prepared to furnish its pressed steel belt pulleys up to 60 inches diameter.

Henry & Wright Mfg. Co., 111-137 Sheldon St., Hartford, Conn., states that its sales for the month of August were the largest in the history of the concern.

James Saunders Co., Dayton, Ohio, is making arrangements for constructing a new plant and blacksmith shop for general forging work, and will soon be in the market for new tools for same.

Foote-Burt & Co., Cleveland, Ohio, recently added a large erecting floor and otherwise enlarged its plant, thus materially increasing its capacity to meet the increased demand for Foote-Burt drills, etc.

L. S. Starrett Co., Athol, Mass., announces that its Chicago store is now located in new and larger quarters at 17 N. Jefferson St. A complete stock of Starrett's mechanical tools is carried. Mr. Al. T. Fletcher is manager.

Tate-Jones & Co., Inc., Philadelphia, Pa., has received an order from the Frick Co., Waynesboro, Pa., for a large plate heating furnace, 8 feet by 10 feet inside. This furnace will be equipped with the Kirkwood fuel oil burning appliances.

Rockford Tool Co., Rockford, Ill., manufacturer of engine lathes, moved into its new factory, situated at the corner of 11th and Harrison Ave., October 1. The shop is 64 by 120 feet, and will be equipped with modern machinery throughout.

Bay State Screw Co., Hatfield, Mass., has been sold to the Hatfield Construction Co., a recently organized Massachusetts corporation, which will continue the manufacture of screw machine products, adding new machinery and materially increasing the business.

Cincinnati Ball Crank Co., Cincinnati, Ohio, which recently suffered a severe loss through fire, is now established in its new location at 1249 Plum St., and is running full capacity. It is therefore in position to take care promptly and efficiently of any orders received.

Rockwell Furnace Co., 26 Cortlandt St., New York, maker of oil, coal, and gas furnaces and furnace equipment, has opened an office for western business at 718-719 Fisher Building, Dearborn and Van Buren Sts., Chicago, Ill. The office will be in charge of Mr. A. L. Steven, an experienced furnace engineer.

Mead-Morrison Mfg. Co., Cambridge, Mass., engineer and manufacturer of elevating and conveying machine and hoisting engines, announces a generally good condition of business in its line and states that the plant is working to the extent of its facilities; in fact it has fifty more machinists than ever before at one time.

Pawling & Harnischfeger Co., Milwaukee, Wis., designer and builder of traveling electric cranes and hoists, has appointed Mr. Arthur Fritsch manager of its Chicago office in the Monadnock Block, Chicago. Mr. Fritsch, who succeeds Mr. W. E. Kreamer, resigned, was formerly connected with the engineering and sales department of the Allis-Chalmers Co.

The Survey for September 3 is devoted to the general subject of human conservation in industries. The issue analyzes the legal and medical aspect as to the length of hours of labor, the question of relief in the case of accidents from both the legal and philanthropic points of view, proper safeguarding and health conditions in industries. *The Survey*, 105 East 22nd St., New York.

National Machine & Tool Works, Rockford, Ill., has changed its name to the Rockford Milling Machine Co. The company is now located in its new shop having about 9000 square feet of floor space. The company is bringing out a line of power milling machines in addition to its line of hand milling machines and intends to gradually develop a complete line of milling machines for all purposes.

Amerika Esperantisto, 700-714 East 40th St., Chicago, Ill., has published a brief grammar of Esperanto which will be sent free to any person sufficiently interested to write for it and enclosing a stamp. The movement for an international auxiliary language now embraces fifty nations in its scope and is of such importance as to warrant the attention of those interested in international trade.

The following concerns were among those exhibiting at the recent Cincinnati Industrial Exposition: Hisey-Wolf Machine Co., Lodge & Shipley Machine Tool Co., Acme Machine Tool Co., Cincinnati Planer Co., Cincinnati Shaper Co., Cincinnati Bickford Tool Co., Cincinnati Pulley Machinery Co., and Triumph Electric Co., all of Cincinnati; Lock Nut Reamer Co., New Haven, Conn., and Link Belt Co., Indianapolis, Ind.

Supplement to MACHINERY, November, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Setting up Work for Boring on the Milling Machine"

SHOP OPERATION SHEET NO. 151

John Edgar — MACHINERY, November, 1910

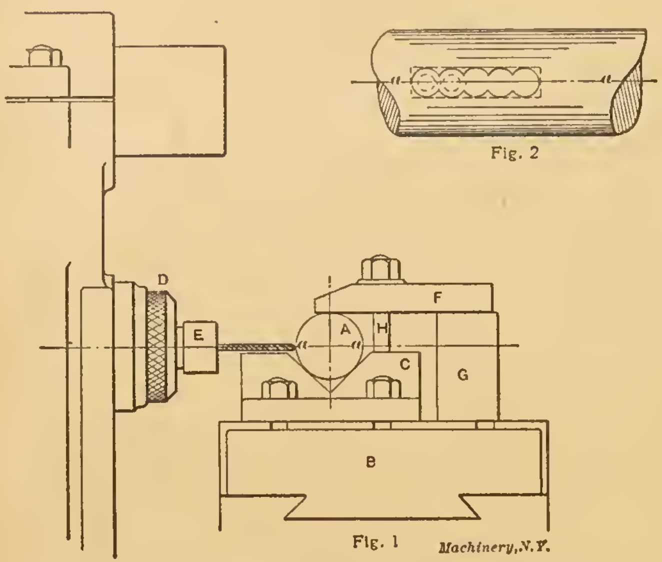


Fig. 1 *Machinery, N.Y.*

Fig. 2

To Drill and Counterbore a Bar or Shaft for Slotting

NOTE.—The slot is to extend entirely through the bar, and is supposed to have been previously laid out as shown in Fig. 2.

1. Select the following tools, *viz:* A counterbore six or eight thousandths smaller than the width of the proposed slot with a pilot about half that diameter; a twist drill of same diameter as pilot of counterbore; a spotting drill carefully ground, and a suitable chuck for holding these tools.
2. On the milling machine table *B* bolt two V-blocks *C*, far enough apart to leave ample space for working, but close enough to support the bar firmly.
3. Place in the main spindle *D* the drill holder *E*, with the spotting drill set to run true. Lay the shaft or bar *A*, to be slotted, into the V-blocks with the center line *a—a*, Fig. 2, toward the spotting drill, and the center line *a—a*, Fig. 1, exactly horizontal, as shown by a surface gage. Clamp the bar by two straps *F* after having set it at right angles to the axis of the spindle. Test the truth of the setting by means of a swinging trammel placed in the spindle.
4. Set the table *B* so that the center line *a—a*, will be exactly at the height of the point of the spotting drill.
5. With the spotting drill, center a series of holes at such distance apart that when drilled, and the counterbore is used, it will not cut into the next small hole.
6. Replace the spotting drill with the twist drill, and bore the series of holes entirely through the bar *A*, the carriage being fed inward by hand.
7. Replace the twist drill with the counterbore, and counterbore the series of holes entirely through the bar *A*, again feeding by hand. The slot in the bar will now appear as shown in Fig. 2.

SHOP OPERATION SHEET NO. 152

John Edgar — MACHINERY, November, 1910

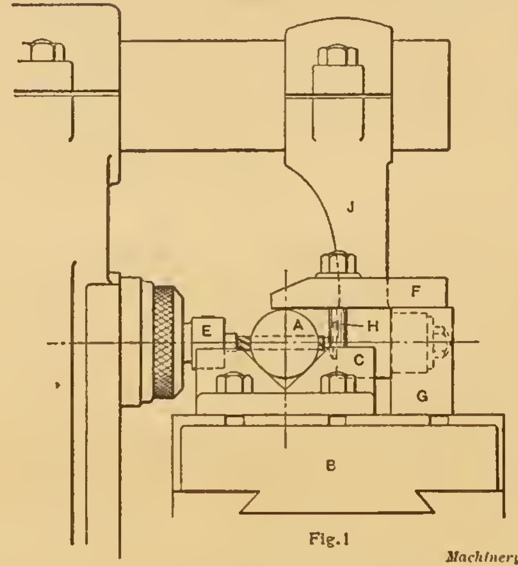


Fig. 1 *Machinery, N.Y.*

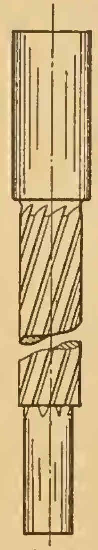


Fig. 2

To Finish a Slot by Milling

NOTE.—The bar or shaft to be slotted is supposed to remain clamped down in the grooves of the V-blocks as located and held in the last operation.

1. Select or provide two milling cutters of the form shown in Fig. 2, one to be of a diameter equal to the finished width of the slot to be milled, and one from six to eight thousandths of an inch less in diameter.
2. Place the smaller of these milling cutters in the drill holder *E*, and bring the shaft *A* to the proper position to permit the milling cutter to pass through the end hole of the series that have been drilled and counterbored through it, as described in the previous operation. Bring up the outer supporting arm *J*, and adjust it to support the outer end of the milling cutter.
3. Start the machine at a proper speed, which will depend upon the diameter of the milling cutter and the quality of the material of the bar to be slotted, and using the hand feed, move the work along until the slot is milled nearly to the opposite end.
4. Replace the smaller milling cutter by the larger one, and feed the work in a direction parallel to the axis of the cutter until the cutter is through the slot. Then adjust the supporting arm *J* to its outer end, and repeat the milling operation as described in Step 3. The slot will now be the required width, and it should be finished to within about ten thousandths of an inch of the proper length.
5. Remove the outer support of the milling cutter, and take out the cutter. Let the shaft *A* remain clamped in the V-blocks as in this and the preceding operation, for squaring the ends of the slot as described on the next sheet.

SHOP OPERATION SHEET NO. 153

John Edgar — MACHINERY, November, 1910

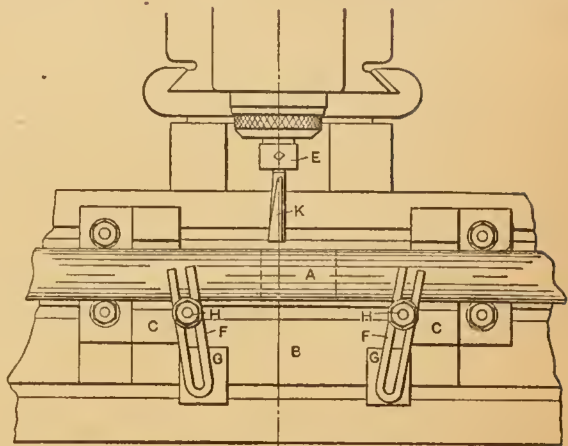


Fig. 1

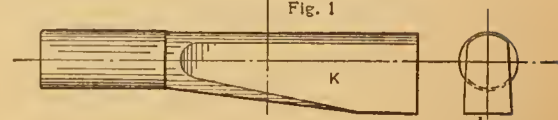


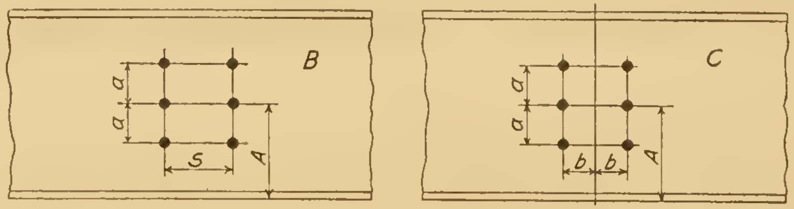
Fig. 2 *Machinery, N.Y.*

To Square the Ends of a Slot

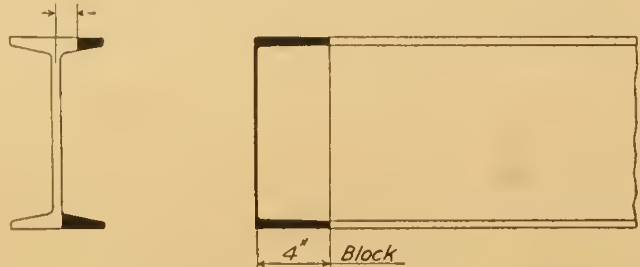
NOTE.—The above engraving shows a plan view instead of an end elevation as in the two former operations.

1. Select or provide a slotting tool *K*, of the form shown in Fig. 2, the cutting edge *k* being of the exact width of the finished slot.
2. Throw the back gears of the main spindle of the machine into engagement. With the usual lock-nut, fix the driving cone and face gear to each other so as to prevent any rotary movement of the main spindle.
3. Place the slotting tool *K* in the drill holder *E*, with its cutting edge *k* set at right angles to the machine table *B*, testing the position with a square upon the top of the table.
4. By means of the cross-feed screw, work the carriage inward so that the slotting tool *K* passes through the slot. Work the table *B* alternately outward and inward in this manner, using the lateral feed screw of the table *B*, as a hand feed, and thus forcing the slotting cutter to take a light cut at each inward stroke until the circular end of the slot is squared up to the limit line.
5. After one end of the slot is finished release the slotting tool *K*, and turn it half way around so that its cutting edge *k* faces in the opposite direction. Again set the cutting edge *k* at right angles with the table, and clamp the tool in this position.
6. Square the opposite end of the slot as described in Step 4, finishing the slot to the required length. In doing this job, if it is kept in mind that one makes haste slowly on this class of work, the time required may be reduced to a minimum.

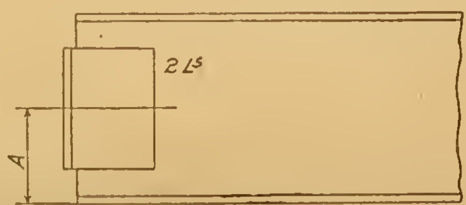
STANDARD METHOD OF DETAILING I-BEAM WORK—I



When showing web holes where another beam or channel connects to the one being detailed, give A from bottom of beam to center of connection. For a beam connection give S as shown at B. For a channel connection give b-b as shown at C. Do not give any dimensions for a-a, as this is always 2½" except for 18", 20" and 24" beams, which will be 3". Where there is a special connection always give A, b-b, and a-a. Always give vertical dimensions from bottom of beam or channel.



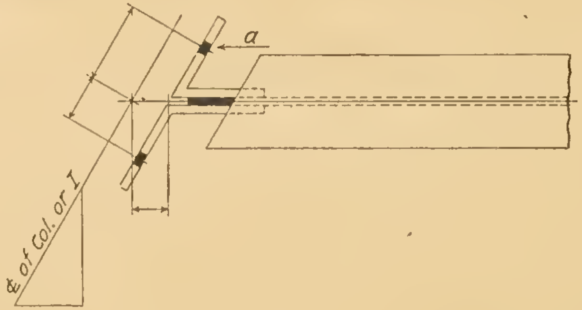
When flanges must be cut for clearance, detail same as shown above except for a bevel cut, for which a top or bottom view must be shown.



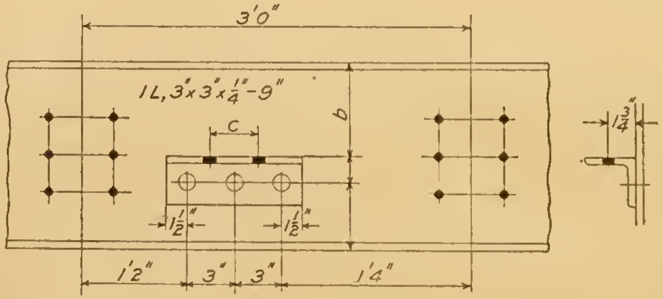
Do not show any rivets or open holes in standard clip angles. Always give A from bottom of beam to center of connection.

Contributed by Harry Gwinner

STANDARD METHOD OF DETAILING I-BEAM WORK—II



To obtain the dimensions required for the above detail, make lay out of 3" = 1'0" of the point in question. Make sure that a is located in a position that there may be no trouble to rivet same in field. Cut beam back from face of bent plates ½" as shown.

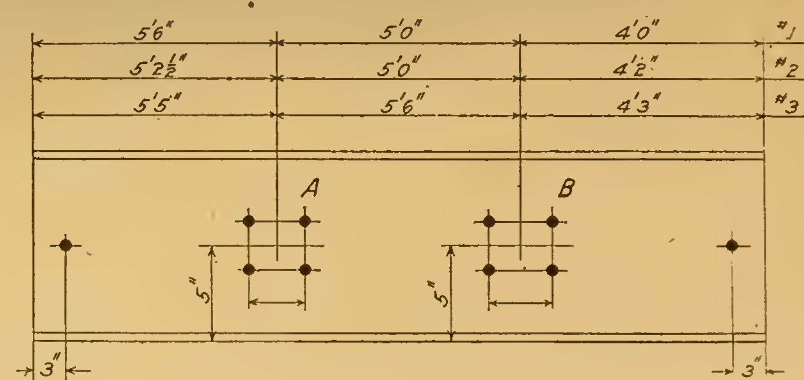


In case of a lug being riveted to the web of beam or channel, tie rivets with center line of nearest web connections. Give gage for open holes as shown. Dimension b is very important and should not be omitted. As shown in sketch, c is symmetrical with center rivet. When not symmetrical, tie with center rivet.

Note:– In detailing beams, make details as simple as possible for the shop. Do not give any figures or notes that will mislead the shop. Do not tie holes in flange with web holes. Do not use the word "omit."

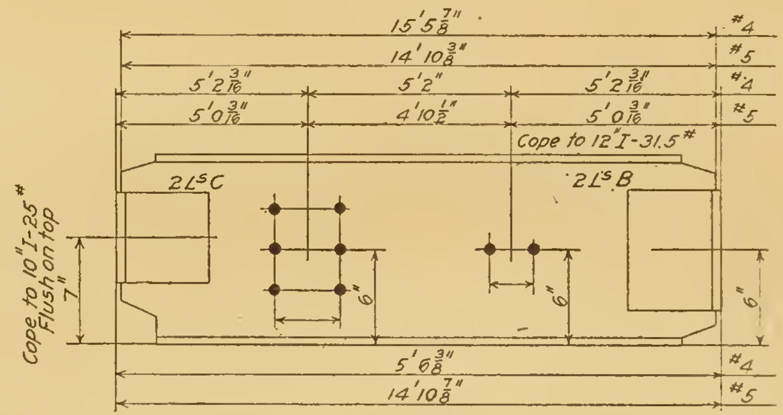
Contributed by Harry Gwinner

STANDARD METHOD OF DETAILING I-BEAM WORK—III



Make 2, 10"- 25 #Is 14'6" Mark #1
Make 1, 10"- 25 #I 14'4½" Mark #2
Make 1, 10"- 25 #I 15'2" Mark #3

The above shows beam having both ends wall bearing. At A is shown beam connection and at B channel connection. Always give figures for channel spacing as shown. It is understood that the two end holes are located in center.

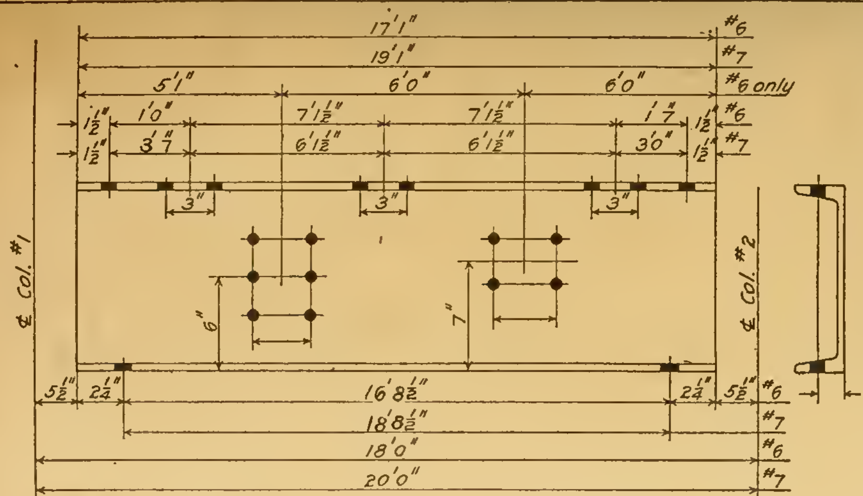


Make 2, 12"Is - 31.5# 15'6⅜" Mark #4
Make 2, 12"Is - 31.5# 14'10⅞" Mark #5

This sketch shows beam having coping at each end with standard clips, holes for tie rods and 12"I connection. Carry all dimension lines above beam except total length over end clips. Do not give any more dimensions than shown, for a beam of this kind. Do not show any rivets in standard clips.

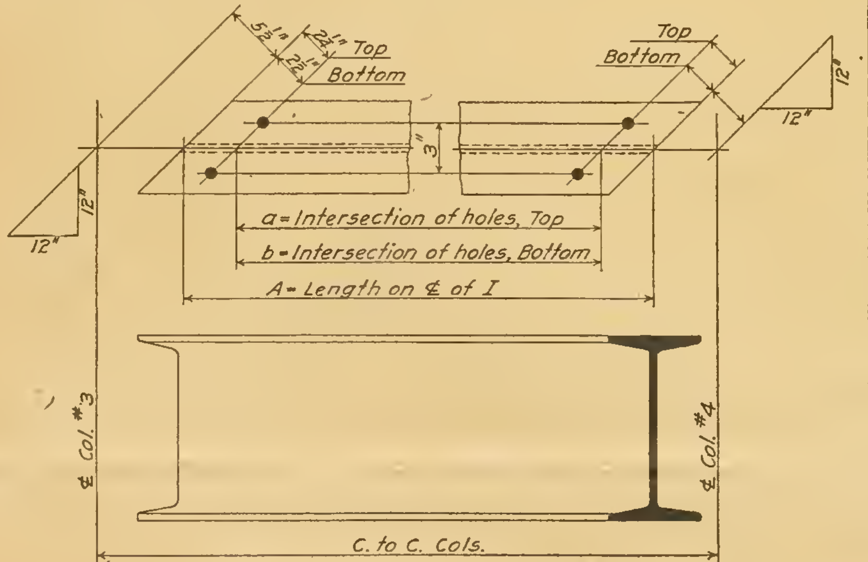
Contributed by Harry Gwinner

STANDARD METHOD OF DETAILING I-BEAM WORK—IV



Make 2-12"[s. 20.5#-17'1" Mark #6 R as shown, L opp. hand
Make 2-12"[s. 20.5#-19'1" Mark #7

The above sketch shows a beam fitting between Columns. Always give the distance c. to c. of Cols., as shown. Also give the distance c. to c. of end holes in bottom flange below sketch of beam; all other dimensions above the sketch.



Make 1-12"I, 31.5 #A Mark #8

Contributed by Harry Gwinner

Machinery
November, 1910

WIRING ON MOTOR-DRIVEN MACHINERY

By R. S. WATSON

ELECTRICAL wiring on the motor-driven machines furnished by even the best manufacturers, is too often poorly arranged and inefficiently installed. This is because the wiring is not considered when the machine is designed. Its installation is usually left to some workman who

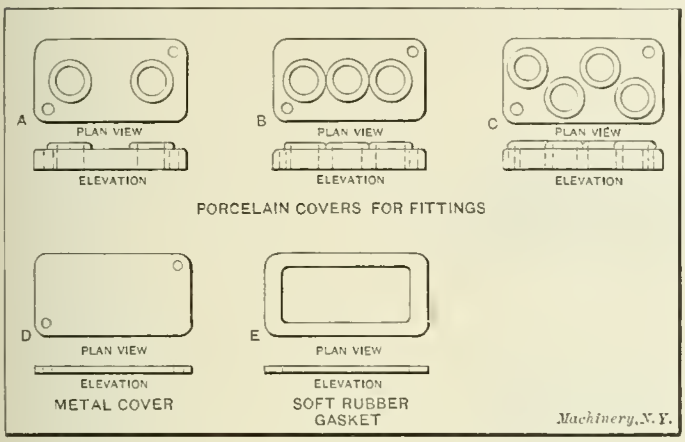


Fig. 1. Covers and Gasket for Conduit Fittings

does the best he can. The wiring and arrangement of the control apparatus should be laid out in the drafting-room. This article discusses the best methods of machine wiring,

TABLE I. SPECIFICATIONS FOR WIRE AND CONDUIT ON MOTOR-DRIVEN MACHINERY

Double-braid, Rubber-covered, 0 to 600 Volts, N. E. C. S. Copper Wire, N. E. C. S. Wrought-iron Conduit

	Number of Wire, B. & S. Gage	Area of Wire, Circular Mills	Number of Wires in Strand	Safe Current-carrying Capacity, Amperes	Size of Conduit, Inches: 1 Wire in Conduit	2 Wires in Conduit	3 Wires in Conduit
Solid Wire	18	1,624	Solid	3	½	½	½
	16	2,583		6	½	½	½
	14	4,107		12	½	½	¾
	12	6,530		17	½	¾	¾
	10	10,380		24	½	¾	1
	8	16,510		33	½	1	1
Stranded Wire	6	26,250	7	46	¾	1	1¼
	5	33,100	7	54	¾	1¼	1¼
	4	41,740	7	65	¾	1¼	1½
	3	52,630	7	76	¾	1¼	1½
	2	66,370	19	90	¾	1½	2
	1	83,690	19	107	1	1½	2
	0	105,500	19	127	1	2	2
	00	133,100	19	150	1	2	2
	000	167,800	19	177	1¼	2	2½
	0000	211,600	19	210	1¼	2	2½
	....	200,000	19	200	1¼	2	2½
	....	250,000	37	235	1½	2½	2½
	....	300,000	37	270	1½	2½	3
	....	350,000	37	300	1½	2½	3
	....	400,000	37	330	1½	3	3
	....	450,000	37	380	2	3	3½
	....	500,000	61	390	2	3	3½
	....	550,000	61	420	2	3½	4
	....	600,000	61	450	2	3½	4
	....	650,000	61	475	2	3½	4
	....	700,000	61	500	2	3½	4

describes the materials used, and gives concrete directions, rules and tables for wiring motor-driven machinery.

One industrial corporation which purchases many motor-driven machines incorporates the following clauses in the specifications for all such equipments:

1. The machine manufacturer shall mount the motor and controlling devices on the machine so that they shall form a part thereof, and shall wire between them as hereinafter noted.

2. The controlling apparatus shall be conveniently arranged for manipulation by the machine operator.

TABLE II. APPROXIMATE FULL-LOAD CURRENT (IN AMPERES) TAKEN BY ELECTRIC MOTORS

H.P. of Motor	Direct-current Motors			Alternating-current Motors: Single-phase			Two-phase (Four-wire)			Three-phase (Three-wire)		
	110 Volts	220 Volts	500 Volts	110 Volts	220 Volts	500 Volts	110 Volts	220 Volts	500 Volts	110 Volts	220 Volts	500 Volts
1	9	5	2	14	8	3	6	3	2	7	4	2
2	16	9	4	25	13	5	12	6	3	13	7	3
3	27	13	6	34	17	8	17	8	4	19	9	4
5	42	21	9	53	26	12	25	13	6	31	15	6
7½	60	31	13	75	38	16	39	20	8	45	22	9
10	77	37	18	93	49	22	44	23	11	51	25	13
15	111	57	26	....	....	....	66	34	15	77	39	17
20	151	76	34	....	....	....	89	44	20	103	52	23
30	226	114	49	...	....	....	135	68	30	155	78	33
40	303	152	67	....	....	....	179	90	39	205	107	46
50	369	183	83	....	..	....	205	102	44	237	119	52
75	551	277	123	....	....	....	310	155	69	356	179	78
100	737	369	162	...	....	....	409	206	91	473	236	105
150	1114	556	245	..	....	....	618	308	137	711	356	157
200	1475	736	326	....	....	....	820	410	183	940	472	210

3. All wiring shall be installed in accordance with the regulations of the National Electrical Code.

4. All wiring shall be carried in wrought-iron conduit or in metal conduit fittings. These shall be firmly attached to the frame of the machine.

5. So far as possible, all "live" bare metal parts shall be enclosed with metal covers.

It was found desirable to make these requirements because of the awkward practice prevailing in this respect among machine builders. Frequently, the builder of a motor-driven machine, although he carefully mounted the motor and arranged the drive between the machine and the motor, would fail to mount the motor-starter or controller on the machine. If he did mount it on the machine, in the great majority of cases he would either provide no wiring between the motor and the controller, or install the wiring in such a careless, unbusinesslike manner that it would have to be reinstalled. Usually, the machine builder makes an extra charge for ar-

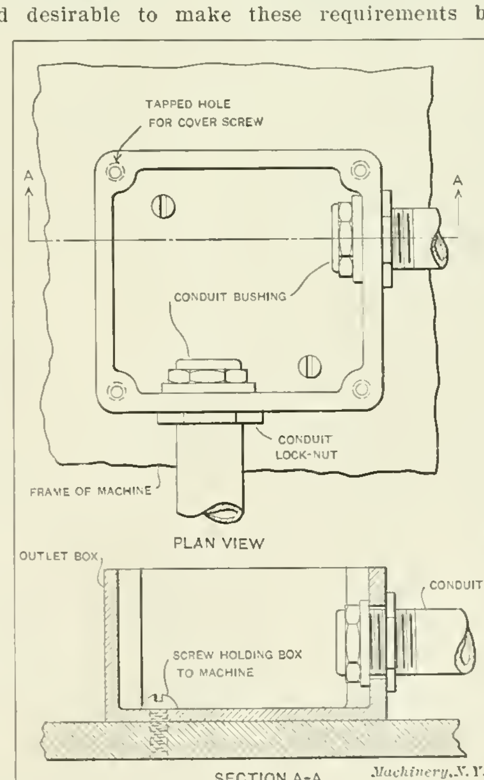


Fig. 2. Outlet Box Mounted on Machine

ranging the wiring in accordance with the above specifications; but it was found that the work was done better and more cheaply by the builder than by the wire-men at the plants where the machines were installed. At the present time, when motor-driven machinery is so generally used, machine builders are paying more attention to the electrical details; but there is still much to be desired. In the following will be given some practical information that may be of value to manufacturers desiring to arrange and install the wiring on their machines as efficiently as possible. It is believed that good wiring will be appreciated by the purchaser.

Rule No. 1 in the specifications given states that when the machine is direct-driven the motor and controller should be considered as a part of the machine. Obviously, they are just as much so as is a gear. If possible, the complete equipment should be shipped so that, after setting up, it will only be necessary for the plant electrician to run a pair of wires to put the machine in service. For large machines, which must be dismantled for transportation, the motor and controlling equipment must be shipped separately, and it may be necessary to dismount the conduit carrying the electrical conductors; but if the wiring has been properly connected and the conduit strapped to the machine in the erecting shop, it can easily be reinstalled. Thus, cranes, which have complicated wiring, can be taken apart, shipped, re-erected and rewired with very little difficulty.

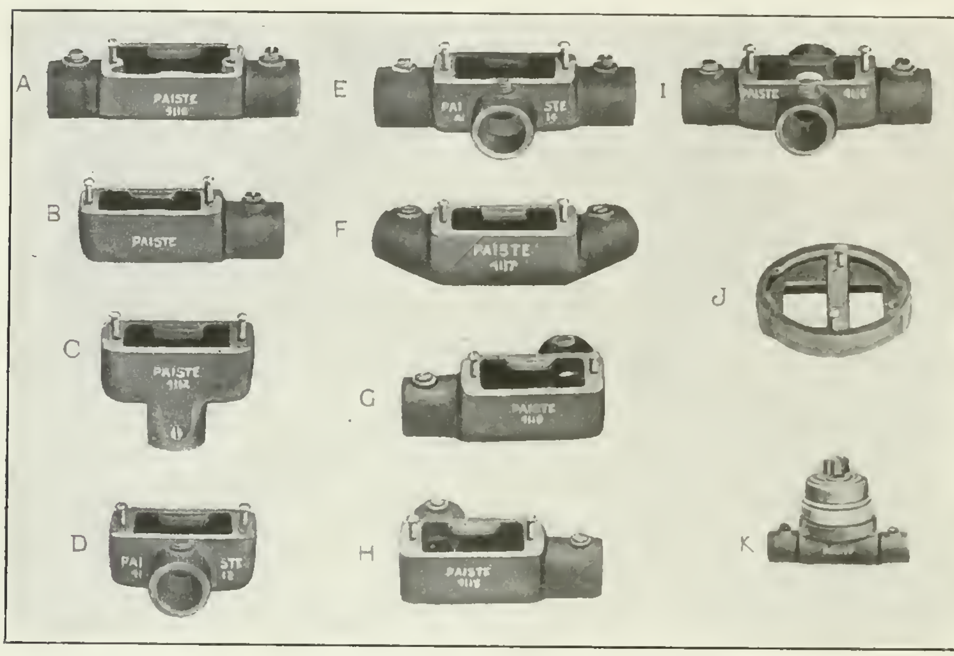


Fig. 3. Types of Cast-iron Conduit Fittings

The desirability of the requirements of Rule No. 2 is so obvious as to need no discussion.

Rule No. 3 requires that all wiring be installed in accordance with National Electrical Code regulations. Standard fire insurance policies require that the electrical work in all plants having insurance protection be installed in accordance with these regulations. It has taken many years to mold the regulations into their present excellent form, and they are revised constantly to keep abreast with the advances in the art. It is therefore essential that machines which are to be installed in plants carrying fire insurance, be wired in accordance with the Code. Even if insurance is not carried, it is advisable to follow these rules, as they outline a substantial and safe method of wiring. A copy of The National Electrical Code will be supplied free to anyone making request to the local Fire Underwriters' Inspection Bureau or to the Underwriters' Laboratories, Chicago, Ill.

Rule No. 4 requires that wiring be installed in wrought-iron conduits or in metal conduit fittings. It costs several times as much to run wiring in metal conduit (the properties of conduit are given in Table III) as to arrange it without mechanical protection. However, it is only the first cost of conduit wiring that is high. When placed in conduit the wiring is done once for all; there is no future trouble from broken wires, grounds or short circuits, due to abraded insulation. When arranged with conduit wiring, the machine is easier to keep clean and looks neater. The conduit fittings (which will be described later) are used at points where wires issue from the conduit or where a turn in the conduit run is necessary and it is not desired to bend the conduit. In general construction, they somewhat resemble screwed pipe fittings, but they are always arranged with removable covers so that the wire is easily accessible. Conduit and fittings are attached to machine frames with either pipe straps (Table VI) or machine screws, as will be described.

Rule No. 5 requires that all "live" bare metal parts be enclosed within metal covers. It is usually feasible to enclose these parts. Such enclosure prevents metallic chips from forming grounds or short circuits and renders shock to attendants impossible. With the voltages at which machine motors are usually operated, a shock is not often fatal, but one hears of cases where men have been killed from contact with 220-volt circuits. At any rate, an electrical shock is unpleasant, and if there is a possibility of receiving one the attendant is likely to be cautious and waste time. Fire risk is reduced by enclosing "live" parts. Although the Underwriters do not require enclosure they commend it. The electrical manufacturers appreciate the demand for enclosed apparatus, and it is now possible to buy standard starters and controllers, for nearly all applications, that are well protected and so arranged that conduit wiring can be readily installed.

Wire for Motor Application

The size of wire to use for transmitting electrical energy (in low-voltage work such as that involved in industrial-plant wiring) is determined by two requirements, *viz.*, the cross-sectional area must be large enough to carry the current required without getting too hot, but must not be so large as to cause an excessive drop in voltage—electrical pressure—and consequent energy loss. However, the distances involved in wiring machinery are so short that the latter requirement may be disregarded altogether. The only demand is, then, that the wire be big enough to obviate excessive heating.

The National Electrical Code specifies that all concealed wires shall be rubber-insulated and, in addition, that all wires carried in conduit shall have a double-braid covering. All standard rubber-covered wires used for voltages above 10 and below 600 have the same thickness of insulation. Copper wire is almost universally used for interior wiring. Therefore, if the voltage of the motor is below 600, wire for the installation should be specified, for example, thus: No. 6 National Electrical Code Standard, 0-600 volts, double-braid, stranded, copper wire. The size of wire, and whether it is to be solid or stranded is determined, as will be explained, by the horsepower output of the motor.

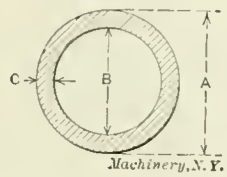
So that wire in service will not be dangerously overheated, the Underwriters have specified a certain safe current-carrying capacity for each size of wire and for wires having different insulating materials. In Table I are given the safe current-carrying capacities for all sizes of rubber-covered wire that the machine builder is likely to use. The sizes listed are all commercial ones and are, as a rule, readily obtainable. When the current or amperes taken by any motor is known, the size of wire to be used can be ascertained from Table I. Although Nos. 18 and 16 wires are listed in the table, the Underwriters do not permit the use, for applications such as herein treated, of any wire smaller than No. 14. It will be noted that the wires between No. 18 and No. 8 inclusive are tabulated as

"solid" and those larger than No. 8, as "stranded." Solid wire is that having a solid conductor, while the conductor in stranded wires is twisted up from several or many wires of relatively small diameter. Stranded wires are sometimes called cables. It is the usual practice in conduit work to specify that wires larger than No. 8 be stranded because, if solid, they are too stiff to be handled and pulled into the conduit readily. Solid wires can be obtained, if desired, in sizes much larger than No. 8 and these are much used in "open-work" wiring. The numbers of wires in a strand given represent the practice of some manufacturers, but other manufacturers have different standards. They vary little, however, from those shown. As a rule it is not desirable to specify the "number of wires in strand" when ordering, as the dealer may not be able to furnish just the stranding designated, from his stock. Any stranded wire, for conduit work, will answer the purpose, and the use of stock sizes will obviate delay.

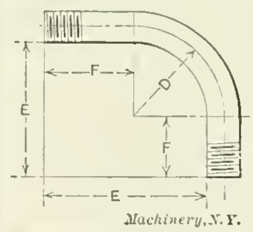
The size of wire to use for machine wiring is determined by the current (amperes) only. The current taken by any motor may readily be computed from rules given in electrical handbooks. If the motor is available, its exact full-load current is, in accordance with a Code rule, stamped on its name-plate. If the motor is not available, a full-load current value, accurate enough for the present need, can be taken from Table II. It should be understood that the tabulated values are averages and may vary somewhat from name-plate ratings. Different makes of motors of the same horsepower, have different efficiencies and, with alternating-current motors, different power factors, and both these appreciably affect the amount of current taken. The figures given in Table II indicate the current in each wire. That is, they show the number of am-

TABLE III. PROPERTIES OF CONDUIT, ELBOWS AND COUPLINGS

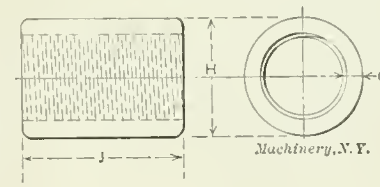
CONDUIT



ELBOWS



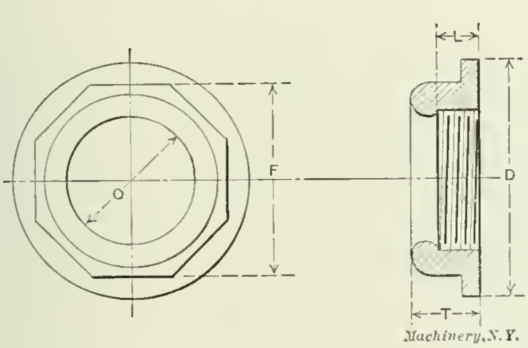
COUPLINGS



Nominal Size of Conduit	A Outside Diameter, Actual	A Fraction to Nearest 64th	B Inside Diameter, Actual	B Fraction to Nearest 64th	C Thickness of Walls, Actual	C Fraction to Nearest 64th	Nominal Weight, Pounds per Foot	D Radius of Center Line	E Offset	F Length of Str'ght Portion	Weight of 100 in Pounds	G Thickness	H Outside Diameter	J Length	Weight of 100 in Pounds
1/2	0.84	27/32	0.623	5/8	0.109	3/32	0.85	4 1/2	7 1/2	2 3/16	73	1/4	1 3/32	1 5/16	15 1/2
3/4	1.05	1 1/16	0.824	53/64	0.113	7/64	1.12	5 3/8	9 1/4	3 1/4	132	19/64	1 11/32	1 9/16	25 1/2
1	1.315	1 21/64	1.048	1 3/64	0.134	1/8	1.67	5 3/4	10 1/8	4 5/8	200	11/32	1 21/32	1 3/4	40 1/2
1 1/4	1.66	1 21/32	1.380	1 3/8	0.140	9/64	2.24	7 1/4	11 1/8	3 7/16	300	11/32	2	1 15/16	57 1/2
1 1/2	1.90	1 29/32	1.611	1 39/64	0.145	9/64	2.68	8 1/2	12 5/8	3 3/16	415	5/8	2 3/32	2 3/16	71 1/4
2	2.375	2 3/8	2.067	2 1/16	0.154	5/32	3.61	9 1/2	15 1/4	4 3/16	700	1 1/32	2 13/16	2 5/16	132
2 1/2	2.875	2 7/8	2.468	2 15/32	0.204	13/64	5.94	10 1/2	17 3/4	5 13/16	1138	17/32	3 9/32	2 11/16	185
3	3.50	3 1/2	3.067	3 1/16	0.217	7/32	7.54	13	19 3/8	4 5/8	1885	33/64	4 1/64	3	300
3 1/2	4.00	4	3.548	3 35/64	0.226	7/32	9.00	15	21	4	2100	1/2	4 1/2	3 1/8	400
4	4.50	4 1/2	4.026	4 1/32	0.237	15/64	10.66	16	32 1/2	4 1/2	2160	1/2	5 3/32	3 1/8	412

All dimensions in inches. All tubes are 10 feet long, threaded at both ends and furnished with a coupling. These dimensions were taken from manufacturers' tables and from samples.

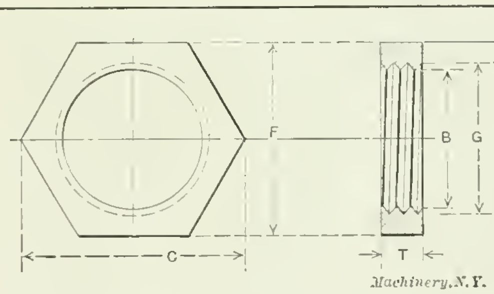
TABLE IV. DIMENSIONS OF CONDUIT BUSHINGS



Thomas and Betts Bushings. All Dimensions taken from Samples. All Dimensions in Inches

Size of Conduit	F	D	O	T	L
3/8	25/32	27/32	15/32	11/32	3/16
1/2	15/16	1 1/32	19/32	13/32	1/4
3/4	1 5/32	1 1/4	3/4	15/32	1/4
1	1 13/32	1 17/32	31/32	17/32	5/16
1 1/4	1 11/16	1 23/32	1 5/16	19/32	3/8
1 1/2	1 31/32	2 5/32	1 17/32	5/8	13/32
2	2 15/32	2 11/16	1 15/16	21/32	13/32
2 1/2	2 7/8	3 5/32	2 11/32	3/4	15/32
3	3 17/32	3 25/32	2 27/32	7/8	17/32
3 1/2	4 1/8	4 7/16	3 5/16	1	19/32
4	4 5/8	5 1/16	3 13/16	1 1/16	21/32

TABLE V. DIMENSIONS OF CONDUIT LOCK-NUTS



Thomas and Betts Lock-nuts. All Dimensions taken from Samples. All Dimensions in Inches

Size of Conduit	Threads per Inch	B	G	F	C	T
3/8	18	0.568	0.658	1	1 1/8	3/16
1/2	14	0.701	0.815	1 1/16	1 7/32	5/32
3/4	14	0.911	1.025	1 1/4	1 7/16	5/32
1	11 1/2	1.144	1.283	1 1/2	1 23/32	3/16
1 1/4	11 1/2	1.488	1.627	2 1/32	2 5/16	3/16
1 1/2	11 1/2	1.727	1.866	2 1/4	2 9/16	3/16
2	11 1/2	2.223	2.339	2 23/32	3 1/8	7/32
2 1/2	8	2.620	2.820	3 1/4	3 3/4	1/4
3*	8	3.241	3.441	4 11/32	4 11/16	11/32
3 1/2	8	3.738	3.938	4 3/4	5 1/16	3/8
4	8	4.234	4.434	5 1/2	5 7/8	5/16

* This size is octagonal.

peres flowing through each of the two wires to a direct-current or to a single-phase alternating-current motor, through each of the four wires to a two-phase alternating-current motor or through each of the three wires to a three-phase alternating-current motor.

Having found the current, in amperes, taken by a motor, the size of wire to be used can not be selected without first considering another point. National Electrical Code, Rule 8b, reads, in part, as follows: "The motor leads or branch circuits must be designed to carry a current at least 25 per cent greater than that for which the motor is rated. Where wires under this rule would be over-fused in order to provide for the starting current, as in the case of many alternating-current motors, the wires must be of such size as to be properly protected by these larger fuses." The machine builder has no means of knowing what size fuses the purchaser of his

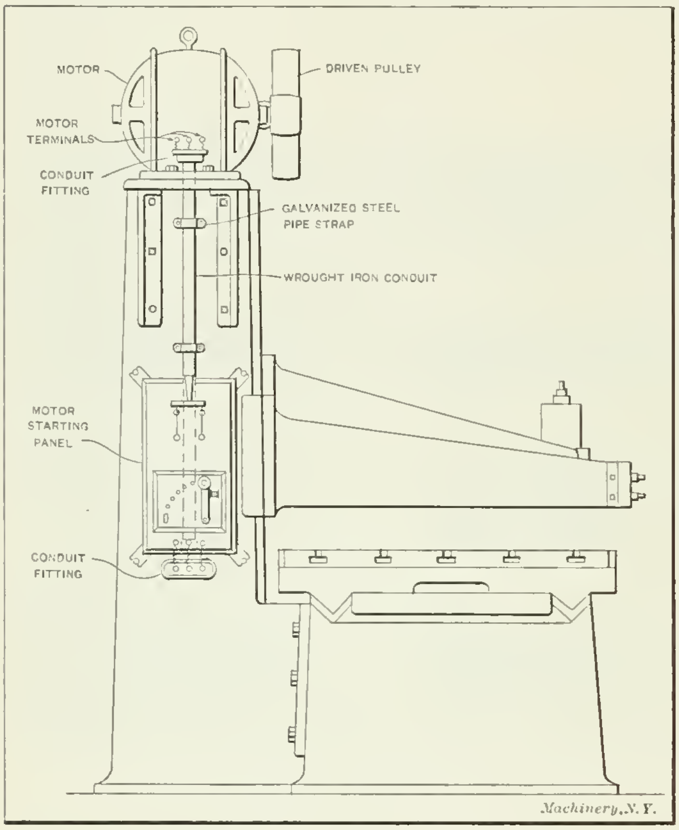


Fig. 4. Open-side Planer with Well-arranged Wiring

appliance will use so that the best thing he can do, ordinarily, is to provide wires capable of safely carrying 25 per cent more current than the full-load rating of the motor in question. The wire size is, then, selected on this basis.

For example, assume that a 10-H. P., 220-volt, three-phase motor is to be wired. Referring to Table II, we find that this motor takes about 25 amperes when operating at full load. To allow for a 25 per cent excess current, in accordance with

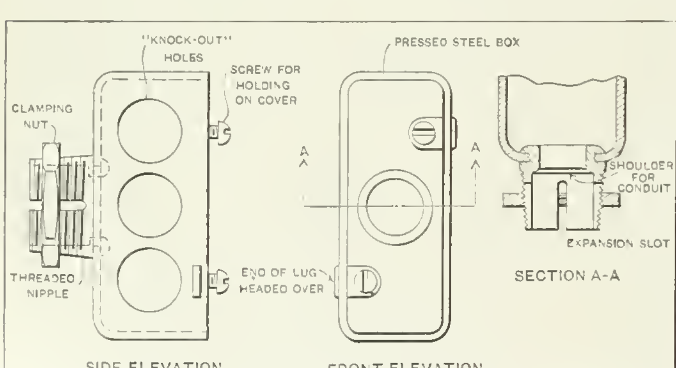


Fig. 5. Details of Typical Pressed-steel Fitting

the Code rule, an estimate is made thus: $25 \times 1.25 = 31$ amperes (about). Referring to Table I, a No. 8 (solid) wire which has a safe carrying capacity of 33 amperes is the smallest that can be used.

The insulation on rubber-covered wire deteriorates very rapidly under the action of heat, so if it is necessary to install conductors where they will be subjected to high temperatures, wire having "slow-burning" insulation should be used. Such wire, if enclosed, must be (according to the Code) in "lined" conduit. This conduit is described under the following heading.

Conduit for Motor Application Wiring

Wrought-iron conduit is merely standard-weight steel, or possibly in some cases wrought-iron pipe, which has been thoroughly cleaned to remove burrs and scale, and then either enameled or coated with zinc. Conduit which meets the requirements of the National Electrical Code and which has been approved by an Underwriters' inspector, is called National electrical Code standard conduit or N. E. C. S. conduit. In Table III are given the principal dimensions of commercial N. E. C. S. conduit, elbows and couplings. Conduit is furnished only in lengths of ten feet. Electrical conduit is threaded with standard pipe threads and standard-weight screwed pipe fittings will fit it.

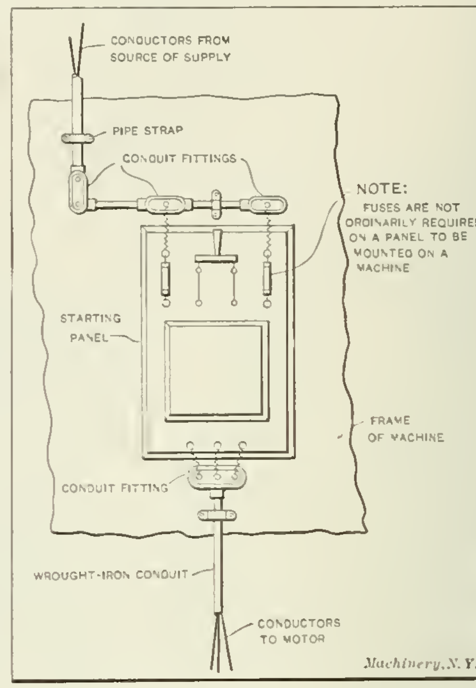


Fig. 6. A Neatly Wired Starting Panel

In addition to the "unlined" conduit, described above, a "lined" conduit is manufactured which has a relatively thick

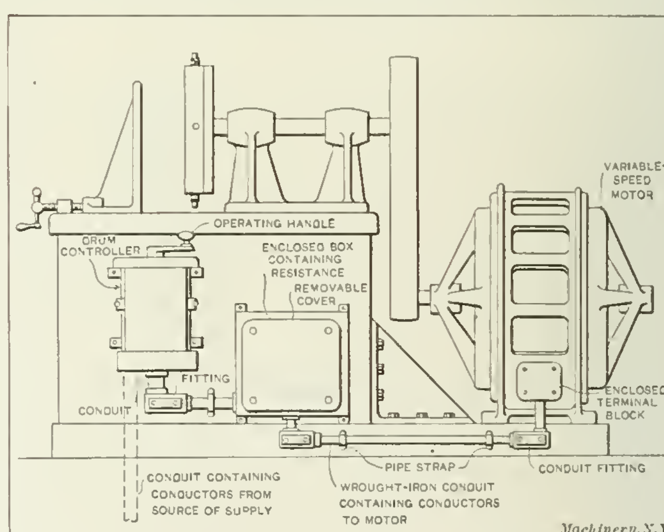


Fig. 7. Machine Equipped with Drum Controller

insulating lining. The lined conduit is seldom used as it is more expensive than the unlined and the latter has given entire satisfaction. The insulating lining appears to be unnecessary, as the rubber insulation on standard wire provides excellent protection.

Although its use would be prohibited by the Underwriters, there is really no objection to using commercial wrought-iron pipe instead of conduit for wiring machines. Such pipe should be carefully cleaned inside and out and every precaution taken to make sure that there are no burrs or slivers on

the inside of the pipe which might cut insulation on wires. After the pipe is painted, it is almost impossible to distinguish it from conduit.

Conduit elbows are formed from conduit to the dimensions indicated in Table III. The smaller sizes of conduit can be

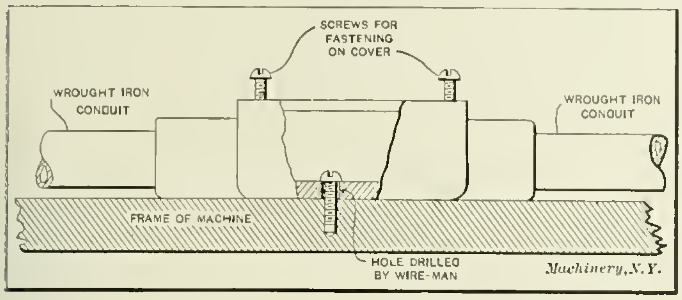


Fig. 8. Satisfactory Method of Supporting Fittings

bent cold to any desired contour, but it requires some skill to do the bending. Conduit-bending machines are obtainable and their installation pays if there is much wiring to be done. Both power- and hand-operated types are manufactured.

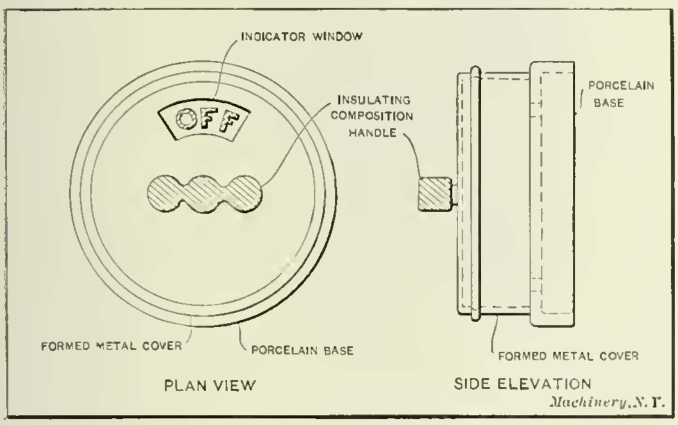


Fig. 9. Indicating Snap Switch

Couplings for conduit are exactly the same as screwed couplings for standard-weight pipe, except that the former are either enameled or coated with zinc, and have a better finish.

After determining the proper size of wire to use for supplying energy to a given motor, the size of conduit to carry it can be selected from Table 1. The sizes there tabulated,

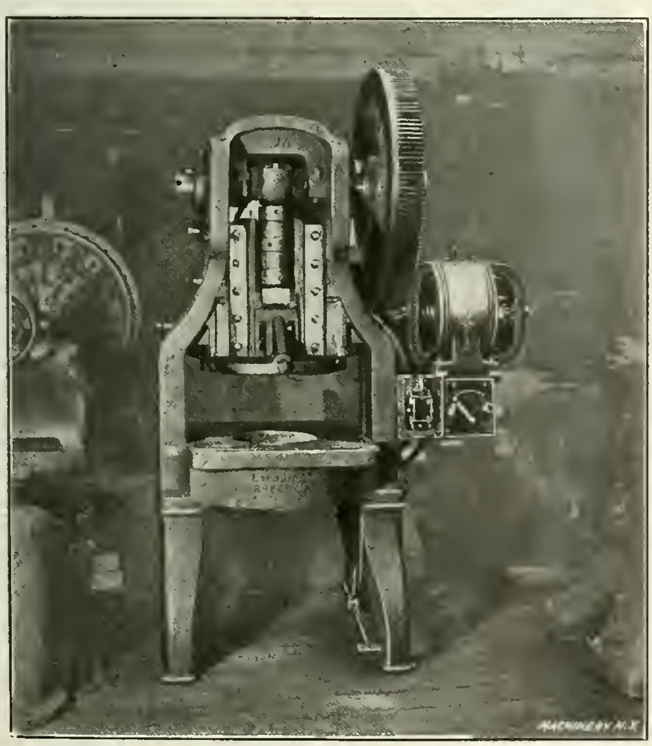


Fig. 10. A Motor-driven Power Press with Well-arranged Switch and Starter

for the different sizes of wire, have been chosen as the result of much experience with conduit wiring. They are sufficiently large to allow wires to be drawn in or out without the application of excessive force. It is a common error to choose a conduit size so small that the wires must be pulled in with blocks and tackle. If this is done, the insulation is likely to be injured and withdrawal may be impossible.

Conduit Fittings and Sundries

Where wires emerge from conduit ends, the Code requires that provision be made so that a possible burr on the inside of the conduit will not abrade the insulation on the wires when they are being drawn in or out. Conduit ends may be protected either by a bushing, such as shown in the engraving accompanying Table IV, or by a fitting, of one of the types

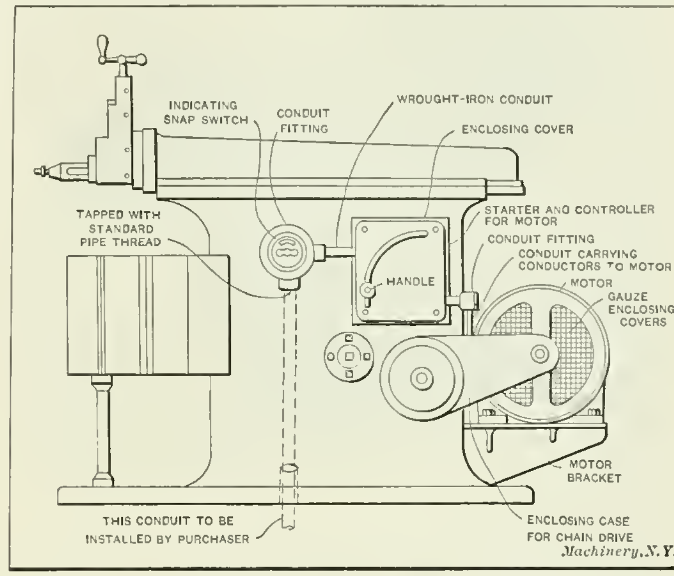


Fig 11. A Motor-driven Shaper with Completely Enclosed Wiring

shown in Fig. 3, equipped with a porcelain cover, Fig. 1. The bushing should be used when the conduit terminates within an enclosed outlet, junction, or panel box (see Fig. 2) which may be made of either cast or sheet iron. The dimensions given in Table IV will prove useful in indicating what clearances are required for screwing the bushing on the end of the conduit and will also assist in determining the locations for the conduit holes.

Outlet boxes usually have unthreaded holes for the conduit, as indicated in Fig. 2, but where a waterproof installation is

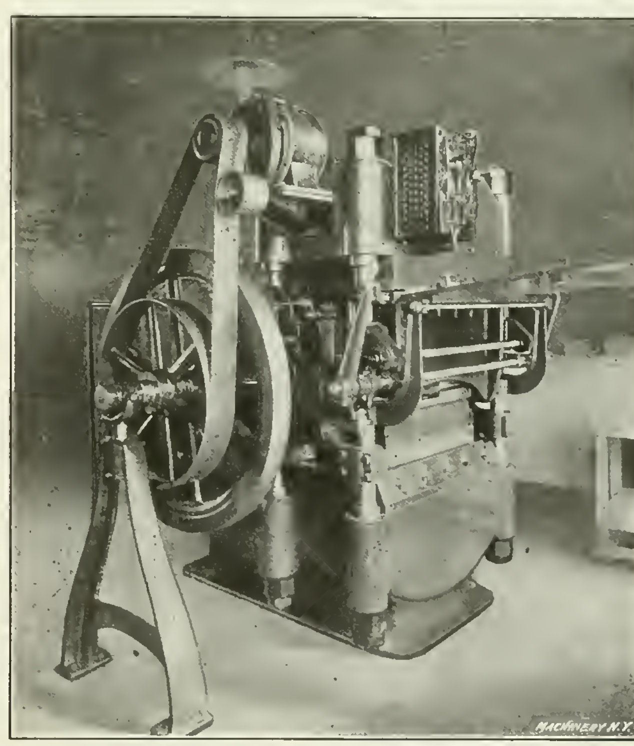


Fig. 12. Seybold Embossing Press with Wiring in Conduit

essential, the holes should be threaded. When the holes are unthreaded, a lock-nut (shown with Table V) is run on the end of the conduit and, after the bushing is screwed to posi-

tion, the lock-nut is turned up snugly against the side of the box, binding the conduit firmly in position. It should be understood that the dimensions given in Tables IV and V for bushings and lock-nuts are accurate for only one manufacturer's line. There are several different makes available, but all will measure approximately the same as those shown.

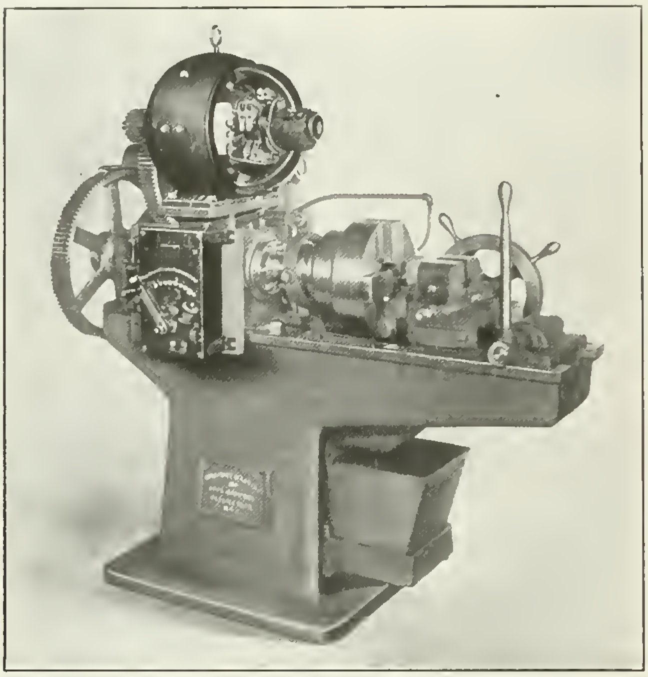


Fig. 13. Motor-driven Pipe Threader with Complete Electrical Equipment

The application of conduit fittings can best be shown by an example. In Fig. 4 is illustrated a motor-driven open-side planer with the wiring between the starter and the motor neatly carried in conduit. At the motor terminal the conductors issue through a fitting which is of the type shown in Fig. 3 at *C* equipped with the cover shown in Fig. 1 at *B*. The conduit fittings are so made that any style of cover of a given pipe size will fit any cast-iron fitting of corresponding pipe size. The covers are held on with brass screws. In Fig. 6 is shown an arrangement of fittings that might be used with the type of starting panel shown in Fig. 4, if the motor were located below instead of above the panel. It will be noted that where "elbow" fittings (*G* and *H*, Fig. 3) are arranged with metal covers, they are effectively used at turns in the conduit run, instead of bends or wrought-iron elbows. Fig. 7 illustrates further applications of conduit-fitting elbows.

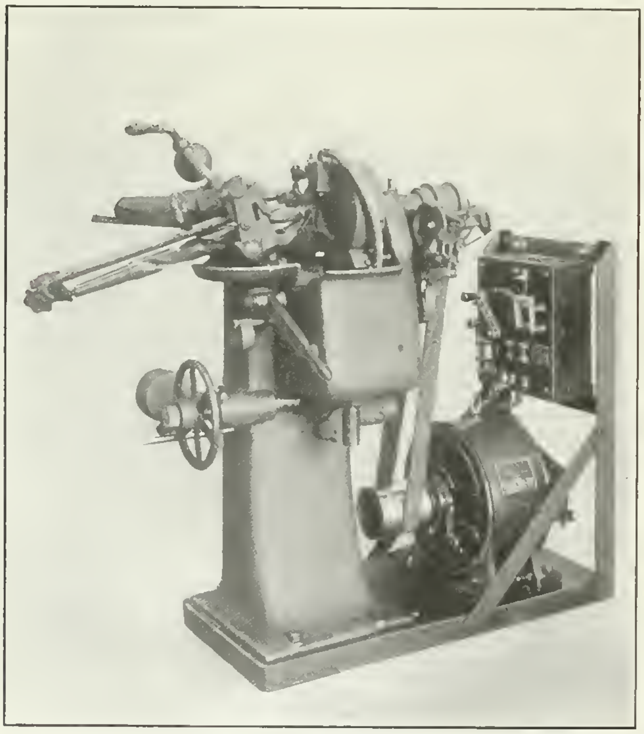


Fig. 14. Drill Grinder with Specially-constructed Support for Starter

A very convenient feature of the fittings shown in Fig. 3 is the provision of a headless set-screw in the throat. By means of this set-screw it is possible to secure a conduit end firmly in a fitting even if the threading on the conduit is faulty or if, because of a bend in the conduit, it does not set up tightly in the fitting, when in its proper position. In this type of fitting, conduit can be secured without being threaded at all. The set-screw provides ample attachment, if conduit and fittings are firmly fastened to a supporting surface, as they usually are on machinery. Nor is it necessary to thread conduit running into fittings like that in Fig. 5. An unthreaded end of a conduit length is inserted in the nipple, the nut is tightened, and the conduit is secured. The threaded portion of the nipple is split and tapered. These fittings possess several advantageous points. Being of sheet-steel, they are unbreakable. The fact that each fitting has several "knock-out" holes makes possible a great number of combinations from a comparatively small stock of fittings and covers.

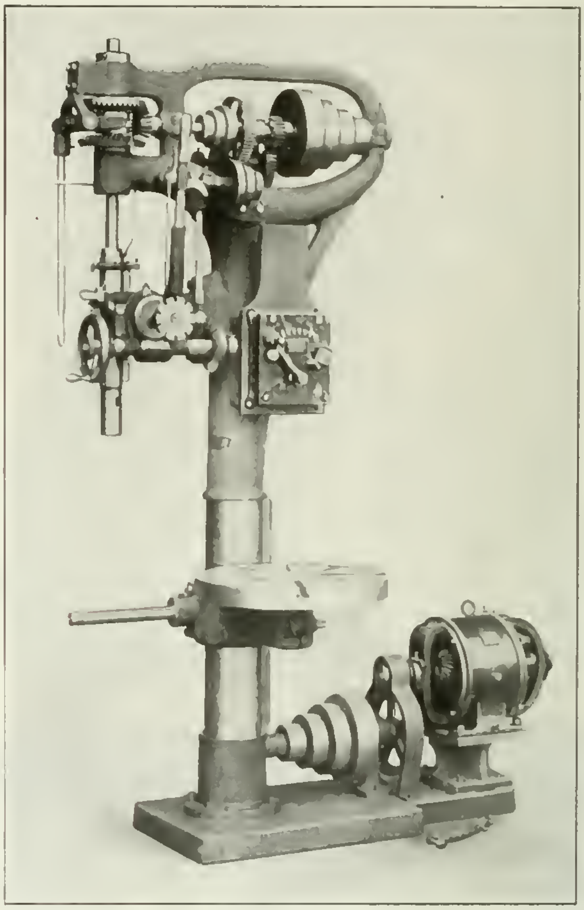


Fig. 15. Motor Starter and Board for Switch Mounted on a Drill Press

Supporting Conduit Wiring

Obviously, conduit carrying conductors should be so securely supported that there can be no chance of its being displaced under reasonable conditions. Pipe straps, formed from sheet-steel and then galvanized, such as that shown with Table VI, are most frequently used for supporting conduit, as shown in Figs. 4, 6 and 7. The dimensions given in Table VI will be found useful in making clearance allowances and in determining the locations for the tapped holes for the round headed machine screws, with which the straps are fastened. The dimensions of Table VI are accurate only for the lines of certain manufacturers but will be approximately correct for all makes.

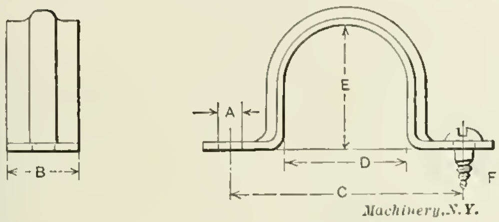
Another good method of supporting conduit runs is by fastening the fitting to the machine frame with machine screws, as shown in Figs. 1 and 8. The screws pass through a hole drilled in the bottom of the fitting and down into a hole tapped in the machine frame. It is often feasible to support a complete conduit installation by this method and there-

by entirely avoid the use of pipe straps. This sort of a job presents a neat appearance.

Motors Arranged for Conduit Wiring

When it is specified that the "motor shall be arranged for conduit wiring," certain motor manufacturers will provide, without extra charge, a metal terminal box, with a removable cover, around the motor terminals. A motor so arranged is shown in Fig. 7. Such a terminal box permits of the best possible installation, and through its presence a conduit fit-

TABLE VI. DIMENSIONS OF PIPE STRAPS



All Dimensions taken from Samples. All Dimensions in Inches

	A	B	C	D	E	F		
Nominal Size of Pipe	Diameter of Screw Hole	Width of Strap	Distance between Centers of Screw Holes	Width of Opening	Height of Opening	Size of Wood Screw to Use	Approximate Cost per 100	Approximate Number per Pound
						No. in.		
1/4	0.20	5/8	1 9/16	9/16	17/32	8× 5/8	$0.40	75
3/8	0.20	5/8	1 3/8	11/16	23/32	8× 3/4	0.45	72
1/2	0.20	5/8	1 5/8	7/8	25/32	8× 3/4	0 50	40
3/4	0.22	3/4	2 1/8	1 1/8	1	10× 3/4	0.75	29
1	0.22	3/4	2 3/8	1 3/8	1 11/32	10× 7/8	1.00	21
1 1/4	0.22	13/16	2 3/4	1 3/4	1 5/8	10×1	1.25	18
1 1/2	0.22	13/16	3	2	1 7/8	10×1	1.50	14
2	0.22	1	3 3/4	2 1/2	2 5/16	10×1 1/4	2.00	12
2 1/2	0.25	7/8	4 3/8	2 3/4	2 15/16	11×1 1/4	2.75	6

ting, like that at the motor in Fig. 4 can be dispensed with. A bole is provided in the terminal box and the conduit is terminated with a bushing in the hole.

Switches on Machines

It is required by the Code that every motor and starting box be protected by a double-pole cut-out (fuses or circuit break-

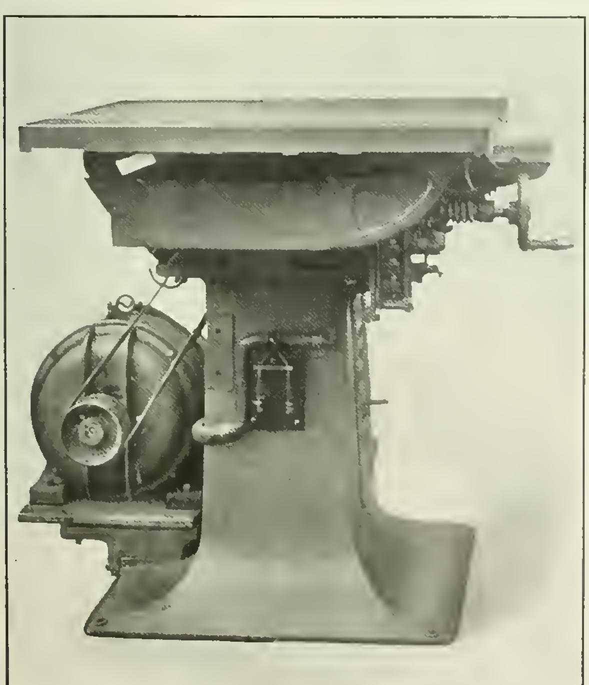


Fig. 16. Saw for Trimming Electrotypes, with Enclosed Wiring

er) and controlled by an indicating switch that plainly indicates whether the circuit is open or closed. For motors exceeding in capacity ¼ horsepower, a double-pole switch is required, but a single-pole switch may be used for smaller ones. It is always advisable, however, to use the double-pole type, as through its use both sides of a circuit are rendered dead when the switch is open.

For handling currents up to 20 amperes, or thereabout, the best switch to use is of the indicating-snap type, shown in Fig. 9. This type can readily be obtained as either single-

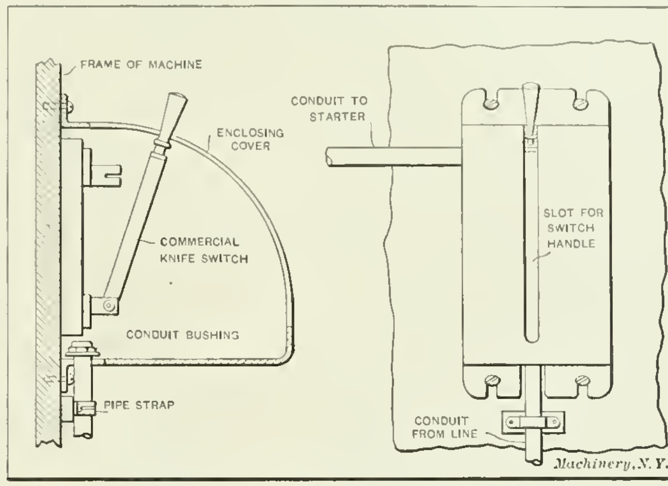


Fig. 17. Enclosing Cover for Knife-switch

pole, for direct-current and single-phase alternating-current motors, or triple-pole for three-phase motors. All "live" parts are effectively enclosed in a formed, sheet-metal cover (Fig. 9)

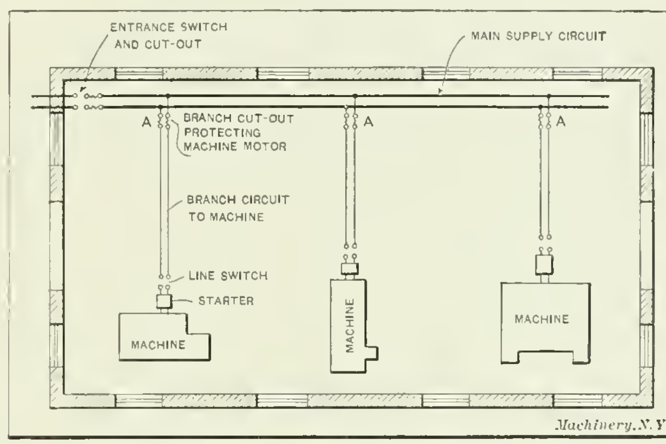


Fig. 18. Wiring Diagram for Motor-driven Machines

which is lined with an insulating material. By unscrewing the composition handle, the cover can be quickly removed for making connections. Wires enter the switch through holes

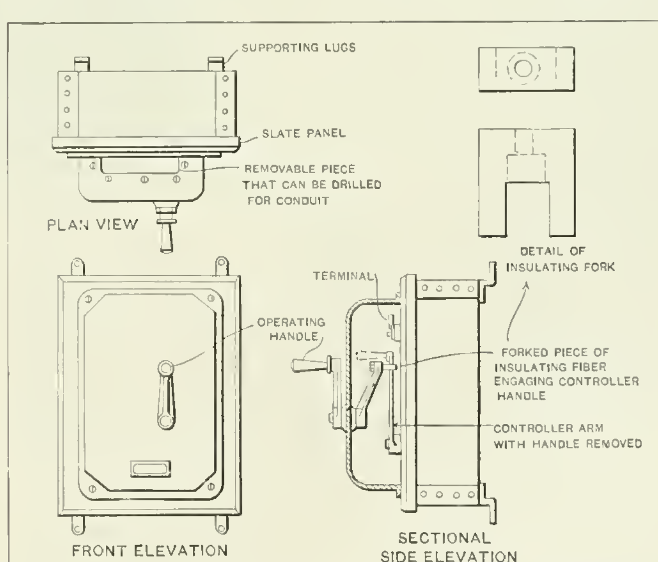


Fig. 19. A Good Enclosing Cover Design

in the back of the porcelain base. A revolving dial, bearing the legends "On" and "Off," indicates whether the switch is open or closed.

An indicating-snap switch mounted on a conduit fitting as

shown in Fig. 11 makes a rugged and safe switching combination. All wires and "live" parts are completely enclosed. Some manufacturers make conduit fittings especially designed for carrying switches; but an equivalent fitting may be assembled, as shown in Fig. 3 at *K*, with the components *A* and *J*, or with *J* and any other piece shown in Fig. 3.

For handling currents above 20 amperes, open-knife switches are commonly used. The open type is used because (so far as the writer is aware) no enclosed-knife switch is

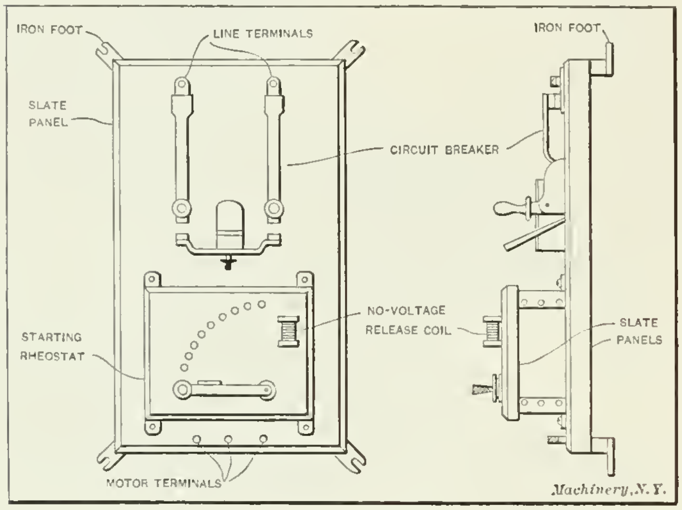


Fig. 20. A Circuit-breaker Starting Panel

regularly manufactured. These open switches are best mounted close to the motor starter, as shown in Figs. 10, 12 and 13. Controllers and starters, as will be outlined later, can be purchased with the line switches mounted directly on them, as indicated in Figs. 4, 6 and 14. Such combinations are called starting or controlling panels. In Fig. 15 is shown a drill press with the starter neatly mounted on it, and room provided on the mounting board for a line switch. Enclosed wiring is used in Fig. 16 and the leads to the switch are taken from the conduit, at the side of the frame, above the line switch.

In all of these examples of knife-line-switch and controller applications, it was evidently deemed unnecessary by the designer to enclose the switches and controllers. If enclosure is desirable (and as many view it, there are few cases where it is not) a cover for a knife-switch can readily be constructed from sheet or cast metal as suggested in Fig. 17. As will be described subsequently, circuit-breakers are often used on motor-driven machines, making switches unnecessary.

While a cut out is required by the Code to protect every motor-controller combination, it is not advisable to mount this on the machine. As a rule, it is best located at the point where the branch-circuit to the machine taps from the main supply circuit, as shown at *A* in Fig. 18. Hence the machine manufacturer should not be expected to provide a cut-out. A cut-out is ordinarily required at *A* inasmuch as the branch wires are usually smaller than the main wires and the Code requires the installation of a cut-out wherever there is a decrease in wire size.

Motor Controllers and Starters

Motor starters as regularly furnished by the motor manufacturers are of the open types shown in Figs. 4, 10, 12, 13, 14, 15 and 16. By "open type" is meant a type which does not have its "live" parts protected by a cover. These open starters have given and will give entire satisfaction in places where it is reasonably clean. But some purchasing concerns prefer to have, in so far as possible, all electrical apparatus enclosed, and it is believed that, all things considered, this is usually the most economical method although the first cost of enclosed equipment is a trifle higher. An enclosed starter is shown in Fig. 11. It consists merely of a standard open starter fitted with a cover which encloses all "live" parts, and has a semi-circular slot for the operating handle. Most of the electrical manufacturing concerns have standardized and are prepared to furnish enclosing covers for their control equipment. Such a cover makes it difficult for the unauthorized to tamper with the adjustment of the starter, keeps it clean, eliminates liability to shock and prevents grounds or short circuits due to flying metal chips.

The purchaser of an enclosing cover for a starter should insist that it enclose not only the dial-contacts but also the terminals on the starter. Certain manufacturers will furnish a cover that will shroud the dial and not the terminals, unless specifically directed as above: *all* bare current-carrying parts should be enclosed.

In Fig. 19 is detailed an excellent enclosing cover that can be applied to standard starters. Instead of being slotted for the operating handle as is the one shown in Fig. 11, a better construction is used. An auxiliary operating handle and arm is mounted on the cover; on the end of this arm is an insulating fork which engages the controller arm when the cover is in its normal position, and thus transmits the movements of the operating handle to the controller arm. The absence of a slot in the cover makes the starter dust-proof. The terminals are completely enclosed and a removable piece that can be taken out altogether, for the admittance of wires, or drilled for conduit, is provided above the terminals. When this cover is applied to the standard controller the old controller handle is removed.

Sometimes a circuit-breaker is substituted for the switch on a starting panel, as shown in Fig. 20. A circuit-breaker is one type of cut-out. It opens a circuit automatically when a current, of a value for which it is set, flows through it. It

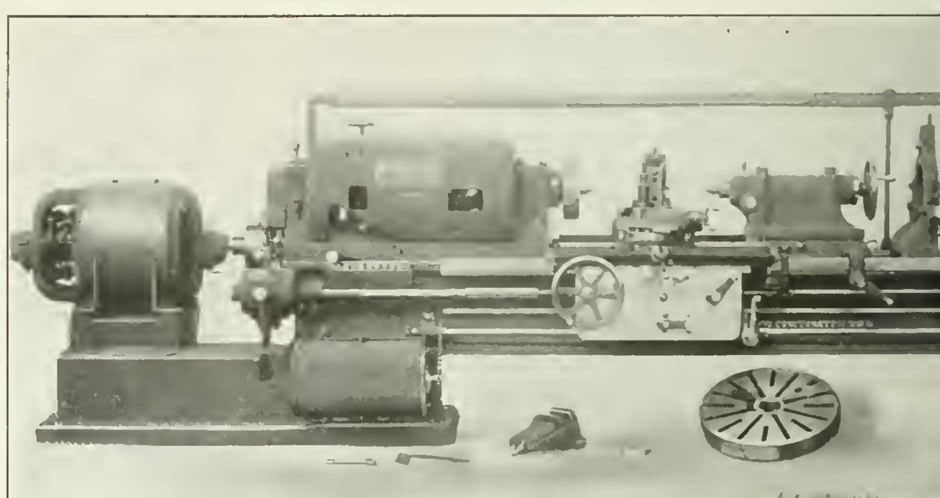


Fig. 21. Drum Controller with Sprocket Mechanical Transmission

can also be opened manually by releasing a catch. Circuit-breakers, of reliable types, are considerably higher in first cost than a switch-fuse combination, but in the long run they are more economical. The reasons for this are: First, fuse renewals, which are relatively expensive, are not required, and second, the cost of labor wasted while fuses are being replaced, is saved.

The panel in Fig. 20 is shown without enclosing covers so that its construction will be apparent; but it is made with covers which expose only the circuit-breaker and starting-rheostat operating handles. Some manufacturers enclose panels like that of Fig. 20 in sheet-metal steel boxes having hinged doors, but this is not a satisfactory arrangement for machinery applications, because, to operate the starter or manipulate the switch, the attendant must open the door. This is awkward and, in case of accidents, when the motor should be stopped without delay, prevents quick action. The

consequence is that the door is usually left open or is taken off altogether.

As previously mentioned, motors on machines are frequently protected by branch-fuses located at the supply circuit as shown at *A* in Fig. 18, and a circuit-breaker or a starting panel provides additional protection. However, the circuit-breaker should be set to trip on a smaller current than will rupture the fuses. The circuit-breaker takes the brunt of an overload and operates instantaneously, saving the cost of fuse renewals. As the economies of circuit-breaker applications are becoming better understood they are becoming more popular. Some large industrial corporations specify them on every motor starting or controlling panel.

Drum controllers with external resistances are deservedly becoming very popular, particularly for variable-speed control. In Figs. 7 and 21 are shown drum-controller applications. The drum controller receives its name from the fact that contact is made between stationary fingers and rotating segments mounted on a drum. All the parts can be made very rugged and can be so arranged as to be readily removable for renewal and repair. The resistance is arranged in a separate frame which can be provided with an enclosing cover and arranged for conduit wiring as shown in Fig. 7. The drum usually contains only the contact-making mechanism. It is believed that a drum controller is preferable in every way to one of the dial type, which has contact buttons arrauged on the face of an insulating panel and a swinging arm to make electrical contact with them.

In Fig. 21 the drum controller is mounted conveniently near the motor at the head of the lathe. The controlling handle, whereby the lathe is started, stopped or has its speed varied, is attached to and travels with the apron and hence is always handily located for operation. The handle engages with a longitudinally-slotted shaft so arranged that when the handle is turned the shaft turns. The shaft extends nearly the entire length of the lathe and motion is transmitted from it to the controller drum by means of sprockets and a chain. It will be noted that the cover of the drum controller cau be easily removed by unscrewing a couple of swing nuts.

Enclosing Motors

Motors can be furnished either open, semi-enclosed or fully-enclosed. A fully-enclosed motor of a given horsepower and speed costs more than a semi-enclosed or an open one, because a large frame is needed for the enclosed type. The power capacity of a motor depends largely on its ability to dissipate the heat generated within it, and if it is enclosed, the heat is dissipated with difficulty. To reduce the quantity of heat generated, the parts must be proportioned more generously; hence the necessity for larger frames for enclosed motors. Motors seldom need to be fully enclosed unless they are to operate in very dirty places, or in other special cases. Gauze enclosures such as those indicated in Figs. 11 and 14 are ample for most machinery applications. Gauze or wire-netting enclosing covers reduce the rating of a motor very little, if any. The use of such covers is advocated on motors for nearly all machine drives. One small metal chip, striking a motor in just the right place, can involve more money for repairs and lost time than would be spent for several sets of gauze-enclosing covers. An investment for them is good insurance.

Mounting Motors

The Code specifies that the frames of all motors operating at potentials in excess of 550 volts shall be either permanently grounded or else insulated by wooden frames or otherwise. The use of a wooden frame or any other insulating arrangement is not usually feasible, so the almost universal practice is to bolt the motor frame into good electrical contact with the frame of the machine. It devolves upon the purchaser of the machine to see that it is well grounded, either through the conduit conveying the conductors to the machine (the Code requires that the conduit of all conduit wiring systems be grounded) or through a specially provided ground wire connected to the machine. It should be noted that the Underwriters require that special permission be obtained before motors with grounded frames are installed.

CUTTING SPEED AND GRINDING OF HIGH-SPEED STEELS

By WOLFGANG KOCH

The properties of the so-called "rapid" steels are not yet thoroughly understood, although their use is increasing. They have been well introduced for roughing, and their capacity for this work varies, according to the kind of steel used and the care taken in hardening. But in any case it is well known that the rapid steels rough better and last longer than carbon steels of any of the compositions common in recent years. As regards finishing, it is asserted by some that the rapid steels can only rough, not finish. Without doubt, this unfavorable view is due very largely to the fact that it is often undertaken to finish a piece of work with the same tool that has just been used vigorously for roughing it. No experienced machinist would undertake to finish a piece of work with the same carbon-steel tool that he had used to rough it; but from a new article everything is demanded. The writer has very often found in testing new rapid-steel tools that for a job of roughing which was beyond the capacity of any ordinary steel, it has been demanded by the superintendent, and also by the workman, that the same tool should do the finishing; and it has been considered a fault when the finished work has not been satisfactory. The newly-ground tool finished very well; but after roughing cuts had been taken with it, the edge turned, which prevented it from taking a good finishing cut. It is, in fact, foolish to demand this; but it is a fact that it is demanded.

A second demand made on rapid steel is that tools made from it should finish with the same cutting speed as that with which they rough. No one would demand such a cutting speed of carbon steel; but as rapid steel is expensive, one demands of it in finishing a very much higher capacity in every way; and when it does not act, the conclusion is at once arrived at, that it cannot finish.

If a properly-ground cutter of rapid steel is used, at a somewhat higher speed than is possible with carbon steel, but with by far less speed than is permissible for roughing, it will be seen that its cutting edge lasts longer than one of carbon steel. Therefore, with the same length of work-time, several sharpenings are saved, with the accompanying interruption of the work; and the tool lasts correspondingly longer. But above all things the advantage is that entire pieces of work can be finished without the necessity of grinding, with its consequent change in the cutting edge; so that an entire set of articles will have exactly the same finished surface. By means of a cutting edge of rapid steel, therefore, one gets more regular and more exact work. But the work of the cutting edge depends on the care taken in grinding.

Some mechanics have the impression that especially the German rapid steels, besides roughing well, can be used to advantage for finishing. As basis for decision in this important question of the cutting qualities of the rapid steels, the editors of the *Zeitschrift für Werkzeugmaschinen und Werkzeuge* sent several German firms the following question: "It is stated by some that the rapid steels cannot finish, but only rough. On the other hand, it is known that finishing tools of rapid steel stand up to the work very long. Careless grinding—especially wet grinding—makes rapid-steel tools brittle. What is your experience?"

There were received at the time of writing this paper fourteen answers. In two, the finishing qualities of rapid steels were denied; the twelve others agree in the main with the above expressed opinion as to the finishing capacity of the rapid steel, or at least did not contradict it. Two answers emphasized the fact that the principal advantage of the rapid steels is for roughing, but state that this steel will finish also. Great care in grinding, and the avoidance of heavy pressure while grinding, were often recommended. Nine answers recommended dry grinding for rapid steel, one recommended wet grinding, and one, wet grinding with hot water. One answer stated that wet grinding even with boiling water was deleterious to rapid steel.

As in these answers many opinions are expressed which are worth publishing, they are given in the following:

Gebr. Böhler & Co. write: "If finishing tools of rapid steel do not fulfill the expectations, they have not been properly handled. The grinding of rapid steels must be done with great care, but special care must be taken that the steel does not get too hot during this process, as when heated these highly alloyed steels are very sensitive and show fine cracks, which cause crumbling of the cutting edge. Grinding can be done either dry or wet. As against the advantage of the more rapid conduction of heat by wet grinding, there is a greater danger of cracking, as by the higher heating in grinding, contact with the water causes fine cracks to appear more readily. In order to prevent too great heating, it is imperatively recommended to choose such a grinding apparatus that the attack of the grinding disk shall always be only on a very small surface at a time; this can be attained by choosing small enough disks."

The Krefelder Stahlwerk writes: "It is our opinion that the wet grinding of rapid steel twist drills is to be avoided in every case. The cutting edges break, so that the drill does not do enough work. * * * According to our experience most twist-drill grinding machines in Germany are for dry grinding, so that account has to be taken of this fact. * * * With careful dry grinding, a good edge for finishing may be obtained." It was added that in practice it could not be ascertained whether steel had been manufactured in an electric furnace or otherwise.

The Siegen-Solinger Gusstahl Co. writes: "Rapid cutting steel has the peculiarity that it holds its sharp edge under high heating by reason of high cutting speed; while tools of carbon steel become dull because of the reduced hardness caused by the heating. It is therefore easily seen that rapid steel is better adapted to dry grinding than carbon steel, which thereby easily loses its hardness."

The Stahlwerk Kabel, C. Pouplier, Jr., writes: "I am of the opinion also, that wet grinding should be done by cooling off with hot water. Experience shows that the valuable but very hard steels readily develop, both by dry and by wet grinding with cold water, fine hairlike cracks, which are naturally disadvantageous in finishing; and these fine cracks are often avoided by cooling in hot water. Very often these cracks are caused by improper and careless grinding; and personally I am of the opinion that when grinding is carefully done, the same results will be attained by wet as by dry grinding."

R. Stock & Co. write: "Our experience in grinding rapid steel, especially twist drills, shows that one can grind just as well wet as dry, if careful not to exert too much pressure against the disk. The heat of grinding must remain within the limit which with dry grinding would cause an annealing or a hardening, and with wet grinding would cause surface cracks. With alloy steel one must be careful in wet grinding as well as in dry; whereas with the high alloys a heavier pressure may be permissible. High alloy steels have a grain which is more resistant to cracking than the lower alloy steels; they are, therefore, in dry grinding less sensitive to the resultant heat of grinding. Also with the high alloys, by reason of their more suitable crystalline form, the danger of cracking by cooling during grinding is less than in the case of the lower alloys. As in wet grinding one can do more work by reason of keeping the tool constantly cool than by dry grinding, so one will find it desirable to wet-grind the less sensitive high alloys, and very carefully dry-grind the low alloys. In reference to finishing with rapid steels, our experience is that these are not so good as the carbon steels."

One of the most important German machine-tool builders, who does not wish to be named, says: "We braze small pieces of Böhler rapid steel to Bessemer steel. After the brazing and simultaneous hardening in a strong air current, the steel is brought to the proper form on the emery wheel, with water cooling and moderate pressure, and then ground smooth on a grindstone with slight water cooling. For fine work the tool is further touched up by the workmen on an oilstone. With steels handled in this way we have not yet discovered any cracks.

"In the use of tools for finishing, the different materials to be worked must be taken into account. On a shaft of fine-grained iron (41,000 to 50,000 pounds per square inch tensile strength) a rapid-steel tool will keep its edge a long while with a cutting speed of 60 meters (197 feet) per minute; and at the same time will do good finishing.

"On a shaft of high-carbon steel of 92,000 to 100,000 pounds per square inch tensile strength and a speed of 12 meters (39.37 feet) per minute it was not possible, with the same rapid steel, to do equally clean work, and the life of the cutting edge was very short. The same unfavorable results were obtained later in working tool steel."

Ludw. Loewe & Co., write: "Concerning the exact properties of rapid steel there is as yet too little done in the way of detailed experiment to enable us giving an opinion. Further, the various kinds differ so greatly in their behavior in hardening and working, that an opinion based on one kind would not be accurate for another. In any case we recommend under all circumstances to grind wet, as all steels have this in common, that the edge will be ruined by improper dry grinding. Naturally, wet grinding must also be properly done, and without too heavy a pressure; else the often-mentioned spoiling of the rapid steel will take place.

"In general one can say that the rapid steel is best used for roughing, and that preferably it is to be used for drills and roughing tools. On the other hand, there are also cases where cutters of rapid steel are greatly to be recommended and specially show a great durability, so that the edges need sharpening very seldom."

The Werkzeugfabrik Gebr. Saacke writes:

"According to our experience, wet grinding is in general little to be recommended for rapid steel; and in most cases, we prefer dry grinding. If the latter is done with the proper precautions, with the least possible heating of the cutting edges, these serve very well for finishing. Highly alloyed rapid-steel cutting tools of different makes seem to show very different properties in this regard."

Droop & Rein write: "Rapid steel will do finishing very well; and with reduced speed will do clean work. The edge of the tool lasts four to five times as long as that of the ordinary steel. It is true that careless grinding will make the cutting edges crumble or rather full of cracks. The reason for this is in the heating—because of the pressure—and in the simultaneous cooling with water. The finishing-tool works best when it is carefully ground with a soft emery wheel and finished off with an oilstone."

Biernatzki & Co. write: "We have only recently posted a notice in our factory, forbidding the wet grinding of rapid steel. We have also in our works, and with our machine tools, which are specially constructed for rapid steel, had the experience that water in every case spoils the rapid steel. It cannot, therefore, be worked with water nor ground therewith. For the milling department, for example, and for lathe work, where finishing is done, we use oil as a cooling material, with good results. In the turning department we finish with rapid tools, and get desirable results especially on cast iron."

Richard Weber & Co. write: "It is just as impossible to grind rapid steel with water, as to harden it therein. It will not permit in a warm condition, any contact with water. If for instance tools of rapid steel are hardened in the air which cools them to about 200 degrees C. (392 degrees F.), and then put in water at once, they will crack even in boiling water; also surface cracks will come in the fine edges, in grinding, if the steel which has been heated in grinding is touched by the cooling water. On the other hand, very careful dry grinding will give, with the majority of rapid steels, good finishing edges; but for all that it is to be recommended even here, for the reason given above, not to grind with water. Some brands of rapid steel or more properly of substitutes therefor are less sensitive to water; experiments in finishing with them have given good results."

The Rheinische Electrostahl-Werke write: "According to our experience, rapid steel of various brands is well adapted to finishing, if the grinding is done dry and with the proper care. Wet grinding makes the cutting edges crumbly and unfitted for finishing."

The Sächsische Maschinenfabrik writes: "Finishing steel and iron with rapid steel at high cutting speeds will not give good results, because small particles of metal become fixed on the edge or tear loose and then crack. With lower cutting speed, and by grinding the tools with the proper facilities, the finish will be just as clean as with an ordinary tool steel. The rapid steel is really better, because one can hardly note any wear on it."

The Wesselmann-Bohrer Co. writes: "Grinding rapid steel is in general very risky, and dry grinding with coarse emery wheels is shown to be the method which is the least so. For finishing, this firm prefers cast-steel to rapid-steel milling cutters; for instance for milling the flutes of twist drills."

From the lack of agreement in the answers, it is evident that the entire question has still many puzzling points. Publishing the answers is certainly the best way to clear up the matter. There seem to be kinds of rapid steel which are as a matter of fact not suited for finishing; perhaps this is proved by two of the communications which deny the use of rapid steel for this purpose. As regards wet grinding, certainly for carbon steel that has been hardened in water, this is well suited; for if heating takes place, at the cutting edge which could cause reduction of the hardness, the heated portion can be at once hardened in water.

Dry grinding, which in the case of carbon steel very easily causes annealing of the cutting edge, can, on the other hand, do less harm to the rapid steel, which anneals very slowly.

In favor of wet grinding it is often claimed that it does not endanger the health of the workman. The danger of dry grinding, however, is eliminated in Germany by the requirements of the law concerning dust exhausters.

THE OPERATION AND MANUFACTURE OF MAGNETOS—2

By HAROLD WHITING SLAUSON*

Not only are the majority of motor cars now built equipped with magnetos, but the older types of automobiles and new and second-hand marine and stationary engines are being supplied with this form of ignition as well, and this has created such a demand that it may be said that the annual production of magnetos in this country, alone, can be counted by the hundreds of thousands. The magneto is a delicate

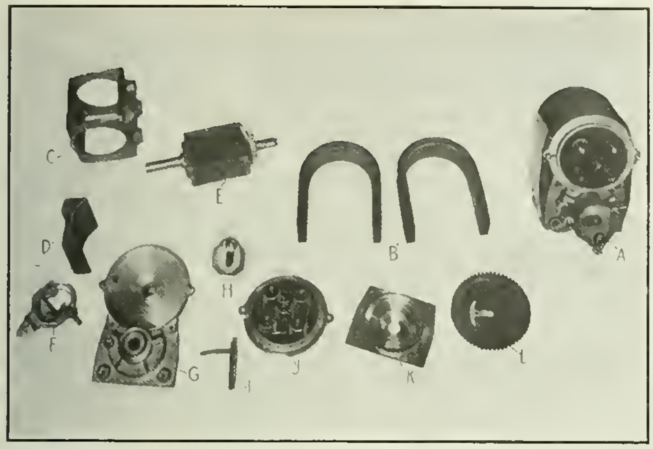


Fig. 6. Component Parts of High-tension Magneto

machine to construct and assemble and the greatest precision and accuracy are required in finishing its various parts, some of which are shown in Fig. 6. The magneto and its parts are designated as follows:

A High-tension magneto, assembled.
B Magnets composing field of magneto.
C Frame in which armature is mounted.
D Pole piece—forming extension of magnetic field in order partially to surround the revolving armature. There are two such pole pieces.
E Armature and driving gear.
F Timer, or circuit breaker, mechanism and case.
G Distributer case back.
H Timer cover.
I Screw and spring holding timer cover in place.
J Distributer case front and high-tension wire terminals.
K Driving end bearing and case.
L Distributer gear and sector.

Making the Permanent Magnets

One of the most interesting, as well as the most important, features of the construction of a magneto is the manufacture


Fig. 7. Bending Magnets to Shape from Bar Steel in the Hercules Electric Works

of the permanent magnets that are used to form the magnetic fields of the machine. Should these lose their magnetism, the machine would be rendered useless until the lines of force could be re-established. Consequently it is necessary so to treat the steel that the magnetism will be retained permanently. Soft iron is unsuitable for this purpose, as it will not retain its magnetism unless in contact with another magnet, or except while excited by a current of electricity passing through a surrounding winding of wire. In many instances the permanent magnets are made of tungsten steel. This is cut into bars of the proper length, and each is heated to a cherry-red. Fig. 7 shows the method of shaping a magnet as used in the manufacture of the Kurtz magneto, at Indianapolis, Ind. When heated to the proper temperature, the bar is placed in the clamp, which has already been set at exactly the proper width to hold it firmly in place. A center block, constituting the form around which the magnet is bent serves as the other jaw of the clamp, and is curved at one end to the proper shape for the inside of the magnet. On a long handle, which is pivoted to the under side of this block, is fastened a hardened-steel roller which swings with the handle and follows, in a concentric curve, the shape of the former. This combination of roller and lever serves to bend the magnet to the proper U-shape very quickly, only a few seconds being required from the time the bar leaves the fire until it is ready for the final heat-treating process.

Hardening the Magnets

After being heated for the proper length of time in a fire of absolutely constant temperature, as shown in Fig. 8, the magnets are cooled in water. As the magnets have already been formed to the proper shape and size, it is undesirable that they should contract to any appreciable extent in the cooling process, and in consequence, each is suspended in the tank of water in a special clamp, which is shown at *A* resting


Fig. 8. Heat Treating the Magnets after they have been bent to Shape in the Hercules Electric Works

against the pile of magnets. This device holds the magnet rigidly in the proper shape, and as the jaws of the clamp consist of a few small points, the water can reach practically all parts of the surface of the steel.

Charging the Magnets

After these shaping and heat-treating processes are completed, the magnet is ready to receive—and to hold permanently, presumably—the magnetism with which it may be "charged." This magnetizing is accomplished by placing the embryo magnet in two upright, parallel, hollow bars, around each of which are wound many turns of wire, and through which an electric current is passed. This forms an electromagnet of the two hollow bars, one being the north pole, and the other the south pole, and this induces magnetism of the opposite kind in the ends of the magnets placed therein. In other words, the end of the permanent magnet placed in the hollow bar constituting the north pole of the electro-magnet, is charged with the opposite kind of lines of force, and this becomes the south pole of the completed permanently-magnetized piece. In like manner, the opposite process takes place in the other pole and the hollow bar. While this magnetizing process is going on, the magnet must be tapped several times in order to distribute and help arrange the molecules properly—for it is on the re-adjustment of the molecules composing the bar of special steel that the magnetism of the completed piece depends. Where magnets are manufactured in large quantities, a special machine, or battery of machines, is provided to facilitate the process. This consists of the

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wire-wound hollow bars, as described above, and a belt-driven spider on which are four or five radial arms, each terminating in a light hammer-head. This spider is revolved rapidly, and is mounted in such a position that the hammer-heads strike the piece to be magnetized with the proper amount of force. Each magnet is kept in this machine for from ten to thirty seconds, and is then tested for its magnetism. Each magnet is tested thereafter several times during the succeeding twenty-four hours to make certain that there is no loss of magnetism during that period, and if at the end of the day it still shows its maximum strength, it is assumed that it will retain this residual magnetism permanently.

Fig. 9. The Winding Room of the Remy Electric Co., in which 2500 Miles of Wire are used per Day

Casting the Bronze Parts

Bronze castings are required in the manufacture of a magneto, and the foundry is by no means the least important part of a well-equipped plant. In one of the largest magneto factories, 8000 castings are made daily, and in order to accomplish this enormous production, duplicate patterns are used extensively. In some instances, as many as 32 duplicate parts will be cast in the same flask at once, and in order to minimize the danger of imperfect molds, pneumatic machines are used for separating the flasks, and compressed air vibrators for loosening the sand around the pattern. Each casting is inspected thoroughly so that only perfect pieces can reach the rough-stock room.

Fig. 10. Impregnating Room in which Coils are treated with Melted Wax or Insulating Varnish

Making the Armatures

After the castings have been machined, those that are to be used as the cores of armatures, coils, or fields are taken to the winding room where they receive the required number of layers of wire. It is important that there should be the proper number of turns of wire in each part of magneto or coil, as it is upon this that the output of the machine, or the proportional increase in voltage delivered by the transformer depends. Most of the winding is done by girls, who become very dexterous at the work. The simple "spool windings" for coils and the like can be made on a high-speed winding machine, but the more complicated process of the manufacture of a direct-current armature requires hand work almost entirely. Fig. 9 shows the winding department of the Remy Electric Co., Anderson, Ind., where over 2500 miles of insulated wire is used daily in the manufacture of the armature and coils. In order to make certain that the proper amount of wire has been put on each winding, and to discover if there are any short circuits or breaks in the insulation, each piece is tested for its resistance by sending a given current of electricity through the winding and observing the readings of the ammeter and voltmeter introduced into the circuit.

Impregnating the Armature Windings

After having been wound, tested, and found perfect, the coils, armatures, or fields, as the case may be, are taken to the impregnating room shown in Fig. 10, where they receive their covering of insulating varnish or wax in order the more thoroughly to separate the individual wires from each other and to protect the whole winding from the outside air and dampness. The impregnating materials are reduced by steam to a liquid state, and the coils to be insulated are heated in a vacuum. Without reducing the vacuum, the impregnating material is turned in, and the vacuum is then changed to a high pressure, thus compressing the liquid wax or varnish

Fig. 11. Battery of Automatic Screw Machinee—Each Piece le inepected at the Machine before the Next Operation

into all the interstices of the winding and rendering leakage of current almost an impossibility.

Making the Small Parts of a Magneto

The small parts of a magneto, such as screws, cam, armature shaft, bearings, and the like, require such absolute precision in their manufacture that hand and automatic screw machines, and other automatic machines will be found to play an important part in the well-equipped magneto plant. Fig. 11 shows the screw machine department of the Remy Electric Co. Limit plug gages are used in testing all collars to within 0.001 inch, and in some instances, 0.0005 inch is the limit of variation allowed. In the above named plant each individual part is inspected and tested for size after each operation; and in this manner, a completed part, which may have passed through the hands of ten or a dozen workmen, will not have to be discarded because of imperfections developed in its earlier stages of manufacture. There is an inspector ready to examine every consignment of parts as it is

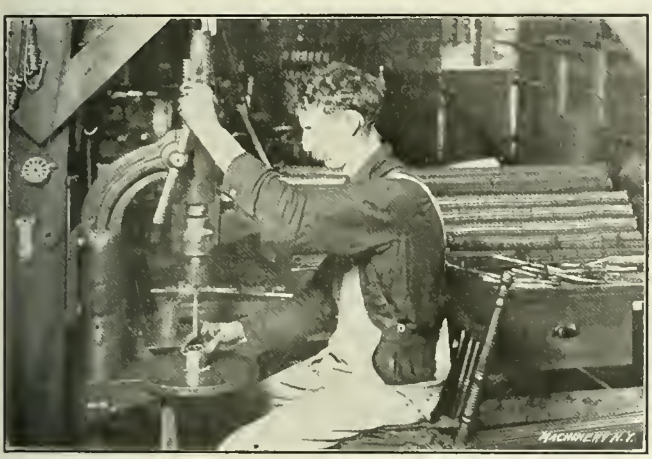

Fig. 12. "Building up" the Laminated Armature of the Direct-current Magneto in the Kurtz Magneto Factory.

finished by each screw machine, and on completion, instead of being sent to the finished stock room, as is generally the case, all pieces are collected at one end of the machine shop for small parts. Here they are assembled, without having been moved more than twenty feet from the machines in which they were made. In other words, the machining, inspecting, and assembling are all performed in the one large room, and there is a minimum amount of transportation of the parts.

Making the Brass Terminals for the Remy Magneto

In the Remy magneto, the high tension wires to the cylinders lead from hard rubber sockets terminating in a split brass shank which has a hole drilled in it of the proper size to give a spring fit to the terminal of the distributer with

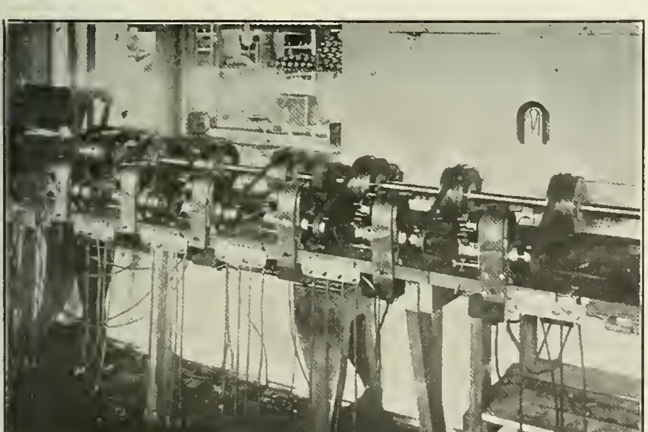

Fig. 13. Testing the Kurtz Alternating-current Magnetos by Belt Power

which each is connected. Each brass terminal is turned out in an automatic machine, and the hole is then drilled in the rounded end. The slotting is done by a special machine built at the factory. This machine consists of a belt-driven circular saw revolving at high speed in a vertical plane. Below this in the same plane, and driven slowly in the same direction by a small belt is a drum in two sections. This drum has threaded holes at frequent intervals in its periphery along the line where the two sections join. One of these sections is divided into segments, each of which is operated by a stationary cam as the drum revolves, thus causing each hole to open and close automatically. The operator places a piece in each

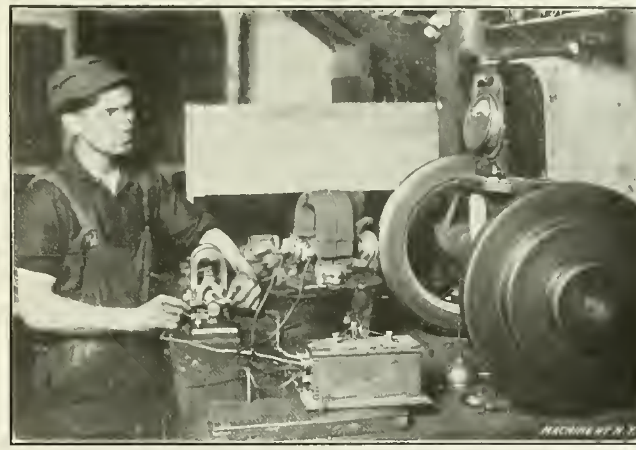

Fig. 14. Testing the Spark Delivered by the Friction-driven Direct-current Magneto. The Spark can be seen jumping between the Ends of the Two Wires between the Terminals of the Coils in the Foregroound

hole as it revolves before him, and as this point of the periphery of the drum approaches the saw, the cam closes the jaw and holds the work solidly in position while the brass terminal is revolved through the lower edge of the saw. On the other side of the saw, the jaw is opened by the cam, and the work drops into a trough. An experienced and quick operator can slot with this machine forty or fifty brass terminals a minute.

Construction of the Direct-current Armature

As has been stated before, the armature of the direct-current magneto is much more complicated than that of the alternating-current type. The latter is a simple forging, shaped

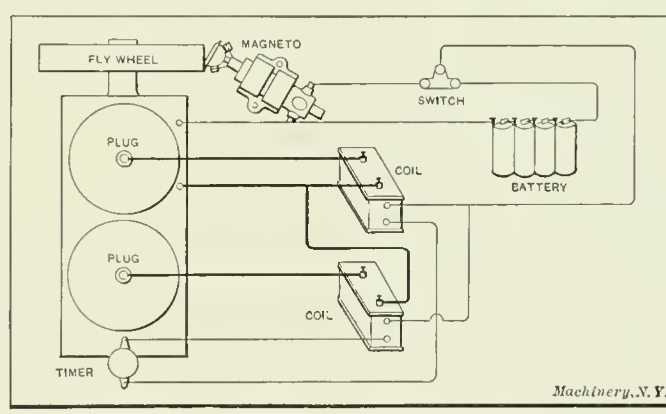

Fig. 15. Diagram of Wiring for a Two-cylinder Jump Spark. This also shows how a Friction-driven Direct-current Magneto may be introduced in the Ignition System to replace a Second Set of Batteries

to receive one continuous winding. The direct-current armature, however, not only has at least six parts of separate windings, or a dozen slots, but in many instances it is built up of thin disks to form a laminated core. The armature of the Kurtz direct-current magneto is manufactured in this manner, and from long experience, it has been found that the best results are obtained if each disk is forced on the armature shaft separately instead of the entire hundred or so forming the armature core being lined up and pressed on all together. Each disk is punched from sheet steel, and is forced on the armature shaft with its companions as shown in Fig. 12. The armature shaft is held in place in a drill chuck having an attachment with a flat face which permits the first disk to be forced on to exactly the proper place. Each disk is held in the proper position so that the slots will line up, by means of a fixture in the bed of the machine. This fixture has a hole in its center to receive the armature shaft, and two pins on its outer edge engage corresponding slots on the disk and serve to hold it steady. The feed handle is released and the armature shaft and chuck are dropped with considerable force on

the fixture and disk, thus forcing the latter into position. The shaft is raised by means of the feed handle and the rack and pinion, and another disk is placed in position on the fixture. Although this may seem like a tedious operation, one man and one machine build up a complete armature of this type in a couple of minutes, and consequently can keep the winding room supplied easily.

Making the Terminal Sockets

Hard rubber is the material best suited for confining the high-tension current within its proper limits, and consequently the terminal sockets, the distributer cover and box, and the distributer disk are all made of this substance. The rubber is molded to shape from soft sheets into which the vulcanizing chemicals have already been introduced. Aluminum molds are used into which the soft rubber, after having been heated on a steam table, is crowded and packed tightly by expert workmen. As there are only a comparatively few different shapes of hard rubber used on a single magneto, the molding and vulcanizing process becomes a duplicate-part-production of the highest type. This will be better realized when it is stated that three and four thousand separate molds are placed in the vulcanizing ovens in a single "heat." Each mold will contain a certain number of ounces or fractions of an ounce of the soft rubber, and it is cut exactly to this weight before the molding process begins. There is consequently no waste whatsoever, and but a minimum amount of time is consumed in packing the molds. The soft rubber is heated in the molds in the vulcanizing oven for several hours. After withdrawal from the oven, the rubber is still soft, but it becomes hard upon being cooled slowly, and after the proper holes have been drilled, is ready for installation on the magneto.

Testing the Magneto

There is such a variety of conditions in the manufacture of the various parts that will affect the performance of the completed magneto, that the testing of the finished machine is an absolute necessity, even though the individual pieces have previously received several inspections. The great difficulty first encountered in the use of a magneto for ignition purposes was due to the fact that it seemed almost impossible to construct a machine that would give a sufficiently hot spark at low speeds of the motor, and yet one which could also be turned at several thousand revolutions with no danger of burning out the coil or other parts of the electric circuit. This difficulty has been successfully overcome, however, by the use of the proper strength of magnets and kind and amount of wire, and the modern magneto will deliver a hot spark at 140 revolutions of the armature shaft, and yet do equally satisfactory work when revolved at twenty times that speed. It is to satisfy the inspector that such is the case, that the magnetos receive their final test. For this purpose, several machines under the charge of one tester will be belted to a common pulley shaft and revolved at various speeds. As shown in Fig. 13 half a dozen Kurtz magnetos are belted in this manner, four spark plugs are connected by high-tension wires to the distributer terminals of each machine. The nature of the spark delivered by the machine to each plug may be observed in this manner for any speed of the armature. The clamps shown in the illustration passing over each magneto are attached to the testing bench, and are sheet-iron strips used for holding the machines in place while they are belted to the pulley shaft.

Inasmuch as a direct-current magneto does not need to be geared positively to the crankshaft of the motor, a friction or belt drive is generally used. It is advisable that the armature of the direct-current machine should revolve at approximately the same speed at all times, and consequently a governor attachment is usually provided with the driving device. In testing out a machine of this type, the bed is clamped firmly in position and the friction pulley placed in contact with the periphery of a rapidly-revolving wheel, as shown in Fig. 14. This would give a high speed to the armature of the magneto were it not for the governor, and the readings of the voltmeter placed above the wheel indicate whether the regulating device is properly adjusted or not. The nature and strength of the spark can be determined in this case by the use of an ordinary vibrating coil and two wires between the high-tension terminals forming a variable gap. The spark is shown in the illustration in question. The other machine shown in this view is a "dummy field" and frame in which all armatures are mounted before final assembly in their respective magnetos. It is known that the magnets composing this dummy field are of the proper strength, and any poor results obtained in the test indicate that the armature is at fault, the discovery thus being made before the final assembly and testing of the machine for which the faulty armature was intended.

The Final Testing

An interesting final test is given to all machines in the Remy factory. Here, also, each magneto is tested for the spark it will deliver at both low and high speeds, but instead of using spark plugs, four variable gaps are provided for each machine. These variable gaps are mounted on a switchboard, each having one fixed terminal and one in the form of a swinging lever which can be moved by hand. The spark is observed with each gap set at the same distance as will be found in an ordinary spark plug, and then this distance is gradually increased until the spark ceases to jump. Three of the gaps are then closed entirely so that the current can easily pass from one terminal to the other with no obstruction, and the fourth switch is opened to a width of two or three inches. Although the whole generating power of the magneto is concentrated at this one gap, the current from so small a machine cannot, of course, jump such a distance. This causes the magneto to "work against itself," and if there were any imperfections or weaknesses in the windings of the machine or coil, they would be certain to assert themselves under such strenuous conditions.

When a modern magneto has once been tested and leaves the factory in perfect condition, it is seldom that it will fail to perform its duty if directions are carefully followed. It cannot be denied, however, that the magneto, though reliable, is a delicate machine, and for this reason no one but an expert, or, preferably, the manufacturer himself, should ever try to readjust or repair a faulty instrument. Even those who understand perfectly the theory of the magneto may be puzzled by some minor adjustment, and it is far better to follow directions and "Return magneto to factory in case of trouble."

* * *

The new Pennsylvania R. R. station in New York City and the tunnels under the Hudson River will be opened to traffic November 27. The four tunnels under the East River to Long Island and the portion of the station required for that traffic were opened September 8. The opening of the Hudson River part of the work will complete one of the greatest engineering projects of modern times, costing approximately $100,000,000. The tunnels are of the most enduring character, being constructed of cast-iron rings lined with concrete 22 inches thick. Heavy trains of Pullman cars will be run through them at top speed without fear of deteriorating effect. An important feature of the construction promoting safety and convenience in clearing up in case of accident, is cross passages at short intervals connecting the tubes. These with foot-paths at the sides afford easy means of discharging passengers and loading them into cars in the parallel tube. Abundant telephonic connections and electric lights contribute to safety of operation. Taking into consideration the use of all-steel cars of heavy construction, the block system, etc., it seems that nothing has been neglected that human foresight can provide, for safe operation.

* * *

In selecting a radial ball bearing to take both thrust and radial load, the Hess-Bright Mfg. Co. advises that 10 pounds of rated radial capacity should be allowed for each pound of thrust load. For a situation involving 150 pounds thrust and 1500 pounds radial, select a bearing rated at $150 \times 10 =$ 1500 pounds for the thrust, and 1500 for radial, or a total rated radial capacity of 3000 pounds. For speeds of less than 1500 revolutions per minute and for heavy duty a thrust and radial bearing combination is preferable.

FLYWHEELS FOR INTERNAL COMBUSTION ENGINES*

By D. O. BARRETT†

In looking up material relative to the design of flywheels for gas engines the searcher is impressed by the scarcity of really usable and practical material on the subject. In works which go into the subject at all deeply the effects of the reciprocating parts, the piston, connecting-rod, etc., are all taken into consideration. This does very well, and it is necessary to make such an analysis for large engines, but the average designer of small engines needs some practical formulas which he is usually unable to find.

This article refers only to internal combustion engines of the single-cylinder, single-acting, four-cycle type with two flywheels. The formulas and deductions which are here presented have been worked up from data from several manufacturers of this type of engine and may be considered to represent average practice.

Diameter.—In designing a flywheel the first point to be settled is the diameter. The practice of different concerns varies considerably on this point, some using a large wheel with small rim, others preferring a small wheel with heavy rim. Of course, other details of the engine influence this to some extent. Engines designed especially for electric lighting have wheels heavier than the ordinary and also usually larger in diameter; this will be spoken of later. The formulas in this article refer to the average engine designed for farm or manufacturing use. When average values are taken the relation between the diameter and the speed is found to follow very closely a certain law. This law for diameters is expressed in the form of the following equation:

$$D = \sqrt{\frac{44,000,000,000}{N^3}} \qquad (1)$$

where D = outside diameter of the wheel in inches.
N = number of revolutions per minute.

The peripheral velocity, V, in feet per minute of such a wheel will be $\frac{\pi D N}{12}$ or substituting in formula (1),

$$V = \frac{\pi}{12}\sqrt{\frac{44,000,000,000}{N}} \qquad (2)$$

For convenience in using, curves have been plotted from the equations as given for the diameters and also for reference for the peripheral velocity. (See Fig. 1.) The velocity curve has been plotted with increasing values downward so as not to cause confusion with the other curve. It will be noticed that the peripheral velocity varies from 2000 feet per minute in the smaller sizes to about 4000 feet in the larger. All these velocities are well below what are considered safe values, from 5000 to 6000 feet per minute.

Weight—Rim Dimensions.—The fundamental purpose of a flywheel upon an engine is not necessarily to maintain a perfectly constant speed but to keep the speed variation within certain limits determined by the work being done. When an explosion takes place in the cylinder of an internal combustion engine, were there no flywheel to absorb some of the energy the momentary speed would rise very high and then the engine would, in all probability, stop as there would be nothing to carry the reciprocating parts over the next compression stroke. The flywheel may keep the speed constant over certain intervals as, one minute; that is, the number of revolutions in one minute will be the same as that in the following one. However, the speed over short intervals is constantly changing. On the explosion stroke the speed of the engine increases slightly while on the compression stroke it is decreased. On the explosion stroke this increase in speed is according to certain laws, in proportion to the amount of energy developed in the cylinder. The amount of this energy is proportional to the area of the cylinder, or to the square of the bore, and to the stroke. When a compression stroke occurs the speed is slightly lessened and a certain amount of energy stored in the wheel by reason of the excess speed is now given up and the speed decreased. The weight of the wheel must be so proportioned that these variations in speed are not objectionable for the purpose for which the engine is used.

The energy of a moving body is proportional to the square of its velocity, but the peripheral velocity of the wheel is directly proportional to the diameter and to the number of revolutions per minute. For a given amount of energy in the wheel due to rotation, the weight could be decreased directly as the squares of the diameter and revolutions per minute were increased.

The idea that a large flywheel gives an engine more power is, of course, erroneous, though held by some. It is true that with a large flywheel, as has been shown, the speed will not drop as quickly, yet it will take just that much longer for it to regain its normal speed.

Expressing the above laws in symbolic form, we have

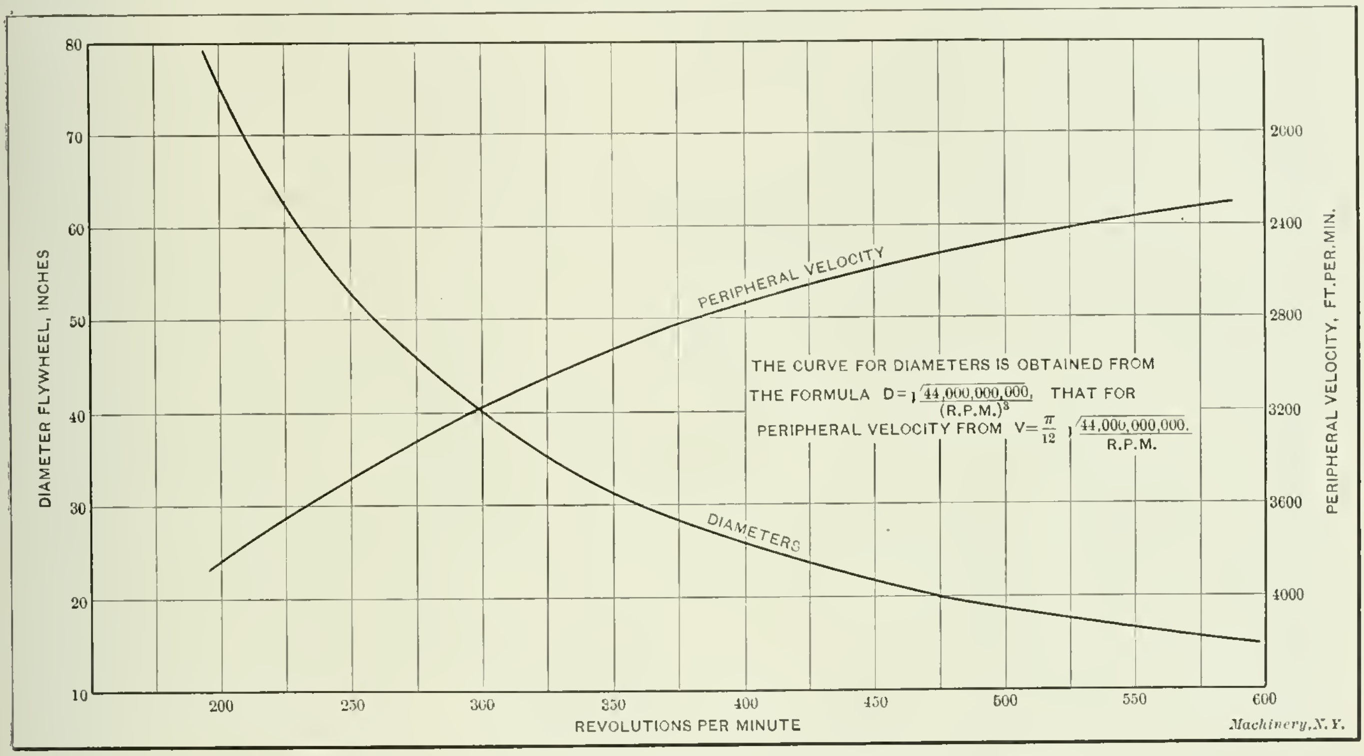

Fig. 1. Diameters of Flywheels for Single-cylinder, Single-acting, Four-cycle Gas Engines

* For previous articles on flywheels and flywheel calculations see: "Simplified Methods of Flywheel Calculations," October, 1909, and the accompanying references; also MACHINERY'S Reference Series Pamphlet No. 40, "Flywheels."

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$$W \text{ is proportional to } \frac{B^2 S}{D^2 N^2}, \text{ or}$$

$$W = \frac{C B^2 S}{D^2 N^2} \qquad (3)$$

where C = a coefficient determined by practice.
W = weight of the wheel, in pounds.
B = bore of the cylinder, in inches.
S = stroke of the piston, in inches.
D = diameter of the flywheel, in inches.
N = number of revolutions per minute.

For simplicity in the calculations the weight of the flywheel may be considered as being concentrated at the rim; and the mean diameter taken as the outside diameter of the wheel. This, of course, credits the rim with more than its actual weight but as no allowance is made for the arms and hubs the assumption is sufficiently accurate for all practical purposes. The weight of the rim is equal to π D multiplied by

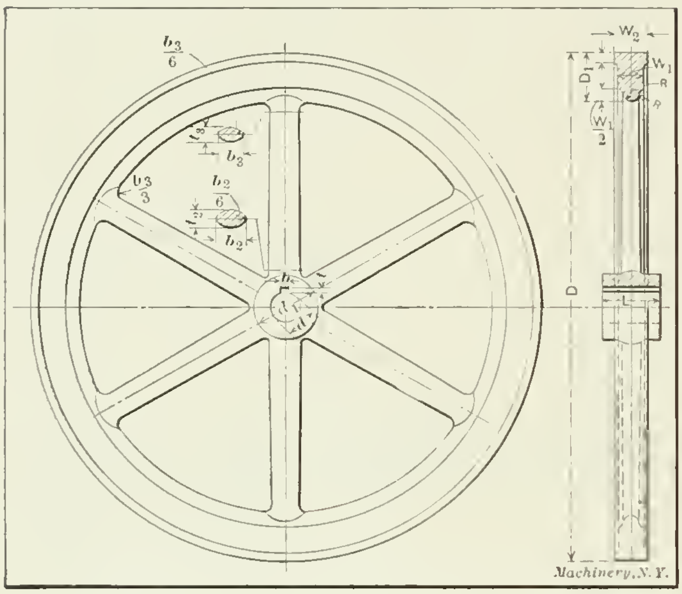

Fig. 2. Proportions of Flywheels for Single-cylinder, Single-acting, Four-cycle Gas Engines

the area of the rim section and by 0.26. (0.26 is the weight in pounds of one cubic inch of cast iron).

Substituting in (3) we have

$$A \text{ (area of section)} = \frac{C}{0.26\,\pi} \times \frac{B^2 S}{D^3 N^2} \qquad (4)$$

Referring to Fig. 2, W_1 is the width or thickness of the rim while D_1 is the depth. D_1 is usually made about 1.9 W_1.

$$D_1 = 1.9\,W \qquad (5)$$

The area of the section of the rim may be said to be equal to $D_1 W_1$ or 1.9 W_1^2. This is another assumption but the metal added at the extreme outer diameter to produce the widened rim is about equal to that cut away from the inner side of the rim to form the rounds.

Substituting in formula (4)

$$W_1 = \sqrt{\frac{C}{1.55} \times \frac{B^2 S}{D^3 N^2}} \qquad (6)$$

The values of the coefficient, C, in the above equation were worked out for a large number of wheels both by substituting the dimensions of the section in formula (4) and also using the weight of the wheels in formula (3). These values averaged quite closely, and 110,000,000 was chosen as representative of good practice. Where engines are to be used for electric lighting or where a closer speed regulation is desired than that afforded by the ordinary engine, it is recommended that a coefficient of 160,000,000 be used. The diameters, D, of such wheels are also usually increased from 10 to 20 per cent. For common practice formula (6) then becomes

$$W_1 = \sqrt{\frac{110{,}000{,}000}{1.55} \times \frac{B^2 S}{D^3 N^2}} \qquad (7)$$

By means of this formula the dimensions of the rim can be obtained directly. See Fig. 2 for references.

W_2 is usually made equal to W_1 plus one-half to one inch.

$$W_2 = W_1 + (1/2 \text{ to } 1 \text{ inch}) \qquad (8)$$

The depth of the widened portion is made from one-half inch in the smaller sizes to one and one-half inch in the larger. The radii of the rounded portion are one-third the width or $W_1/3$.

Arms.—The arms of flywheels are usually six in number though in the smaller sizes five are sometimes used, while above 60 to 70 inches eight are employed. A cross-section through the arms is in the form of an ellipse this making a strong and neat appearing shape.

It is best to give the dimensions at each end of the arm as then the patternmaker can shape these and then taper the arm gradually from one to the other. To give a symmetrical appearance to the wheel the dimensions of the arms should be made a function of the diameter.

The width of the arm at the hub should be

$$b_2 = 0.058\,D + 0.4 \text{ inch} \qquad (9)$$

The width at the rim is eight-tenths that at the hub:

$$b_3 = 0.8\,b_2 \qquad (10)$$

The thickness of the arm is 0.55 times the width:

$$\text{or } t_2 = 0.55\,b_2 \qquad (11)$$

$$t_3 = 0.55\,b_3 \qquad (12)$$

In drawing the section for the elliptical arm a radius should be used at the ends of the major axis equal to 1/6 the width of the arm. The longer radius should then be so determined that the arc drawn will pass through the end of the minor axis and be tangent to the other two arcs. For rounding the arms into the rim a radius one-third width of arm is used.

Hubs.—The diameter of the hub should be approximately twice the diameter of the shaft or

$$d_1 = 2\,d \qquad (13)$$

Length should be from 1.75 to 2 times the shaft diameter

$$L = (1.75 \text{ to } 2)\,d \qquad (14)$$

Many firms use the split hub, that is, a slot is cored through the hub separating it into two parts. One advantage of this type of construction lies in the fact that rather loose fits on the shaft may be quite readily tightened. In putting on the wheels it also facilitates the operation somewhat. A wedge is driven into the slot expanding the bore of the hub, when the wheel may easily be slipped into place and the hub bolts then tightened. With this type of hub it is also possible to use straight keys, thus dispensing with the cutting of the taper keyway although the advantage of this is somewhat dubious. Where hubs are bored the proper size for the shaft and the finishing tools are kept the proper diameter, shafts being standard, the solid hub is perhaps as good as any except for the larger sizes.

Keys.—For the solid hub wheels it is necessary to use taper keys to prevent endwise movement on the shaft. In order to extract the keys readily they should be provided with gib heads. Wedges may then be driven in behind the key and it may be removed without difficulty. When driving keys it is not necessary to use the largest sledge that can be obtained with the consequent danger of breaking the hub; they should be driven with the ordinary-sized hammer, and if properly fitted will hold indefinitely. The end edges of the keys on the bottom should be slightly rounded so that either in driving or removing they will not cut into the shaft. The keys should be so fitted that the gib heads are within from one-half to three-quarters of an inch from the end of the hub. Nothing is more unsightly than to see a key projecting a considerable distance from the wheel and, by the way, nothing is much more dangerous either, besides occupying a lot of good space which should be used for the pulley hub.

One concern uses a square key having a taper of 3/16 inch per foot. The keyway is cut about four-tenths of the total depth in the shaft and six-tenths in the wheel.

The key width may be made according to the formula:

$$b = 0.17\,d + 0.15 \text{ inch} \qquad (15)$$

Nothing has been said as to the practice of attaching pulleys to the flywheel, as the author does not favor this construction. This is a cheap construction as it does away with the long crankshaft, but it requires a special pulley which can only be obtained from the manufacturer of the engine.

TOOLS AND DIES USED IN THE MANUFACTURE OF JEWELRY*

By CHESTER L. LUCAS†

Three hundred tons of jewelry per year, the product of one factory alone, seems enough to adorn a good share of the American people, at least for a year, and yet in the city of Providence, there is a factory with this output to its credit. The Metal Products Corporation, of Providence, R. I., manufacturer of component parts of jewelry, uses each year 300 tons of "low brass"‡ and it is said that they are the largest consumers of "low brass" in the United States. The factory buildings are occupied jointly by two companies owned by the same stockholders. These companies are the Metal Products Corporation and the Screw Machine Products Corporation, of which the former is much the larger. In these two factories are made component parts for nearly every form of jewelry. These parts, a representative group of which is shown in Fig. 1, are used by the jewelry manufacturers in making up their goods. For instance, a small concern making, we will say, hat-pins, buys the stems, heads, mountings and ornaments for its goods and merely does the assembling, plating, carding and selling. By this method of doing business it does not have to make dies and tools and maintain a department to get out the small number of parts used. The finished goods are not necessarily similar to competitors' who buy parts of the same company, for a thousand-and-one different combinations of parts and plate and color can be arranged to suit individual designs.

Tool- and Die-making Department

Needless to say, the tool- and die-making department of the Metal Products Corporation is the important factor in the success of the factory's product as a whole; for without good tools and dies it is impossible to get out good work. The tool-room, shown in Fig. 2, is a well-lighted room on the north side of the factory and is well equipped for making the tools used in the factory.

Originating Designs

In getting out new patterns and designs of jewelry, the first step is, of course, to draw up the design on paper. The next step is to cut the embossing or striking die as it is sometimes called. Then, the stamping which is struck up in the embossing die, is used as a templet in making the piercing and trimming dies, this collection of dies, embossing, piercing and trimming, constituting the set of tools for that particular pattern.

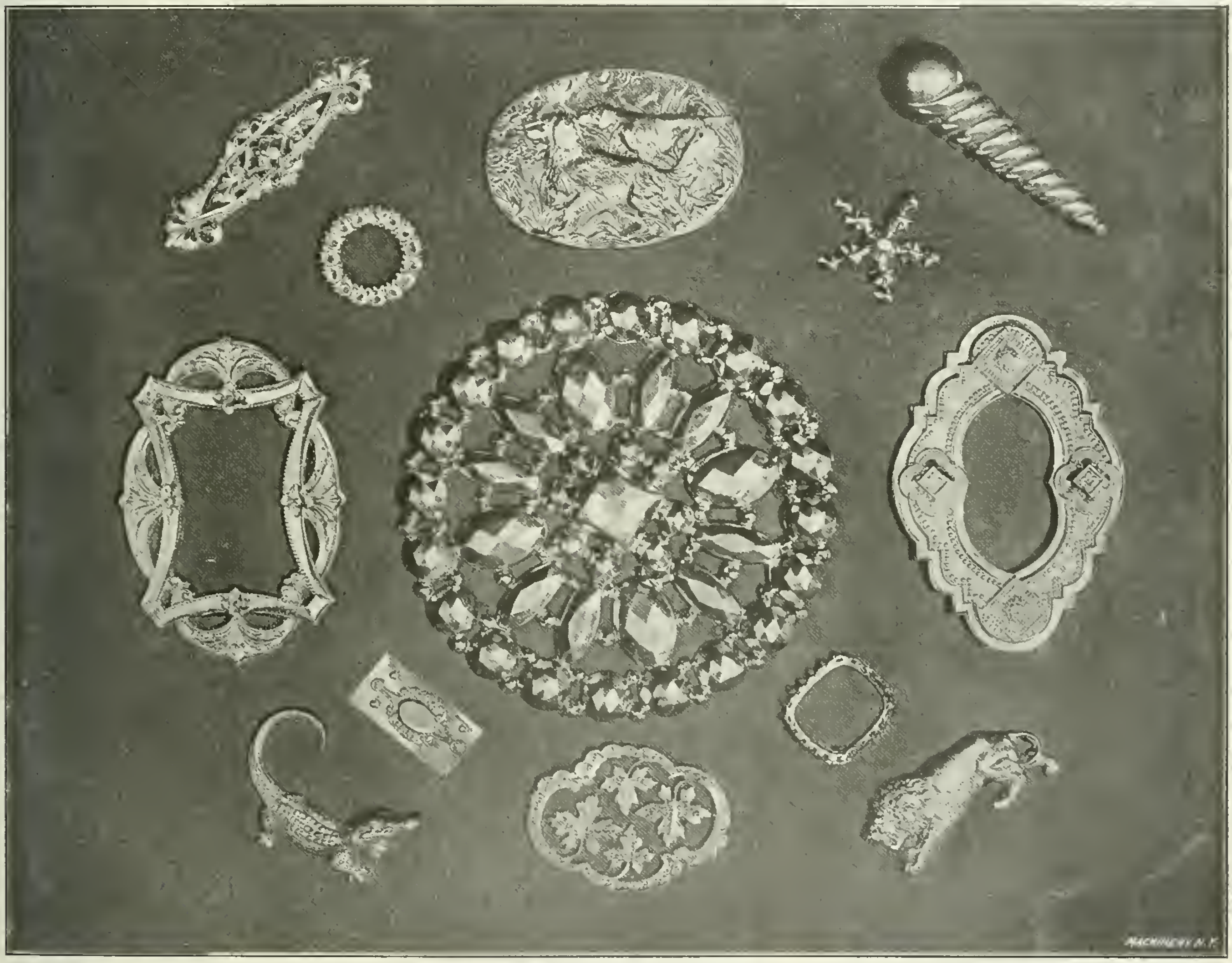

Fig. 1. Specimens of Jewelry Components

Making the Embossing Dies

The making of embossing dies is a very slow and costly process, for the die-sinkers who do the work receive double the wages of the average machinist and thus it does not take a very intricate design to make the die-cost very high. The pieces shown in Fig. 1 are specimens of embossing die work.

At one side of the main factory is a brick storehouse in which is kept the stock for the factory; one section of this building is partitioned off and used as a storeroom for embossing dies. In this room are packed embossing dies for 10,000 different patterns and the dies are valued at $250,000—a quarter of a million dollars tied up in dies! The master hobs from which many of the dies were made, and by means

* For other information on die-sinking and the manufacture of jewelry and kindred subjects see MACHINERY, "Coin and Medal Dies," June, 1909; "The Champney Process of Die-sinking," June, 1909; "Dies and Methods for Making Watch Crowns," December, 1909, engineering edition; "Interesting Molds for Finger Rings," December, 1908.

Address: 4 Bailey Ave., East Saugus, Mass.

‡ The terms "low brass" and "high brass" refer to the amount of zinc in the alloy, and are used only in connection with rolled and drawn metals. The usual composition for "low brass" is 75 to 88 per cent copper and 25 to 12 per cent zinc. "High brass" is usually 66 2/3 copper and 33 1/2 per cent zinc. "High brass" is the common brass of commerce being of a light yellow color. "Low brass" has a dull reddish tinge and is used mostly for stamping and bending operations.—C. L. L.

of which the dies could be easily replaced if broken or worn out, are all kept in a large fire-proof safe.

Janvier Die-cutting Machines

Fig. 3 shows a corner of the die-sinker's portion of the tool-room, and a Janvier die-cutting machine is shown to the right of the engraving. The working of this machine is much simpler than the American machines made for the same purpose, and the Metal Products people claim that the work far excels that of any other machine on the market.

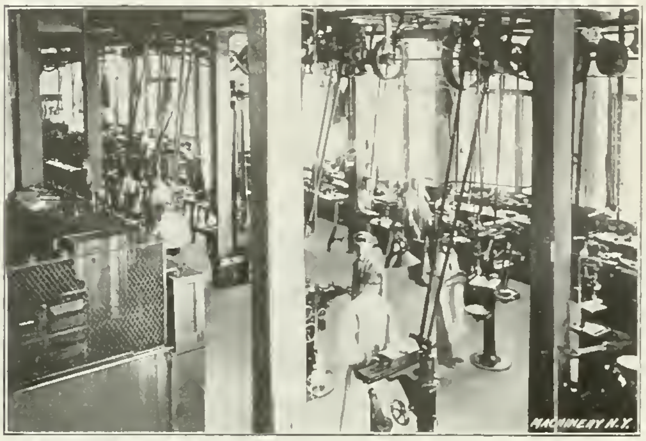

Fig. 2. The Tool-room of the Metal Products Corporation

These machines will not finish a die completely, nor will any of the other die-cutting machines—the finer details must be sharpened up by hand before hardening. However, the design is followed so closely and the work is done so quickly that even with this hand retouching the result is a better and cheaper die than could be made by means of all hand-work.

From the original drawing of the pattern is made a wax model, enlarged about ten times. A plaster-of-paris copy of this model is then made, and lastly a brass casting is made. The brass model is then cleaned up and mounted on the master-plate of the machine and the die blank is mounted on the work-holding plate. Both die and master pattern turn slowly at the same speed. A tracer rides upon the face of the pattern as the pattern turns and follows every detail of the design, starting at the center and working outward. The motion of the tracer, proportionally reduced, is transmitted to the cutter that works at right angles to the die, similar to an end-mill. The face of the die is kept flooded with oil and although the movement of cutter and die seems very slow, a die is cut in from six to twenty hours according to its depth and size. At the bench at the left of this illustration is shown a die-sinker at work finishing up a die cut on the machine. Thus we have the machine and the man combining their work, and the result is a perfect die. Hobs may be cut just as rapidly as dies on this machine. It may be well to explain what is meant by a hob—it is a block of steel with the design cut in relief, just as the finished work will appear. The hob is hardened and driven into another block of steel which becomes the die. Hobs are employed when the design can be more easily cut in relief or when there is likely to be a number of dies made of the same pattern. After the die is made the hob is laid away for future use, should it be needed. The embossed piece just above the center of Fig. 1 was made from a hobbed die.

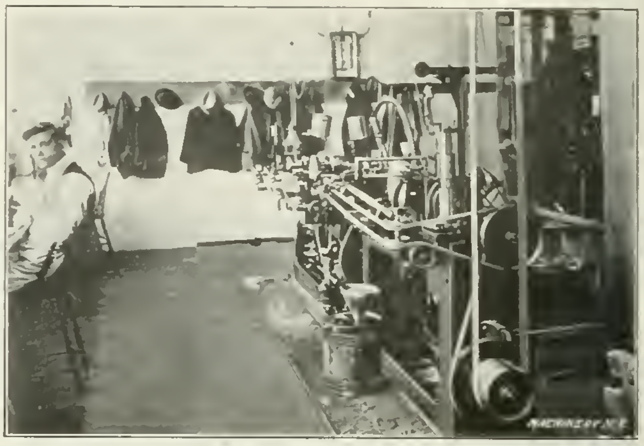

Fig. 3. The Janvier Die-cutting Machine

Trimming Dies

After the embossing die is finished, a striking is taken from it, and carefully sawed out so as to leave a templet whose outline is the exact shape of the embossing die. The blanking or trimming die is then made to fit this templet. In making this die the chief requisite is that it shall fit the outline of the embossing die perfectly, leaving not a particle of stock around it, and of course the die must cut clean and leave no burr.

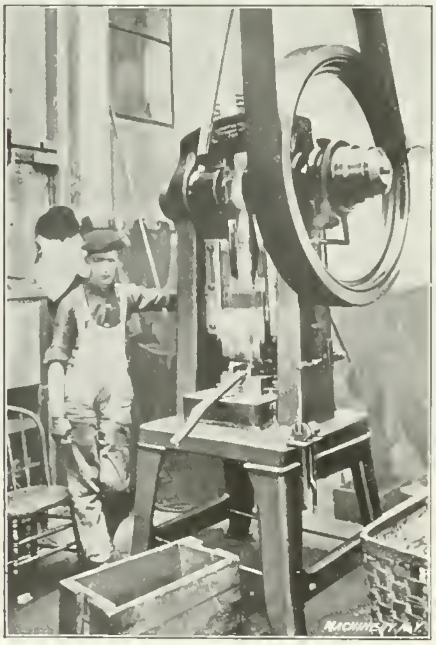

Fig. 4. Embossing and Shearing Press

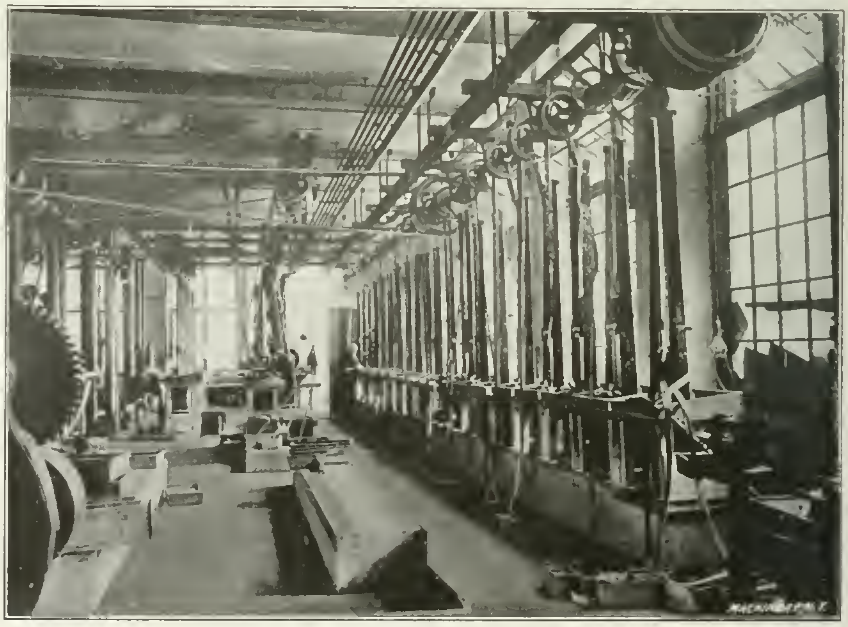

Fig. 5. A Row of 150-pound Drop-presses

After the center of the die is drilled out in the usual way, the die is mounted in an inverted milling machine and the surplus stock removed as close as possible to the outline. One of these machines may be seen in Fig. 2, in the central background with the operator standing beside the post. Trimming dies and piercing dies as well, are made of comparatively thin steel, being from ½ inch to ¾ inch thick, according to the design; therefore, by placing a taper cutter of the desired bevel in the spindle of the machine, the die can be

milled out close to the outline and the clearance angle cut at the same time. The great advantage of this type of machine is that the work is always in plain sight. After the die is milled out, the diemaker clamps it, face up, over the edge of the bench, by means of a special parallel clamp. Then, seated in a low chair that brings his eyes close to the die, he holds his file in a vertical position through the die and with both hands under the die, he files to the line very rapidly. This method of die-filing is universally used in jewelry toolmaking, and is considered superior because there is little tendency toward rocking the file, and besides, as one of the men expressed it: "You can always see what you are doing."

Piercing Dies

Piercing dies are made in much the same manner as trimming dies. From the embossing-die templet, the irregularly shaped holes are laid out upon the die and drilled and filed out to shape. Considerable ingenuity is necessary to make dies for some of the patterns, as sometimes the holes are closely spaced; too close in fact to make a practical die. In some of these cases the piercing is divided into three or four dies, each of which pierces a few of the holes, so that it is possible to have the holes in each of the dies widely scattered, and yet by using the dies successively, every one of the many openings is pierced. An essential point in piercing dies is good alignment of the punches. One good method of reaching this end is to make each of the punches of a piercing die from round stock and shape the punch back only about ½ inch, the rest of the punch being left round. The stripper for the die is made thicker than usual—about ½ inch—and the holes for the punches round, closely fitting the bodies of the punches. Thus the stripper performs a double duty—stripping the stock and guiding the punches exactly like a sub-press. This method is very inexpensive and though it is not employed in many shops it can be used in patterns where the openings are not long and narrow. More care must be taken in making piercing dies than is necessary when making trimming dies, for each of the openings is a piercing die and must register perfectly with the other openings. Unless

Fig. 6. Foot- and Screw-press Department

the dies work perfectly in this respect, the result will resemble some of the poorly printed multi-colored posters that are inflicted upon us, on which the various colors do not register. Piercing and trimming punches, unless for exceptionally long jobs, are left soft, to facilitate refitting and also to avoid hardening troubles.

Automatic Press Work

Fig. 4 illustrates an automatic press for embossing and shearing small jewelry stampings like the one shown between the alligator and the center piece in Fig. 1. The embossing die is at the rear of the press and consequently as the stock enters from the rear, the first operation is that of stamping. The edge of the embossing die is ground so as to correspond to the lower blade of a pair of shears, and when the stock has advanced after being embossed, the top shear severs the stamped piece from the strip. The pieces are trimmed in a separate operation. It will be noticed that the illustration of the piece shows two large "dots" at one end of the piece and one at the other end, all of which are not a part of the design. The purpose of these additions is to make improper setting of the dies impossible, as well as to prevent the stamped pieces from going through the trimming die in the wrong way. These precautions are necessary on a die with a symmetrical design, because punches and dies of such irregular contour cannot easily be made to fit well when reversed and as there is no necessity for such fitting, the "dots" are added to make the dies fool-proof.

Drop-presses

In the manufacture of jewelry, nine-tenths of the embossing is done under drop-presses, for two reasons: It is generally con-

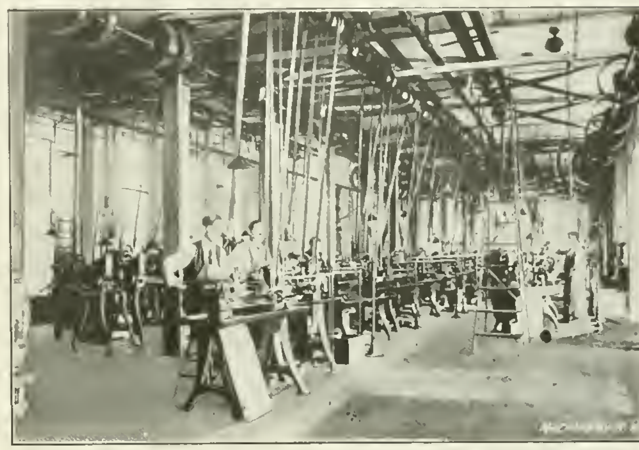

Fig. 7. One Side of the Main Floor—The Screw Machine Department

ceded that the sharp quick blow from a drop-press is more effective for this class of press work, because the blow "sets" the metal in a better manner. In other industries, however, there seems to be a growing tendency to do such work in the ordinary power press, because under proper conditions the work is fully as good and the operation is at least twice as rapid. Another reason and the main point of superiority for the drop-press is its simplicity. There are no shafts to wear or spring, no clutch movements to get out of order, and adjustments may be made to suit any job in a few minutes. For the larger work, automatic drop-presses are generally used, but on the small and medium work plain drop-presses with roller lifts are extensively employed. A row of these presses is illustrated in Fig. 5. The weights of the striking hammers average about 150 pounds. To operate the press the operator places one foot in the strap, which normally hangs about a foot from the floor when the hammer is down. The pressure of his foot brings the roller lift into action and the hammer is lifted. As the operator has both hands free to place and remove the work, there is no time wasted between blows. After placing the work on the die, he raises his foot quickly, which lets the hammer fall, and as it rebounds he drops his foot and holds the hammer suspended again. If an extra heavy blow is required, a pull on the strap with his right hand lifts the hammer to a greater height than ordinarily—to the top of the ways if need be, for the roller lift is very sensitive.

In setting up a drop-press, a good foundation is very necessary. One form of foundation is a long wooden pile driven deep into the ground. Another way is to excavate and build up a foundation of crushed stone and cement. Fig. 5 illustrates a new form of drop-press foundation that has proved very satisfactory. As shown in the center foreground, the foundation is made of concrete with the addition of timbers at the two top edges, which, of course, are added for lagging down the presses. The concrete extends into the ground for six feet. The foundation shown has just been made and is ready for the placing of the drop-presses. The entire row of presses shown along the wall is mounted in this manner and no trouble whatever has been experienced with the foundation.

Foot- and Screw-presses

Foot- and screw-presses comprise an important part of the machinery of a jewelry factory, and Fig. 6 shows one depart-

ment with approximately fifty foot-presses and thirty screw-presses. At first thought it seems rather unprogressive for a factory of this size to be using so much foot- and hand-power machinery, but some of the reasons for their use that were cited are as follows: First, tools may be quickly and easily changed (nearly always by the operators) for the many small orders with which the jewelry factories are filled; second, no expense for power is entailed; third, the first cost and installing cost are low, consequently enough presses may be kept so there will be no hold up of work for want of machines when orders conflict; fourth, the percentage of accidents is low; and fifth, the space occupied by the presses is small, for they can be packed close together as there are no allowances to be made for shafting of any kind. The foot-presses are used on the small forming and trimming work while the screw-presses take care of the larger work. The largest of this class of work is done with the power presses which are of standard type.

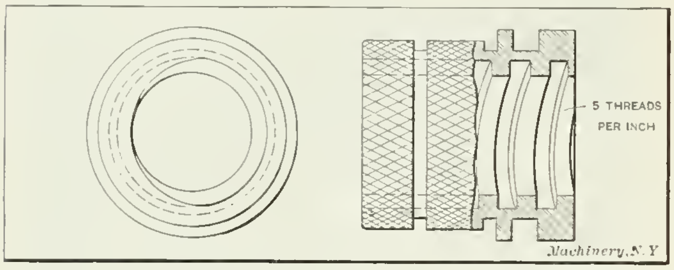

Fig. 8. A Good Job from the Acme Automatic

Soldering

In this illustration, Fig. 6, may be seen a typical jewelry soldering bench. Here the girls receive the work that is to be built up, settings, mountings and other component parts, and after setting them up just as they are to be soldered, borax water and small bits of hard solder are applied to the joints and they are ready for soldering. The soldering operation is a simple one and is easily accomplished if the work has been properly set up and charged with the solder. With the blowpipe (fed by gas and air), the first piece at the corner of the pad is brought to the red heat at which the solder flows, and as soon as the solder flows into the joint, the flame is taken away to the next piece. The soldering of a pad of work usually takes but a few minutes while the setting up may take a half an hour or more.

Fig. 9. General View of the Stock Department

Screw Machine Department

The main floor of the Screw Machine Products Corporation is, generally speaking, no different from any other large screw machine department; but looking beyond the equipment to the product, there are but few, if indeed there are any, screw machine departments that turn out the class and variety of small work that is done here. Small brass balls from 1/16 inch diameter and upwards are turned out by the millions, to be consumed in various industries. So nearly perfect are the tools made and set that the evidences of cutting-off are barely noticeable under a magnifying glass. Brass and iron screws, small posts and studs for the electrical and hardware trades, and many other pieces that can be included under the head of screw machine products comprise the factory's work. Fig. 7 shows one side of the main floor. There are fifty machines comprising Brown & Sharpe automatics, hand screw machines and Acme automatic multiple-spindle machines.

One job that is being done in this factory, and a job that is worthy of mention, is the piece shown in Fig. 8. It is a wrench nut, and up to a short time ago it had been a "bugbear" to several manufacturers of screw machine products, which fact alone was reason enough for the Screw Machine Products Corporation to attempt the job. The piece is made from 1⅜ inch round machine steel bars, is 1¼ inch long and has a 1-inch hole through the center tapped out with a square thread, five turns to the inch. The other details are as shown in the sketch.

The Acme multiple-spindle automatic, upon which these pieces are made, turns out a complete piece every two-and-one-half minutes. It is unnecessary to say that most of the trouble experienced in starting this job was in tapping the square thread in the piece. When the stock is being drilled, the drill is run in far enough each time for two pieces; consequently when it comes to the tapping operation, there is plenty of room to spare when using a long taper tap, and there is less danger from clogging of the hole by the chips and, of course, there is no chance for the tap to bottom and break. This little kink alone has done much to solve this tapping problem and has saved scores of taps and helped the job to run successfully.

Stock Department

A very important factor in a shop like this is the stock room and although there is little of mechanical interest there, it is at least a valuable department. In this building, a section of which is shown in Fig. 9, a recent inventory showed sheet and rod stock valued at $150,000, and as the $250,000 die storeroom is also a part of this department, it can readily be seen how valuable a building it really is. The department is equipped with rolling mills for rolling special stock to gage, and in addition there are square shears and slitting shears for getting the stock ready for the presses.

The officers of the two corporations are A. C. Stone, president; George Briggs, Jr., secretary; and Harry M. Mays, treasurer.

* * *

THE FIRST TYPEWRITING MACHINE

The typewriter is not so entirely a modern idea as most people assume. The earliest record of efforts in this direction is a British patent issued to Henry Mills in 1714. No record of the construction of this machine, however, remains in existence, as at this early date no drawings were attached to the patents and the specifications dwelt rather upon the object of the machine than the means by which it was accomplished. In the interesting old-English the patent specifications read in part as follows:

"*ANNE*, by the grace of God, &c., to all whom these presents shall come, greeting: *WHEREAS*, our trusty and well-beloved subject, Henry Mills, hath by his humble peticon presented vnto vs, that he has by his greate study, paines, and expence, lately invented, and brought to perfection '*An Artificial Machine* or *Method* for the *Impressing* or *Transcribing Letters Singly* or *Progressively* one after another as in *Writing*,' whereby all *Writing whatever* may be *Engrossed* in *Paper* or *Parchment* so *Neat* and *Exact* as not to be Distinguished from *Print*, that the said *Machine* or method, may be of greate vse in *Settlements* and *Publick Recors*, the Impression being deeper and more Lasting than any other *Writing*, and not to be erased, or *Counterfeited* without *Manifest Discovery*, and having therefore humbly prayed vs to grant him our Royall Letters Patents, for the sole vse of his said Invention for the term of fourteen yeares, Know Yee, that wee," etc.

* * *

It is estimated that the Mitchell-Lewis Motor Car Co., of Racine, Wis., will turn out about $12,000,000 worth of automobiles in 1911.

A SYSTEM OF GAGES FOR SMALL PARTS*

By ILION

The success of interchangeable manufacturing, in the long run, depends more on the worth of the gaging and inspection system in use and the ability to hold the finished parts within practicable limits of variation from absolute accuracy, than

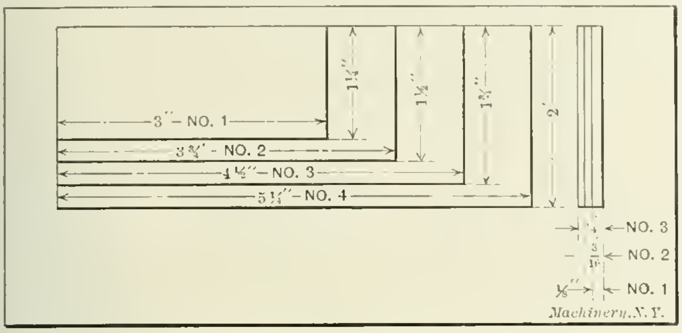

Fig. 1. Standard Blanks used for Snap Gages

on any other factor. A full and complete set of gages and standards must be provided. The system described in the following is used with certain modifications to suit particular requirements, in several factories making light machines, and the salient points are described in detail.

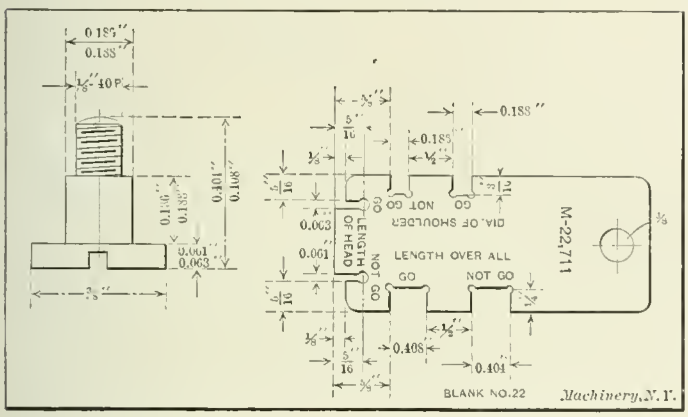

Fig. 2. Completed Snap Gage made from Blank No. 22

Many of the parts of adding machines, typewriters and light machines are comparatively small so that few large or elaborate gages are necessary. Generally most of the gages required are snap gages of the "limit" variety, for gaging the

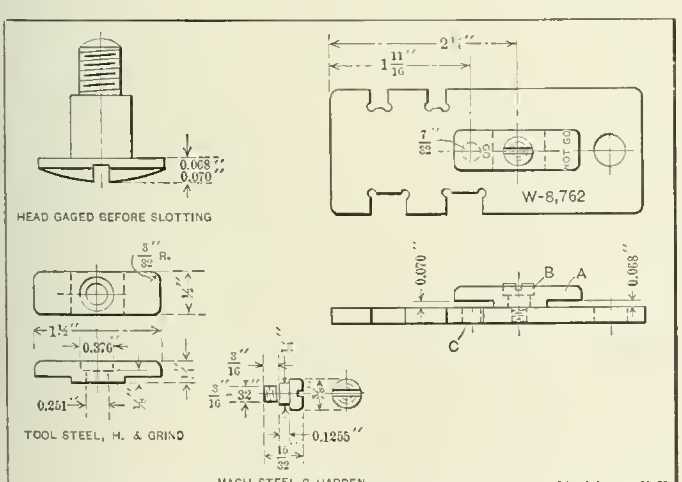

Fig. 3. Snap Gage used in Gaging a Round-head Screw

length and diameter of screw machine product, and the length and thickness of milled work. A set of standard blanks for these purposes is shown in Fig. 1. It will be noted that these blanks are provided in four lengths and three thicknesses, giving twelve different sized blanks to select from. The different lengths are denoted as Nos. 1, 2, 3 and 4, and the thicknesses as Nos. 1, 2 and 3. When called for on a drawing, the two numbers are used in combination as follows: Standard blank No. 11 is one of the smallest length and least thickness; No. 23 is one of the second length and greatest thickness. The blanks are made from machine steel and are carried in stock in the rough in all of the sizes.

Fig. 2 shows a completed gage, and the screw to be gaged by it. Blank No. 22 is used for this gage. The screw is 3/16 inch diameter, and the blank 3/16 inch thick is most convenient for handling it. In selecting the size of the blank to be used, a size of blank should be selected in which the slots will not come nearer than 1/2 inch from the end, and 1/2 inch should always be allowed between the slots. This does not apply to the slots on the end of the blank, as they are generally shallow and narrow. Slots are shown on one side for the total length, and on the other for the diameter of the shoulder.

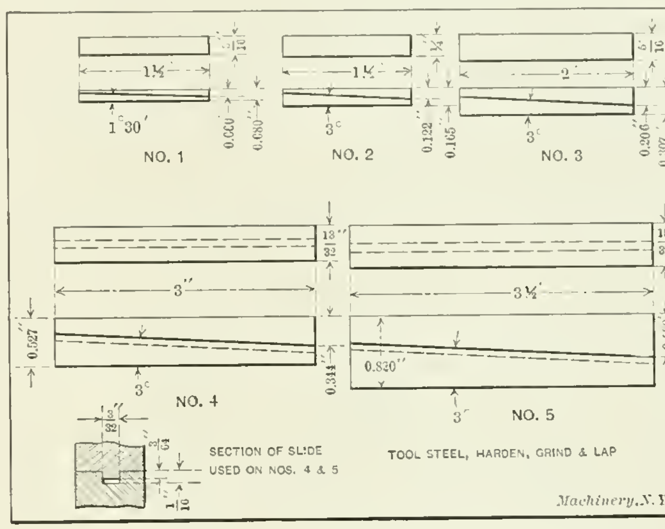

Fig. 4. Wedge Parallels used in Measuring Slots in Snap Gages

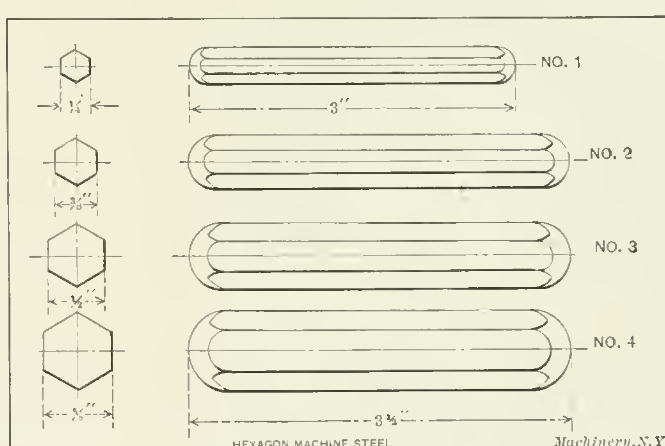

Fig. 5. Standard Handles for Plug Gages

The slots for the length of the flat head are shown on the end of the blank. The maximum slots are marked "Go" and the minimum slots, "Not Go." This has been found to be the most convenient way to designate them. Some firms make the corner next to the longer slot with a radius and the corner next to the shorter with a 45 degree angle, but confusion often results with a new operator, as the reverse method of making the corners is used in other shops. A man having used a set of gages made one way for a long time, often takes some time to become accustomed to the change. With the slots plainly marked, no mistake is possible. A 3/8 inch hole is drilled in the end opposite the one with the slots for the head, for hanging the gage on a screw hook. The large figures near the hole show the part number of the piece to be gaged, the full name of the part and the name of the operation

* For additional information on gages and gage making, see MACHINERY, "Reference Screw Gages," September, 1910; "Accurate Gage Work in the Bench Lathe," May, 1910, engineering edition; "Electric Surface Gage," November, 1909; "Making Thread Gages," February, 1908; and other articles there referred to. See also MACHINERY'S Reference Series Pamphlet, No. 31, "Screw Thread Tools and Gages."

for which it is used being marked on the back of the blank. These gages are hung in the department in which they are used, in rows on racks, with the part numbers arranged in numerical order. It will be noted that the gage shown is made from machine steel and pack-hardened. Most firms

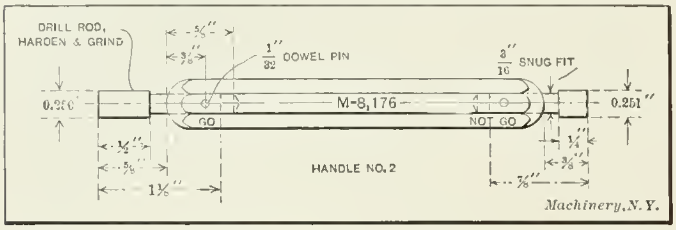

Fig. 6. A Completed Plug Gage

prefer to make them from tool steel and harden them, but the writer thinks that machine steel is just as good and is considerably cheaper. The large figures are stamped before hardening and are later filled in with black enamel, making them show up very prominently.

Fig. 3 shows a snap gage for gaging a round-head screw. In addition to the slots for length and diameter, a swinging

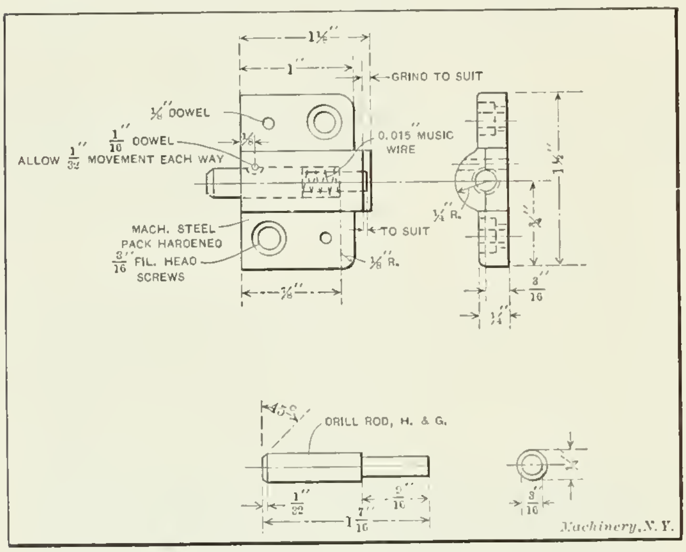

Fig. 7. Detachable Flush-pin Gage and Block

plate is provided for gaging the length of the head. The plate *A* swings on the shoulder screw *B*, and the body of the screw to be gaged is dropped through the hole *C*, the bottom of the head resting on the body of the gage. It will be seen that one end of the plate will pass over the head and the other end will not.

Gage slots are measured by means of wedge parallels, a set of which is shown in Fig. 4. A set of five sizes as illustrated

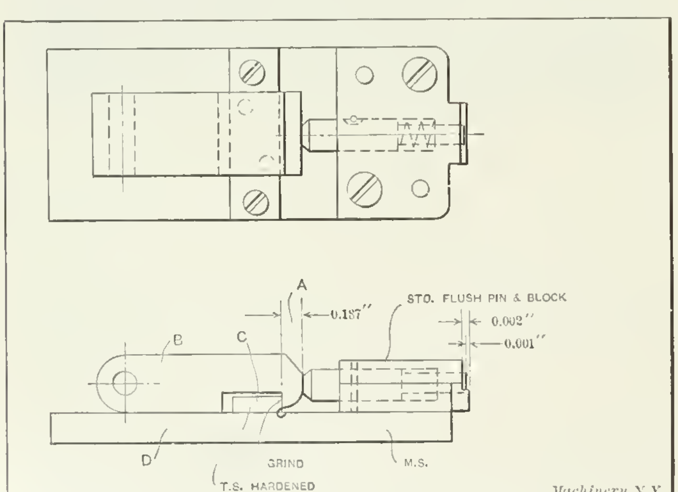

Fig. 8. Application of the Detachable Flush-pin Gage shown in Fig. 7

will give a sufficient range for most work. Each size is so proportioned that it laps over the next larger size by a few thousandths. The parallels are made of tool steel, hardened, ground and lapped. The tongue and groove are used on the two largest sizes only. This method of measuring the slots is not generally known, and the writer believes would be more widely adopted if known.

Fig. 5 shows a set of standard handles for plug gages. These are made of hexagon machine steel. Fig. 6 shows a completed plug gage for gaging the diameter of holes. The gage pins are made of drill rod, hardened and ground, and are a drive fit in the handle. They are secured in place by a small dowel

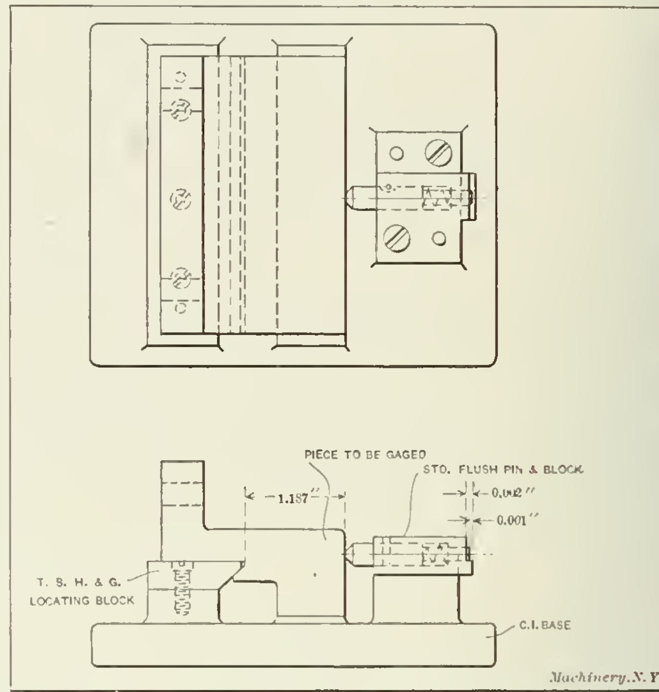

Fig. 9. Another Use for the Flush-pin Gage shown in Fig. 7

pin, and are easily replaced in case of breakage. Some firms prefer to sweat-solder the plugs into the handles, but the advantage of easy removal is thus lost, and the former method is preferable. All the dimensions given are standard, except the diameter of the plugs. These figures have been found by experience to be about right. The plug for the "Not Go" dimension is made shorter than for the "Go" size. This is

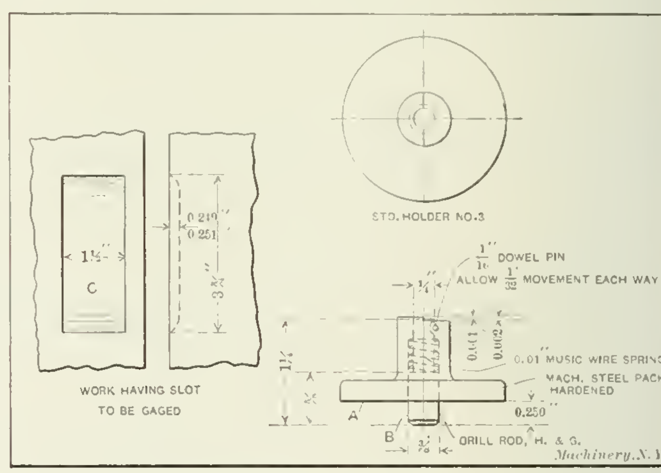

Fig. 10. Flush-pin Gage used for Gaging the Depth of Slots

done in order to make the plugs more readily distinguishable. It might be well to note here, the limits allowed on diameter of holes. In general, they are as follows: For drilled or reamed holes, plus 0.001 inch; for pierced holes, minus 0.001 inch. The plug gages are stored on shelving racks, provided with grooves to hold the handles, and the part numbers are kept in numerical order as mentioned. Square plugs are often used in these handles for gaging the width of milled slots.

Fig. 7 shows a standard flush-pin gage and block of the detachable type. The block is secured to a suitable base or fixture, and the flush pin is used for gaging special shapes which are difficult to measure with any other form of gage. The block and pin are used for a variety of work, so that only the parts shown can be standardized.

An application of this gage is shown in Fig. 8, in which the

dimension *A* on the piece *B* is being measured; the limit allowed is 0.001 inch. The piece *B* to be measured bears against the edge of the hardened tool-steel block *C*, which is secured to the base *D* by two screws and two dowel pins. In Fig. 9, another application of the flush pin gage is shown, and it will be clearly seen that the piece to be gaged is of a very difficult shape, and would necessitate the use of an elaborate fixture if gaged in any other way.

Fig. 10 shows a convenient form of depth gage for gaging slots, holes, etc., the depth of which must be held within certain limits. It consists of the holder *A*, of machine steel,

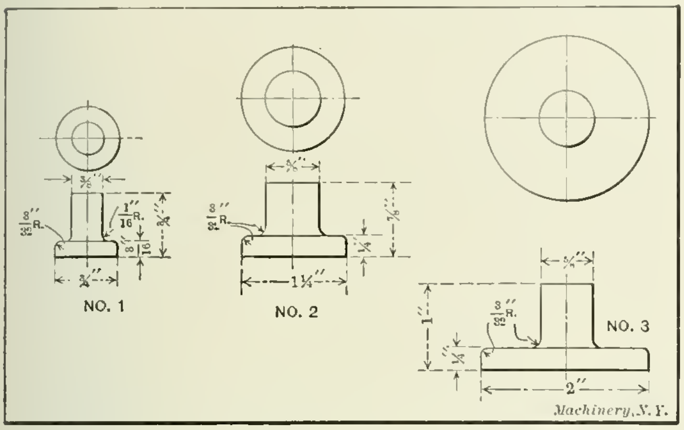

Fig. 11. Standard Bases for Flush-pin Gages

pack-hardened, and the flush pin *B* of tool steel, hardened. It is intended for gaging the depth of the slot *C* shown to the left in the illustration. No. 3 of the set of standard holders shown in Fig. 11, is used for this gage. The slot is 1 1/2 inch wide and the holder must be wide enough to bear comfortably on both sides. Another important use of this form of gage is

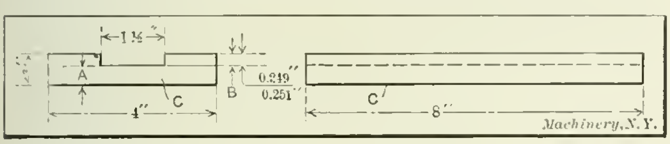

Fig 12. Example showing the Advantage of a Flush-pin Gage

shown in Fig. 12, where the depth of the slot is to be gaged, the slot extending clear across the piece in which the cut is taken. The usual method of gaging such a slot is to apply a snap gage to both ends of the slot. In this case the dimension *A* is given instead of *B*. There are several objections to this method. It is slow compared with the new method, as

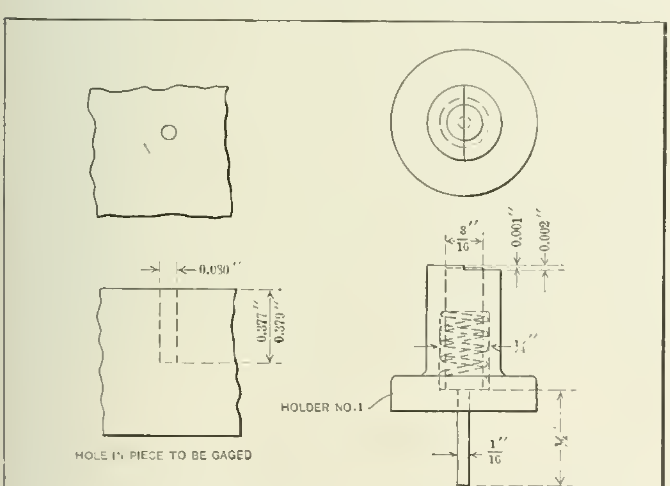

Fig. 13. Flush-pin Gage for Gaging Small and Deep Holes

it is necessary to gage four times, that is, gaging both ends with the "Go" and "Not Go" slots in the gage. The cutter is also liable to ride up and down more or less in the middle of the slot, and the snap gage cannot reach a point far from the end. If there is a limit of say, plus or minus 0.001 inch on the thickness of the block, and also on the dimension *A*, the error in depth of slot is liable to be doubled. The surface *C* as frequently happens is not finished, and the snap gage could not be applied in this instance. It is much more satisfactory to apply the gage shown in Fig. 10 to this case, as it can be quickly applied and can be slid along the entire length of the slot, the flush pin showing any variation in the depth at any point.

Fig. 13 shows one of these gages adapted for a bored hole of small diameter. The smallest holder is used and the flush pin is shouldered, to adapt it to the small diameter.

The above examples show about all of the gages in common use which it is possible to standardize. There are, however, many gages of special form employed which are interesting, but they do not come within the scope of this article.

* * *

STEAM ENGINE EMERGENCY REPAIR JOB

By C. W. INGRAM*

The following incidents and facts took place in a machine shop in Great Britain where I first gained the rudiments of engineering:

My tutor was "Matt," the superintendent, who was an elderly man and certainly one of the very old school of mechanics. Matt used to say that an engineer who could solve a proposition on the spot without running off to consult his text-books was the man for his dollar. "Give me the man who can rise to the occasion." This was one of his favorite remarks to all of his men. "I want action in the case of emergency," was his next sentence. "Always have a ready answer; always be thinking of what to do should there be an emergency."

Matt would preach his gospel like this in short jerks as he took his half-hourly walks through the shop, much, of course, to our annoyance, and we used to review all his short snappy sentences during the meal hours.

Our machine shop was a homemade one. Matt made it, and he boasted that since its equipment, he had never spent more than thirty dollars a year for tools, except files; but in spite of our crude machines, the company made money and kept abreast of the modern, up-to-date rivals. Of course we didn't make near the profit they did, but we certainly had good connections with the trade. Our specialty was brass faucets and general sanitary fittings. Any man who could survive one year of Matt's ministry, was indeed a good man, although our shop was not a very good recommendation if he wanted to obtain a position with another company. We hadn't a single slide-rest on any of our machines; we used all hand tools; no taps or dies, so that all threads had to be chased; no countershafts or belt shifters, it being necessary to shift the belts onto the loose pulleys the best way possible. We didn't even boast a cone pulley on any of our machines, which were chiefly of the polishing lathe style. Our chucks were made of lead and when a part had to be turned in the chuck a recess was cut with a hand tool just under the size of the article to be machined, which was then driven in. We had a good stock of old lead and kept a boy busy all the time making chucks for different jobs.

The company paid lots of money for overtime and still made money. Matt's visits to the shop always meant another sermon for me as I seemed to be his favorite target—was never doing the right thing when he was about. I used to meet him out of the shop occasionally, but his whole conversation was shop; he could talk of nothing else.

Well one day when we were extra busy on a special order of faucets and Matt was hustling them through the shops by standing over the men performing the different operations, our little horizontal steam engine suddenly slowed down, and finally stopped. Matt dropped a box of faucets and rushed off to the engine room. The foreman and I quickly followed to learn the cause of the trouble. To the amazement of us all we found a crack on the crown of the cylinder, running longitudinally to the extent of about six inches. The engineer had noticed a fine jet of steam issuing through this crack and he immediately stopped the engine. Well, I thought, here was a chance for Matt to put into practice what he had for a long time preached to us all in the shop. We were busy and the goods must be shipped, and I could distinctly see that these

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facts were running through the super's mind as he gazed on that cracked cylinder.

No one spoke for about a minute, and then Matt turned to us all and said: "Bring some tools here and use your own judgment. Get some waste and a bucket of water and cool that cylinder." While we were running about getting things, a special messenger was sent to a friendly shop to borrow a half-inch tap, and six half-inch hexagon set-screws, one and a half inch long. Within two hours from our stopping we were at work again. Six holes a half-inch deep were drilled and tapped by hand on the crown of the cylinder, and the six set-screws inserted. The set-screws were arranged on each side of the crack and allowed to project above the cylinder. A mold of sand backed up with clay was next made on the crown of the cylinder, and when all was ready, a ladle of molten brass was brought from the foundry, and run in the mold flush with the heads of the screws. All the men stood around while the brass cooled and no one spoke, not even Matt himself. When the patch was hard, Matt went to the steam valve and slowly turned the wheel. The flywheel began to revolve slowly, and as there were no signs of steam leaking from under the brass, Matt grew somewhat bolder and turned on the full steam pressure and sent us all back to our work again.

The engine was an old horizontal type of twelve horsepower, and had been in use years before she came to our shop. She had done service for us about five years when the mishap occurred; that was twenty years ago and she still works as well as ever, but she no longer drives lead chucks. Her old age has brought her to a lower stage, for she now drives a pug mill in a pottery, but the people who own her say that she is still a good engine.

Matt is never tired of relating to me his ability in solving emergencies, and he always refers to the repair made on "that old steam engine." "I knew brass expanded and contracted more than iron," he says, "and I guess that saddle of brass, boy, pulled up that crack."

* * *

FLUX FOR ALUMINUM

For years those who melted aluminum used no fluxes at all on it, not even charcoal, as it was soon found that this material did more harm than good. On account of the lightness of aluminum, charcoal does not readily free itself and is apt to become entangled in the metal and produce small, black spots in the casting. It is only within the past few years that a flux has been used. The flux that is most extensively used, and which has proved to be so valuable is chloride of zinc. It seems to react with the aluminum, forming chloride of aluminum and metallic zinc which alloys with the aluminum. When this takes place the dross is changed to a fine, granular substance which is readily skimmed off. When aluminum is melted, the surface is covered with a rather thick mass, but the chloride of aluminum will change it to a perfectly clear one closely resembling in appearance molten tin or lead. It is needless to say that such clean metal gives better castings. The method of using chloride of zinc as a flux in melting aluminum is simple. Small pieces are thrown on the surface after the melting has been completed. Enough has been added when the surface is clear. A very small amount usually suffices and for 50 pounds of aluminum a piece of the size of a walnut is generally enough. The metal is stirred immediately after the addition and then skimmed. Those who have not used chloride of zinc should try it, as it is an excellent material.—*Edwin S. Sperry in paper read before American Brass Founders' Association Convention.*

* * *

The advantage of high vacuum in reciprocating engines is exemplified by the experience of the Interborough Rapid Transit Co., New York. This company several years ago substituted a barometric type of condenser for a motor-driven air pump and jet condenser, thereby increasing the vacuum on each of their 8000 horsepower Allis-Chalmers engines from 26 to 28 inches, which increased the power obtained from each of the eight units approximately 275 horsepower.

PRACTICAL HINTS FOR DRAFTSMEN*

By G. G. DANA†

In making drawings there are three fundamental principles that should always be kept in mind: First, accuracy; second, legibility; third, neatness.

Accuracy is the first and most important of the three, and too much emphasis cannot be put on this subject. A drawing may be pleasing to the eye, but if accuracy is lacking it is useless for practical purposes, and in some cases worse than not having any drawing. A mistake on a drawing may be the cause of much loss both in money and time, especially in a factory where manufacturing is done on a large scale. For example, suppose four hundred machines of a kind are to be built. Patterns have been made from the drawings and sent to the foundry for castings, which are made as fast as the facilities in the foundry will allow. The whole order might be run out before any of the machines are assembled, and if there has been an error on the drawings, some of the pieces may not fit into their places and may require the making over of one or more parts, which will delay the erecting, besides making the extra expense of producing new castings, machining them, fitting them to their places, etc.; also delaying work all along the line—all of which might have been avoided if a certain figure had not been wrong on the drawing, an arrow point placed at the wrong line, or some other error made. After a drawing is made it should be carefully checked over to see that all dimensions are correct and that the detail figures add up to the over-all figure and that all lines are properly drawn. It is customary in most factories to build a sample machine and test it before the design is approved and manufacturing orders issued to the shop. This gives a final check of the work all along the line, and often improvement will be noticed while building the sample machine that could not have been noticed on the drawing.

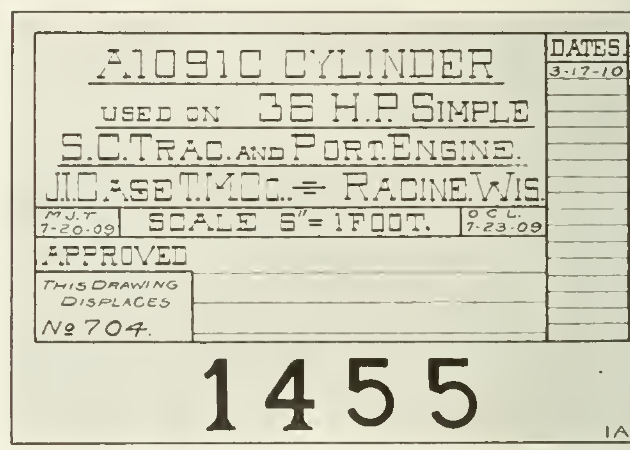

Fig. 1. Sample of Standard Title for Drawings

Under the head of legibility comes the clearness of the drawing or the conveying of the idea that is in the designer's mind. The placing of the views, sections and projections and the arrangement of dimensions, notes, etc., has much to do with the legibility of the drawing. Strive to get all necessary dimensions, notes of explanation, etc., on the drawing, so that those who use it will not have to waste time adding or subtracting dimensions, or figuring out how the piece is to be finished, etc. All of this information should appear on the drawing.

Under the heading of neatness comes the general appearance of the drawing. Good clear lines neatly joined, well-formed figures and letters, and well-arranged dimensions, notes, etc., are among the essentials to neatness as well as legibility.

There might be a great deal more said under each of the headings, but the above will serve as a general guide in the making of drawings.

A good draftsman and designer should be acquainted with

* For additional information on drafting-room practice, see "Some Economies in Making Drawings," MACHINERY, January, 1910: "Sizes of Working Drawings," engineering edition, March, 1909, and other articles there referred to. See also Reference Series Pamphlets No. 2, "Drafting-Room Practice," and No. 8, "Working Drawings and Drafting-Room Kinks."

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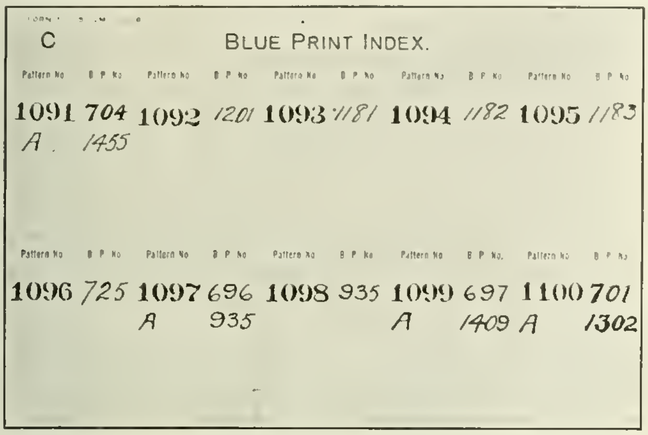
the work of the pattern-maker, molder, blacksmith, machinist and erector. He should be acquainted with pattern-making so that his designs will not involve useless expense in the making of patterns; with molding, so that he will not be designing parts almost impossible to mold or on which there would be time wasted, unnecessary expense in coring out, or other operations which might be avoided if the design were made to conform to good practice in the foundry; with blacksmithing, so that the forging operations will not be unnecessarily difficult or expensive; with the machinist's work, so that the parts will be easily machined and all possible hand work avoided (he must also give the dimensions in such a manner that they will be the ones needed by the machinist in getting out his part of the work); with the work of the erector, so

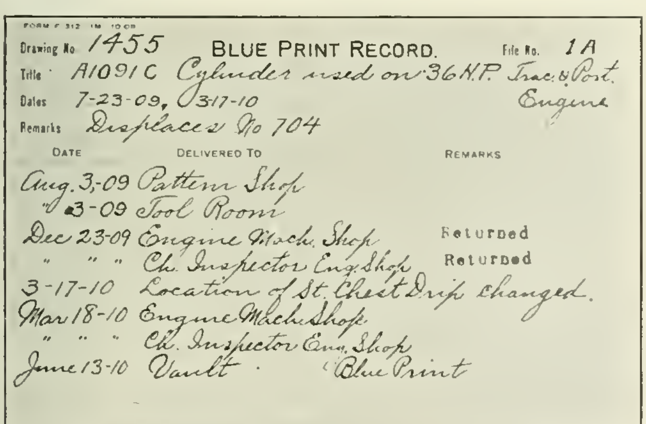

C BLUE PRINT INDEX.

Pattern No	B P No	Pattern No	B P No	Pattern No	B P No	Pattern No	B P No	Pattern No	B P No
1091	704	1092	1201	1093	1181	1094	1182	1095	1183
A	1455								
1096	725	1097	696	1098	935	1099	697	1100	701
		A	935			A	1409 A		1302

Fig. 2. Record Card giving Pattern or Part and Drawing Number

that his designs will go together in the best order without unnecessary filing or scraping. He must figure out in his mind *how* the parts will go together, starting from the foundation and following through the assembling of all of the parts till the machine is completed. In short, the draftsman must be able to follow the work intelligently throughout the whole factory.

In every drafting-room there should be a standard size of drawing which will be most suitable for use in the shop as well as convenient in filing in the drafting-room. Then there will be double-size sheets which can be used when it is impossible to get the work on a standard sheet; also half and


Drawing No 1455 BLUE PRINT RECORD. File No. 1A
Title A1091C Cylinder used on 36 H.P. Trac. & Port. Engine
Dates 7-23-09, 3-17-10
Remarks Displaces No 704

DATE	DELIVERED TO	REMARKS
Aug. 3,-09	Pattern Shop	
" 3-09	Tool Room	
Dec 23-09	Engine Mach. Shop	Returned
" "	Ch. Inspector Eng. Shop	Returned
3-17-10	Location of St. Chest Drip changed.	
Mar 18-10	Engine Mach. Shop	
" "	Ch. Inspector Eng. Shop	
June 13-10	Vault	Blue Print

Fig. 3. Sample of Card used in keeping Record of Blueprints used by Drafting-room

quarter sheets, which will be useful in many instances for sketches of small parts or for lists of parts, etc. Where the writer is employed, our standard sheet is 18 inches by 24 inches, and all drawings are made on this size unless too large, when a double sheet is used, which may be 24 inches by 36 inches (double width) or 18 inches by 48 inches (double length), the size which is most suitable for the work in question being chosen. The double-size sheets must be folded once in order to be placed in the files.

The classification of the different kinds of work on the sheets is an essential feature to convenience in the shop. For example, cast pieces having the same kind of machining to be done are often grouped together on a sheet; shafting is usually placed on a sheet of its own; forgings on another sheet; pins on another, etc. A standard title is also used which contains the name of the part (or parts) in general terms (see first line, Fig. 1), the machine on which the parts are used, and the firm's name; also a space for the date of original drawing and tracing, which are given at the left and right end of fifth line, and the scale of the drawing. At the right of the title is a space for dates of changes and revisions. Below the title is placed the number of the drawing. The title and number are placed at the lower right-hand corner, which is found to be the most convenient place for reference in looking through a set of drawings.

Every pattern or part has its number. A card record is kept of each piece, showing on what drawing it is found (see Fig. 2, Blue Print Index). Each card has ten numbers, and by using the back of the card ten changes on each number may be recorded. A duplicate of this blueprint index is kept in the shop offices, so that the foreman or his men may refer to it to find the drawings needed for use in their work. A card record is also kept in the drafting-room of each drawing (see Fig. 3). This card shows practically a duplicate of the title on the drawing, as well as a record of all blueprints sent out. Changes made on the tracing are also recorded; this entry being made in red on the card makes it easy to see at a glance what blueprints have been sent out since the change was made. When a new print is delivered, the old one is returned to the drafting-room and record made on the card of its return.

A blueprint of each drawing is filed in the vault after the sample machine has been approved and the drawing found correct or has been corrected to agree with the sample machine.

There are many points that have not been touched upon which have to be worked out for each individual shop or class of work to which it belongs. It has been the writer's aim to touch only points that are suitable for general application.

* * *

PRACTICAL HINTS FOR DIEMAKERS—2

FORMING DIES

By RICHARD L. BREUL*

In making templets and blanks always file them straight and square across the edge. In developing the blank always keep a templet or reference blank, so that it will be at hand if alterations are found necessary. Each time a change is made the previous blank which was kept for reference is marked to designate it from others. The marks may be "M" for model or "S" for sample. It should be remembered that metal will not draw around sharp corners, and that corners over which the metal is to be drawn, should be rounded to a true radius. In all cases when making blanks for forming punches and dies consider the thickness of the metal.

In forming blanks they should always be bent with the grain of the metal and not across it (particularly on sharp bends). By the "grain" is meant the way in which the metal is drawn when passing through the rolls. If it is required to make bends at right angles to each other or approximately so, the blanks should be punched out diagonally across the grain. It is sometimes found necessary to form blanks from unannealed stock, that is stock which has been rolled to a certain degree of hardness. In bending this metal it springs back more or less after being struck in the die. This makes it necessary to make a more acute angle or a smaller radius on the punch and die, than is required on the finished product. This difference can be ascertained only by the cut-and-try method. When producing a short bend in blanks in such a position and of such a nature that the blank slips away from under the punch when it is descending into the die, a spring pad is fitted into the die with the lower part of the bend shaped into it, and flush with the top surface of the die. This holds the metal securely against the punch in its descent into the die and insures perfect duplicates of the product. Where holes in a blank come near a bend, a strain in the metal is set up during the bending operation which elongates the holes. This makes

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it necessary sometimes to pierce the holes slightly oval in the opposite direction before forming. In testing the shape of a forming die before it is hardened, always apply a small amount of oil to the surface so that the blank will not bruise or scratch the die, which would be the case if the die were left dry.

Never leave the inside corners of a die sharp when they can just as easily conform to the radius formed by bending the stock around the punch. This will strengthen the die and lessen the possibility of its cracking when hardened. When necessary one forming die can be made to form bends in several pieces which have the same form but are of different lengths. This is accomplished by equipping the die with interchangeable gages or guide strips. Never leave any file marks on the working portions of the punch or die, as these will be reproduced on the blank. A screw hole in a die should be tapped a little larger than the screw, as the die shrinks somewhat in hardening.

When a punch or die is heated in a charcoal or a soft coal fire, the dust and ashes should be thoroughly scraped off the working portion before dipping, so that the water will have a free action upon the steel. Bending and forming dies, unless there is danger of cracking or breaking of weak parts, should be as hard as fire and water will make them. After hardening they may be warmed over a slow fire until water "sizzles" on them. Some toolmakers, when hardening a punch or die, apply cyanide of potassium to the working portions of the steel before dipping. They claim for this that the outer surface of the steel is rendered harder by the application of this casehardening substance and thus will be better fitted to withstand the wear to which it is subjected. This practice is strongly condemned for this reason: If, as is often the case, the tool should fail to harden, this fact will be concealed by the casehardened outer coating, and the tool will respond to the file test as being hard whether it is or not.

Gage plates should never be secured with two screws and one dowel pin. It is far more practical to use one screw and two dowel pins in most cases. A good method of holding gage plates before their exact position is determined, is to clamp them to the die with fillister screws having washers under their heads; and to drill the holes in the gage plate about 1/16 inch larger than the diameter of the screws, so that the gage plate may be shifted around. Always drill the screw holes for the gage plates through the die so that in case a new gage plate is required the holes will be spotted from the die. Whenever the gage plate comes close to the working portion of the die, cut the punch back far enough so that the body of the punch will come within 1/8 or 1/4 inch of the gage plate. In making gage plates for locating large blanks of irregular shape, they should be made to fit the blank only at the point where accuracy is essential, and not to conform exactly to the irregular shape of the blank.

Wood fiber may be formed in the press into almost any shape, but before shaping, it should be immersed in a solution of hot water and soda for a few minutes and then subjected to heavy pressure in the press.

When setting up a press for forming operations the blank as formed by the tools is used to locate the punch in the die before securing the die to the press. If the tools are being tried out for the first time and no sample has been made, they may be set with strips of metal cut from the stock to be formed. When setting the die for a piece in which the bends are not parallel but off at an angle, it is usually impractical to set them with a previous blank, because when the punch is brought down, the tendency is to push both die and blank away. The more practical method is to locate it approximately with the blank and slightly tighten the screws in the press bed; then with two strips of metal the same size as the blank, gage the exact distance, after which the die can be secured to the press.

Do not pass a die as O. K. when the samples have been produced by bringing down the press slowly by hand, as there is sometimes more or less variation in what the tools will do when operated by hand than when operated by power. Another important point to remember is that it is not advisable to use a punch press for drop hammer work, for a broken crankshaft may be the result.

ADJUSTABLE DIE WORK ON THE ELLIS ADDING TYPEWRITER*

By RALPH E. FLANDERS†

It often happens in interchangeable manufacture that there are a great number of separate pieces to be made, all of which are alike, with the exception of slight differences as to length, angle of bending, etc. When pieces of this kind are to be made by press work, the designer has an excellent opportunity to display his ingenuity. If he is smart enough, he can make one punch and die serve for the same operation on a great number of similar parts. This is, of course, a matter of providing the proper adjustments in the die itself. The typewriter parts of the machine made by the Ellis Adding Typewriter Co., of Newark, N. J., offer an unusual opportunity for exercising ingenuity of this kind. The following illustrations and description show the successful manner in which the problems were worked out.

The Typewriter Action

Fig. 1 is a front view of the machine, partly dismantled, so as to show the typewriter mechanism more plainly. Fig. 2 is a diagrammatic section through the machine showing the typewriter action. The keys at *A* are mounted on the ends of long levers *B*, which are pivoted at *C*. These levers carry at their inner ends roll studs *D*, engaging slots in the end of cam levers *E*, which are pivoted to a stationary "comb" at *F*. The upper ends of the cam levers *E*, in turn, carry studs *G*,

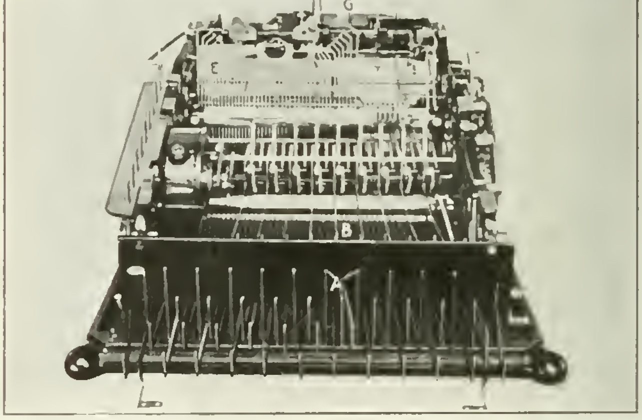

Fig. 1. The Ellis Adding Typewriter Dismantled to show the Cam Levers

which engage slots in the type-bars *H*, which are pivoted at *J* to a "comb" having the outline of an arc of a circle; this gives the type-bars *H* the regulation "basket" form. In Fig. 1 the "basket" of type-bars is removed to show cam levers *E* more plainly. The same reference letters apply to both engravings.

The action of the machine is plainly shown by the dotted lines in Fig. 2. Pressure on key *A* raises stud *D* at the inner end of the type-bar *B*. As stud *D* rises, its engagement with the inclined slot of cam lever *E* throws the upper end of that lever toward the left as shown, and the engagement of stud *G* with the slot in type bar *H* throws it to position H_1 against the paper roll at *K*.

The use of adjustable dies in this mechanism is best illustrated by the tools used in making cam levers *E*. As is shown clearly in Fig. 1, these cam levers are of varying lengths, and are bent at their upper ends to conform to the arc of the circle in which the type-bars are arranged. Many of them, in fact, have two bends, and a few of them have three. The latter cases are made necessary by the provision of openings between the bars for the passage of the "universal bar," against which the cam levers strike just before the type strikes the paper, and thus control the escapement for the carriage movement.

The fact that cam levers *E* are of varying lengths also makes necessary a difference in the angle of the slot at the lower end, where it engages pivot *D*. *D* has the same vertical

* This is the fourth installment of a series of four articles on the construction, action and manufacture of an adding typewriter. The previous articles appeared in the August, September and October numbers.—EDITOR.

† Address: Springfield, Vt.

movement on each one of the whole row of key levers, and the upper end of all cam levers must have the same amount of movement. It is necessary then for the long outside levers to have the slot set at a more acute angle than is the case with the short central levers. Going each way from the center the angle thus becomes a little more acute, so that each lever is different from its neighbor in this particular, as well as in its length and in the number and angle of its bends.

The first operation on this job is that of blanking out the cam lever. One of the blanks is shown lying on the table at *E* in Fig. 4. The blanking die is not shown, since there is nothing unusual in its construction. The blank produced is used for the whole series of cam levers, and so is long enough for the longest, or outside one. Besides blanking, this die pierces the hole for the pivot at *F* in Fig. 2.

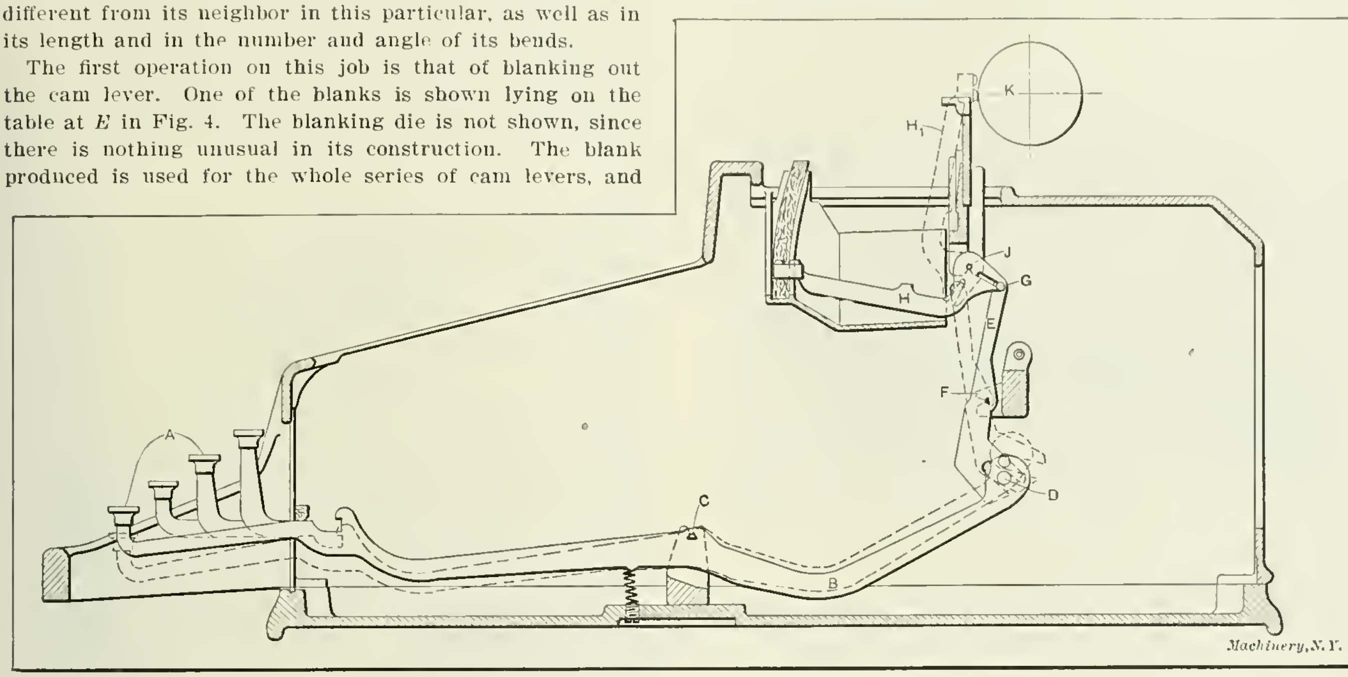

Fig. 2. Typewriter Action of the Ellis Adding Typewriter

An Adjustable Combined Slotting and Numbering Die

Fig. 4 shows the first, and in some respects the most remarkable, of a series of adjustable dies. The purpose of this tool is to cut the cam slot at the lower or enlarged end, and also to number the blanks. The purpose of doing these operations simultaneously will be at once recognized. As explained, the cam slots are cut at varying angles, but the difference in the angle between one lever and the next one to it on either side is so slight that delicate measuring instruments would be required to detect the difference. To prevent the possibility of the levers ever being mixed up, or of their ever having the wrong number stamped on them, the numbering mechanism and the adjustable angle mechanism of the die are positively connected, so that the number stamped on the lever is an absolutely reliable indication that the angle of the slot is right for that particular number.

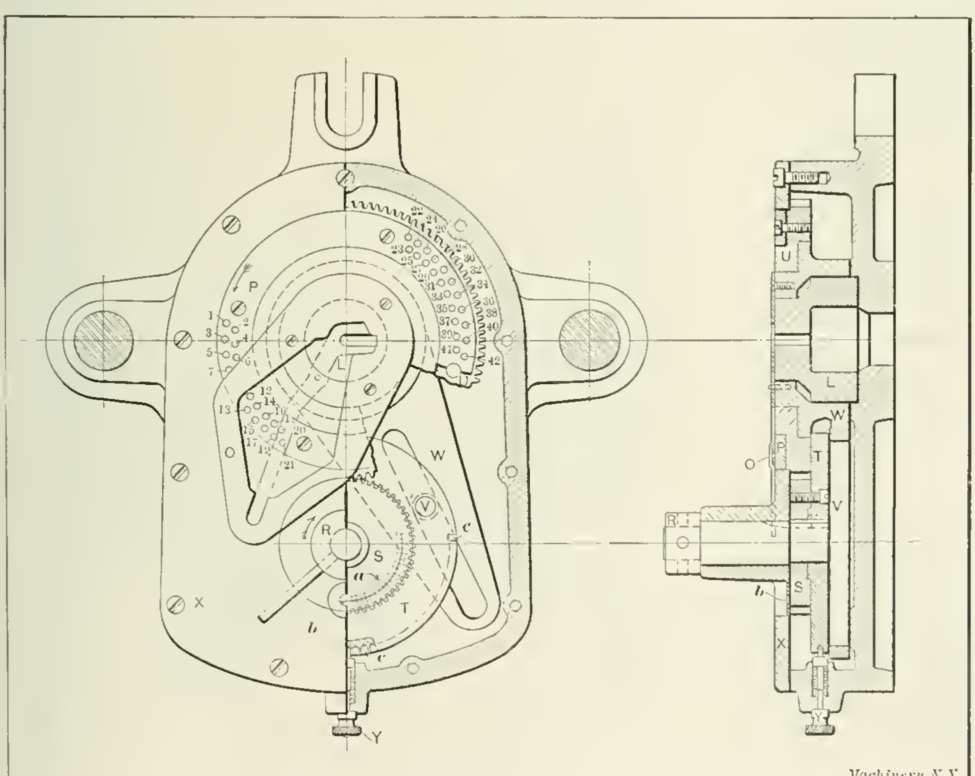

Fig 3. Details of the Mechanism of the Die shown in Fig. 4

The cutting member of the die is shown at *L* (see Fig. 4), the punch which cuts the slot being shown at *M*, surrounded by stripper-plate *N*, which is mounted on the usual spring-supported pad. This holds the work firmly in place during the cutting and during the return of the punch, until it has been drawn clear of the slot which it has cut.

The angle of the slot is changed by shifting the gage-plate *O* which locates the blank, as shown by the dotted lines representing the outline of the latter in Fig. 3. A series of number types is inserted in ring *P*, which may be adjusted to bring the proper number beneath the blank. This number is stamped by the pressure on the blank of pad *Q* on the punch, which may be adjusted in height to give the proper pressure. The movements of gage-plate *O* (which controls the angle of the slot) and of type ring *P* (which stamps the number), are positively connected, and are controlled by turning capstan head *R*, using for a wrench a pin stuck in one of the holes in its periphery.

The connections between *O*, *P* and *R* are best shown in Fig. 3. Capstan *R* is keyed to gear *S* and disk *T*. Gear *S* meshes with gear *U*, to which type-ring *P* is screwed and doweled. Disk *T* carries a stud *V* which engages a slotted arm *W*, which, in turn, has gage-plate *O* screwed and doweled to it. By means of this positive connection, the movements of *O*, *P* and *R* are made positive with each other.

It will be seen that two revolutions of *R* are required to give the full range of adjustment. The sketch shows the tool set for one of the central cam levers, having the slot at an obtuse angle. As *R* is moved in the direction of the arrow, gage-plate *O* is moved to the right through its connection with lever *W*, making the angle of the slot more and more acute.

At the same time, type-ring P is moved in the direction shown by the arrow, bringing the corresponding numbers in place under the work. When the last of these numbers has been reached, a continued movement of R for nearly three-quarters of a revolution is required to bring the punch into the next operative position. These positions are for the levers on the other side of the center, which have to be set at the same angles as on the first side, of course, changing from obtuse to acute. But this complete revolution of R which

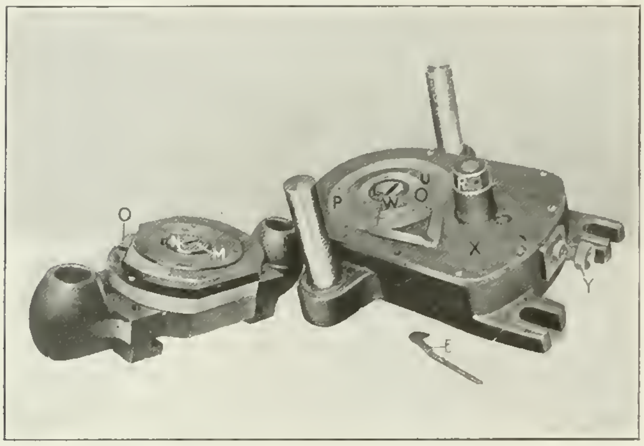

Fig. 4. An Adjustable Die for Slotting and Numbering the Cam Levers

brings O to the same position as before, has turned type-ring P only halfway round, so that it brings a new set of numbers into action. Thus the second set of adjustments gives work having the same angles of slot as the first set, but with different numbers stamped on it.

The proper adjustment for each number is indicated by the graduations a on gear S, read through a hole b on the top casing X of the die. This location for each position is positively determined by spring index plunger Y, whose point

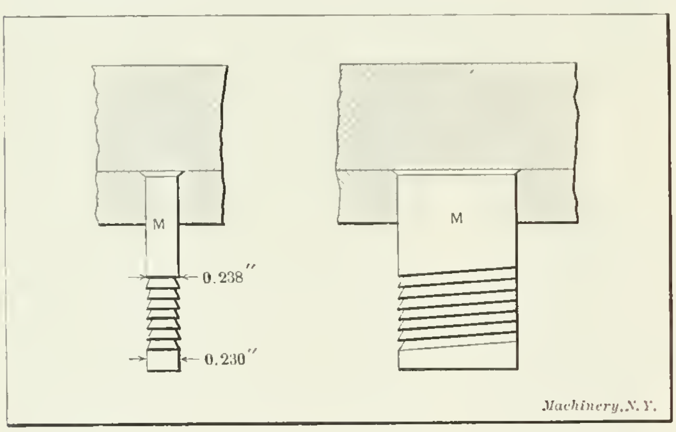

Fig. 5. A Combined Blanking and Broaching Punch

enters holes c, properly located to receive it in the edge of disk T.

A Punch which Blanks and Broaches at One Stroke

A peculiarity of punch M should be noted. As shown in Fig. 5, it is so made as to not only blank out the slot, but to broach the edges as well to a finished size. The lower end of the punch, which is a loose fit in the die, cuts out the blank. Above this blanking edge, it is provided with a series of shaving or broaching teeth. Between the first and the last of these teeth the punch tapers about eight thousandths, leaving four thousandths on each side for a finish. The slot is thus left cleanly and smoothly finished and accurate to size. This construction was a new one to the writer.

Adjustable Die for Cutting to Length

The next operation in making these cam levers is that of trimming them to length. This length is a variable matter, as has been explained. The die for this operation, and also for properly forming the end and punching the hole for the stud, is shown in Fig. 6. The work is located by gage-pin A_1, which enters the pivot hole of the blank. This gage-pin is mounted in a slide Z_1, adjustable in V-ways by means of the knurled screw head B_1. It is by means of this that the length of the different levers is determined. Pointer C_1 shows the proper location of each number of cam lever on a scale attached to the base of the die. A vernier giving the actual length in hundredths of a millimeter is also provided (see D_1) as an added check on the adjustment.

The construction of the punch for this end-trimming operation is interesting. The cut is, of course, an unbalanced one, there being a tendency for the punch to dodge away from the die. To prevent this, pilots E_1 are provided, which enter the rectangular slots provided for receiving them in the die-plate, before the cutting edges meet the work. These preserve the alignment between the punch and die, making flinching impossible.

As shown, there is an elongated slot beyond the cutting edge of the die at F_1, which allows scrap of varying lengths, cut from the ends of the blanks to fall through the base of the die. A pressure plate G_1 is provided in the punch to hold the work firmly while the punching is in progress.

The First Operation Bending Fixture

The first bending operation is performed in the hand-operated bench tool shown in Fig. 7. The work is held in the vise

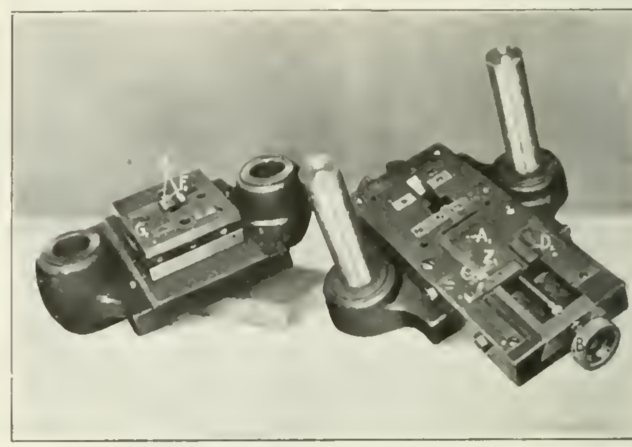

Fig 6. Adjustable Die for Trimming Cam Levers to Length

jaws J_1, being located by the spring pin shown, which snaps into the pivot hole. The position of the bend is determined by adjusting the slide K_1 on which this vise jaw is mounted, to the proper position on the base of the machine, by means of the knurled-head adjusting screw L_1. The bend is made by inserting the tail of the work into the slot in fixed jaw M_1 and pivoted jaw N_1, the slot in the two being in line, of course, when the work is inserted. Jaw N_1 is mounted on a revolving stud, controlled by handle O_1. The movement of this handle to one side or the other of the center is limited by stop P_1, clamped

Fig. 7. Adjustable Die for Making the First Bend in the Cam Lever

in a circular T-slot under the circular dial. Graduations on the edge of this dial enable the stop to be set to the proper position for each of the different cam levers, as indicated by their numbers. This dial, in connection with the scale Q_1 for the position of slide K_1, gives all the information needed for locating the proper position, amount and direction (whether to the right or to the left) for the first bend on each of the cam levers.

The Final Bending and Inspection Fixture

It was stated that two or three of the cam levers had three bends. These secondary bends are made in special dies, which need not be here described, as they are not used for all the levers. The final bend, however, given by the fixture shown in Fig. 8, is used on each one of the different cam levers. This final bending fixture is used both for bending and for inspecting. Its principle will best be understood by comparing it with the lay-out of the cam levers at E in Fig. 1. It will be seen that the studs at the upper ends of these levers form an arc of a circle. The final bends must then bring the upper ends of all the levers to this arc. In Fig. 8, this arc is represented by a circular tongue R_1, which has

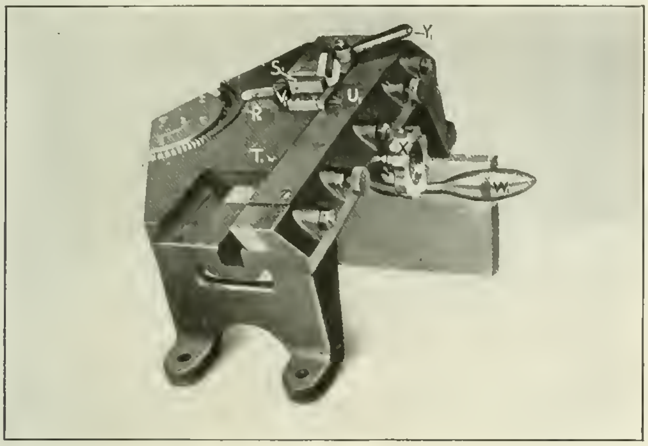

Fig. 8. Bending and Inspection Die for Final Operation on Cam Levers

slots in it corresponding to the proper positions for the studs on the different cam levers, these studs having been riveted in place just before the final bend.

The lever, as it comes to this fixture, is clamped in jaws S_1 on slide T_1, which latter is located by means of scale U_1 to a position accurately corresponding to its position to the right or left of the center in Fig. 1. This slide T_1 carries a pivoted bending stud with a slot, shown at V_1, and connected with handle W_1. This operates in identically the same fashion as does handle O_1 and pivoted jaw N_1 in Fig. 7. No positive stops are used to limit the motion of the handle, however; the workman simply bends the lever enough so that the stud

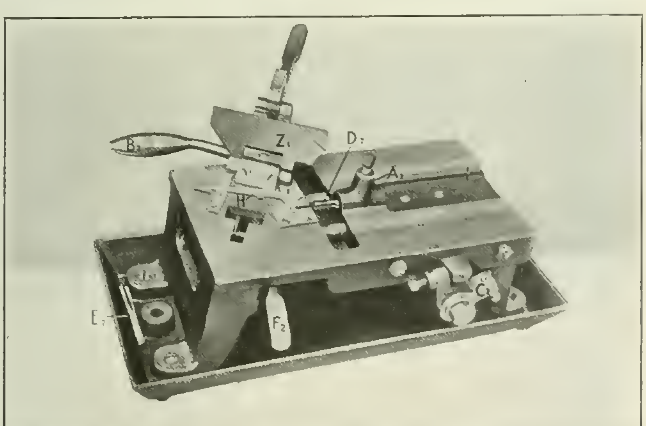

Fig. 9. Miniature Shaper for Rounding Edges of Type-bar Slots

accurately matches with the slot marked with the number of the work in the circular index R_1. Slide T_1 is adjusted by a rack and pinion movement operated by scalloped knob X_1. It is provided with clamping gib screws as shown. The jaws for holding the work (which is located by a gage-pin in the pivot hole) are operated by cam lever Y_1.

This bending and inspection fixture, it will be seen, holds the work in exactly the relative position it occupies in the finished typewriter, and bends its upper end to exactly the position it must occupy in the finished machine. For this reason it is correct to call it an inspection fixture as well as a bending fixture.

A Hand-operated Shaper

The tool shown in Fig. 9 is not used on the cam levers, but on the type-bars. It is here shown as a matter of general interest in the line of special toolmaking. It is, in effect, a hand-operated bench shaper. In Fig. 2 it will be seen that the slot at the lower end of the type-bar H is engaged by stud G in cam lever E. Now the pivots J of type-bars H at the extreme outer sides of the basket approach the horizontal, so that the action between G and the slot in H is not direct, but has a slight rolling effect. On this account the edges of the slot have to be slightly rounded to give easy action. This little bench shaper is used for the operation of rounding the edges of these slots.

The work H is located by the gage-plates shown, and is clamped in place by the cam lever hinge plate Z_1. The ram A_2 of the shaper is operated by handle B_2, and its motion is limited by the adjustable screw stops at C_2. The tool at D_2 is held in the ram by the set-screw shown. It cuts on its end, and is formed to give the correct rounding to the edges of the slot. Two cuts are taken, all the type-bars being given a roughing cut with the tool shown, and then a finishing cut with the second tool lying in the base of the machine at E_2. The lever at F_2 operates the knock-out for pushing the work from the gage-plates.

We would commend these dies and fixtures, particularly those shown in Figs. 3 to 8, as worthy of the study of any tool-maker whose work requires the design of multiple-purpose punch and bending tools.

* * *

BUILDING FOR THE FUTURE

Many of the manufacturing plants erected forty or fifty years ago were laid out without taking into consideration the possibility of growth, the result being that to add to an old plant often means re-construction and re-arrangement very costly to carry out. On the other hand, it is a not uncommon mistake to build nowadays with a large future in view, the result being that the business is handicapped for many years with heavy interest charges and an inefficient layout, because the conditions for efficient operation lie in the future. Mr. Henry G. Brinckerhoff, in a paper "Natural and Artificial Draft," read before the September meeting of the National Association of Cotton Manufacturers, touched on this phase of plant construction in discussing power plant and chimney construction, as follows:

"If you must add something [to the chimney] for "good luck" put it onto the height, as you stand to lose less on this, as excess [cross section] area will only come useful in a long distant future when the plant has grown to it. I have seen too many plants handicapped by strained proportions for a great future, whereas when the future did arrive, it was entirely a different mill or a problem altogether dissimilar to any initial conception. In following the mill development for twenty years here in New England, it has inclined me to believe that if I had the making of any new power plant layout, it would be my purpose to plan for the highest economy for the immediate needs, not extending farther perhaps than the next five years. This burdening a new plant to struggle under heavy fixed charges and loss in operating until the work develops to meet the initial undue proportion, is as bad as buying a man's suit for a boy because you know he is going to grow to it some day. Make things of right proportions to get the best economy for what you need now, and then success brings ample capital and you can then easier afford to throw away the old plant, if you like, and start out with another up-to-date outfit. In our conceit at any present time, we lay out big schemes for additional future boilers of the same kind in a great shed of a building and what do you generally find ten or fifteen years later but a collection of big and little units, different makes, different piping systems, etc., with the same thing seen in the engine room and elsewhere."

* * *

A common practice of French mechanics, when adjusting the crankshaft and connecting-rod bearings of automobile engines, is to chalk the bearings all over freely and then adjust the boxes until they "pinch" lightly. The chalk works out with a few revolutions and the space left provides sufficient clearance for running without heat, being just about the right amount for oil, but not so much as to cause pounding at high speed.

MAKING LOCKING BOLT BLOCKS AND SPINDLE CARRIER FOR GRIDLEY TURRET LATHE

By F. R. HUMPHREY*

An illustrated description of the machining operations on the spindle head of the Gridley automatic turret lathe was contained in the November, 1908, issue of MACHINERY. In this description most of the important operations on the spindle head were treated in detail, but the making of the locking bolt blocks was not dealt with at that time, and will, therefore, be described in the following.

As may be remembered from the original description of the Gridley automatic turret lathes, contained in the February, 1908, issue of MACHINERY, and also from the article in the November, 1908, issue, the salient feature of the machine is the construction of the spindle head, a general assembly view of which is shown in Fig. 1. The most vital point in the making of the spindle head is to provide for accurate alignment of the tools in the tool holder with the spindles. To accomplish this, it is also highly important that the locking mechanism for the spindle head make it possible to obtain exact and accurate indexing. As was mentioned in the previous article, if the indexing ring of the turret in a single-spindle machine was not exactly divided, the machine could still be made to do its work accurately, because the holes in the turret would be bored to line up exactly with the spindle in each position. In a multiple-spindle machine, however, if the spindle head is not exactly divided, accurate work is impossible, because there will be no coincidence between the tools and the work in the different positions. The machining of the spindle head and all its details, including the locking mechanism and locking bolt block, therefore, is of extreme importance.

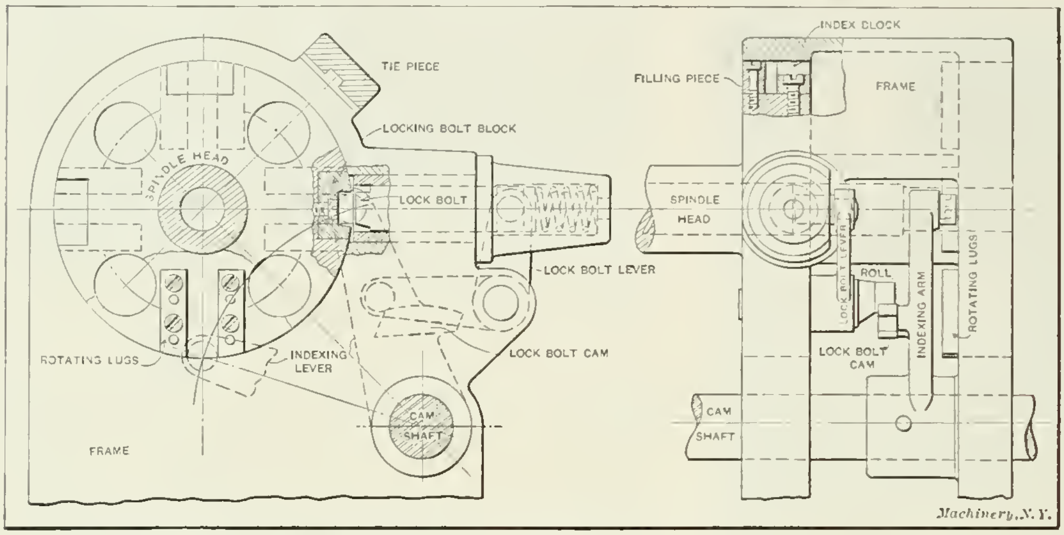

Fig. 1. General Design of Spindle Head and Indexing and Locking Mechanism of the Gridley Automatic Turret Lathe

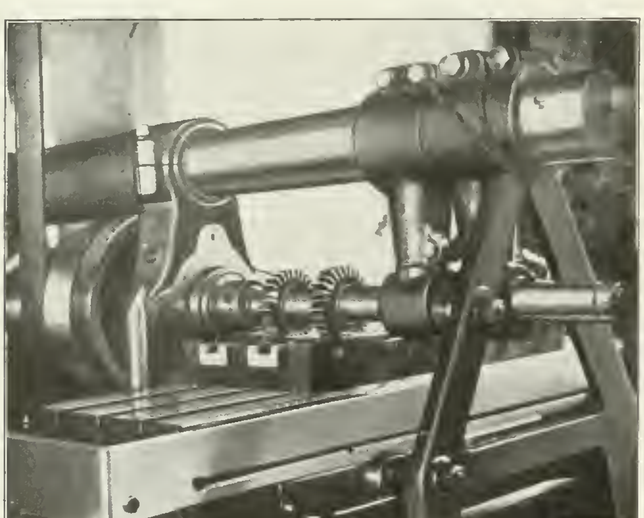

Fig 2. Fixture for Milling the Grooves in the Locking Bolt Blocks

* Address: Windsor Machine Company, Windsor, Vermont.

The locking bolt blocks for the spindle head (see Fig. 1) are made of tool steel planed from bars $2\frac{1}{2}$ inches wide and $1\frac{1}{4}$ inch thick, the bars being about 30 inches long. From the planer the bars are taken to the milling machine, where they are put into a fixture in pairs as shown in Fig. 2, and rough milled. This milling leaves the inside surfaces of the slots straight. A finishing cut is then taken in the same milling fixture, one side of the groove being beveled in this finishing operation.

After having been milled, the bars are taken to the cutting-off room and are cut into pieces $1\frac{1}{4}$ inch long, these pieces forming the individual locking bolt blocks. These blocks are now taken to the drill press and drilled and counterbored for a one-half-inch round-head screw. The jig used for drilling the blocks is shown in the center of the group in Fig. 3. After being drilled and counterbored, the blocks are hardened.

The most important part of the machining—that of grinding—is now to be done. The blocks are held one at a time in a vise on a Pratt & Whitney vertical-spindle wet grinder, and the bottom of the blocks ground. Then the blocks are put in sets of eight into a fixture, the blocks being held by screws. The fixture itself is held by means of a magnetic chuck on a Brown & Sharpe surface grinder, and the ends of the blocks are ground square with the bottom face and brought to the correct length. A narrow-faced wheel is used for this operation. In the next operation the inside of the groove is ground with a cup-wheel, Fig. 4 showing the piece held at an angle for grinding the tapered side. After the grinding the blocks are ready to be put into the spindle head or carrier. The finished block is shown to the right in the group in Fig. 3.

Fig. 3. Finished Locking Bolt Block, and Jigs used in Drilling Holes in Block and Spindle Head

The spindle carriers are made from cast iron. They are chucked, bored and turned in an engine lathe, and from the lathe they are taken to the radial drill and the spindle holes roughed out by the aid of a pair of plate jigs. After this operation, the spindle carrier is taken to the grinder and the outside cylindrical surface ground. The spindle carrier is now ready for the milling machine.

In Fig. 5 is shown the spindle carrier held in a milling fixture, a roughing cut being taken to provide a groove for the locking bolt blocks. The index disk on the milling machine is made of the greatest diameter which the machine will accommodate in order to eliminate errors in indexing as much

as possible. To accomplish this, two plates were made and the index holes, drilled and taper reamed together. By moving the top disk one division, the total error was divided by four. Then the disks were taper reamed again. By repeat-

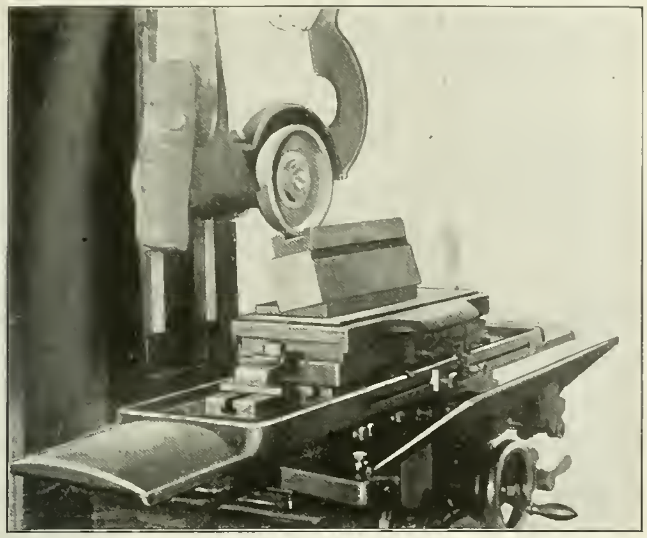

Fig. 4. Grinding the Tapered Side of the Locking Bolt Blocks

ing these operations the error was reduced until it could not be detected.

After the slots have been finish milled, the spindle carriers are taken to the radial drill and the screw holes for the blocks are drilled and tapped. The jig for this operation is

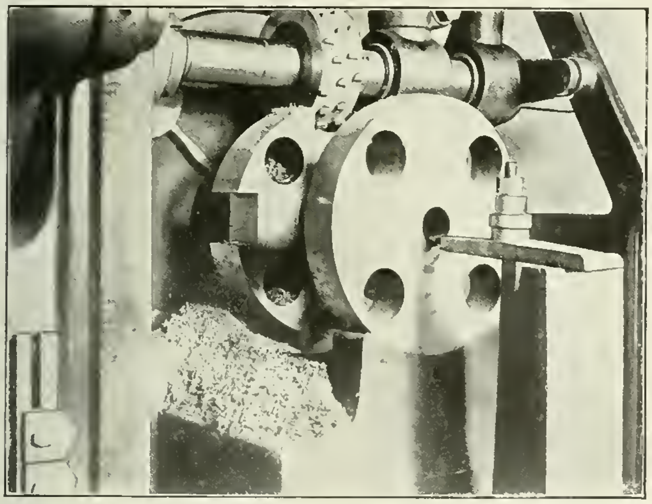

Fig. 5. Rough Milling the Spindle Carrier

shown to the left in the group in Fig. 3. The blocks are now put in place and tested with an indicator for any possible error in spacing which may have developed during the machining. The indicator is shown in position on the spindle

Fig. 6. Indicator for Inspecting the Location of the Locking Bolt Blocks

carrier in Fig. 7, the tool itself being shown in Fig. 6. The body of the indicator is made of cast iron, the handles being made of wood to prevent any expansion caused by the heat transmitted by the workman's hands. The needle is similar to that used on the Starrett indicator. The ratio is 0.001 inch to 1/16 inch and the scale is movable so that the readings can always be taken from the center.

If any error in the spacing of the blocks is indicated by this tool, the blocks are removed and the errors are marked on the bottom of each block with copperas. Small errors are removed by stoning, and for the correction of greater errors the blocks are sent to be ground. When the blocks are corrected the spindle carrier is ready for the last operation—that of finish boring the spindle holes. In Fig. 8 is shown a spindle carrier placed in the boring jig. This jig is made very rigid and the greatest care was exercised in machining it. The spindle holes are bored in the same relation to the blocks

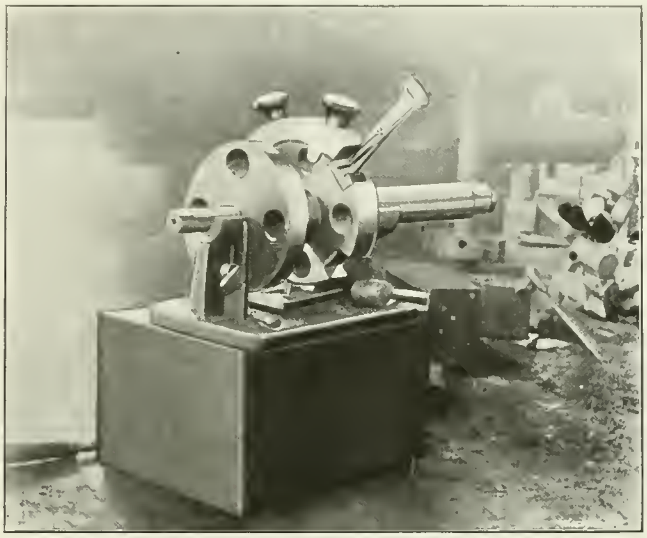

Fig. 7. Inspecting the Location of the Locking Bolt Blocks

as they will be, when in place in the machine. When the spindle holes are finished, the bushings are put in place and the spindle carrier is ready to be assembled on the machine.

* * *

The articulated locomotive is generally supposed to be of comparatively recent origin; this conception, however, is erroneous. In an article in the *Railway Age Gazette*, the history of the articulated locomotive is reviewed, and it is of

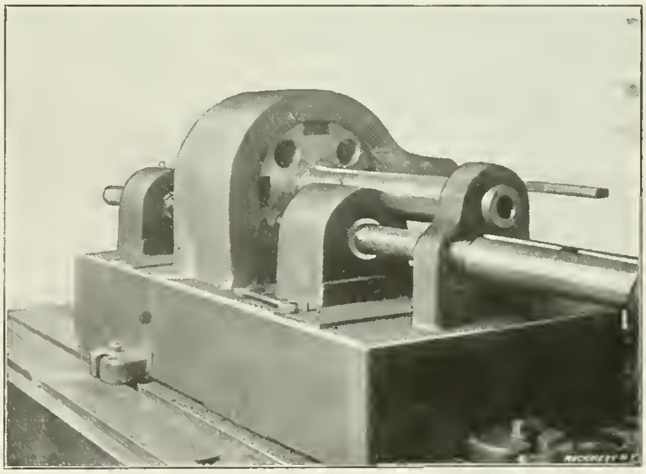

Fig. 8. Finish Boring the Spindle Carrier Holes

interest to note that the first type of articulated locomotive was built as early as 1831 at the West Point Foundry, from designs of Horatio Allen for the South Carolina Railroad. At the end of 1833 four of these locomotives were in use on that road. In 1850 an articulated locomotive was built at Neustadt, Austria, but it is stated that this engine soon proved a failure. As early as 1873, however, a type of articulated locomotive was built at Brussels for the Central Railway of Belgium, which, in some respects, had the appearance of a modern articulated locomotive. This locomotive was of the Meyer's system. The first Mallet articulated compound locomotive was built in 1888, and the first locomotive of this type, in America, was built at the Baldwin Locomotive Works in 1904.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Ethan Viall,
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Associate Editors

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

NOVEMBER, 1910

PAID CIRCULATION FOR OCTOBER, 1910, 26,154 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE DEADLY SET-SCREW

Statistics show that about five hundred thousand persons are killed and injured every year in industrial occupations, including railroads and mines, in the United States. In manufacturing establishments the innocent-looking set screw on pulleys, gears and other revolving parts, is the cause of a considerable percentage of the maiming and killing. If we put it at only one per cent, which is undoubtedly low, the casualties for the last twenty years directly attributable to this one bad feature of machine construction alone would exceed those of the bloodiest battle in the Civil War. Is not that too great a price to pay for a means of securing pulleys to shafts?

We seldom make a proprietary article the subject of an editorial, but where the use of an improved mechanical device means the saving of life and limb it is a duty and a pleasure to advocate it; and this is the case with the hollow flush head set-screw put on the market a few years ago and now available in improved form. This appliance should solve the set-screw problem, for it is neat, effective, durable, easily applied and, best of all, perfectly safe. The stringent labor laws recently passed in New York, New Jersey and other states make it imperative to protect machinery effectively at all danger points, and if all safety devices were as cheap and as easily applied, the path of the reformer of dangerous machinery construction would be much easier.

* * *

THE DEVELOPMENT OF SPECIAL MACHINERY

When it is found necessary to deviate from the beaten path in designing machinery, experimenting is always necessary. Some, not familiar with this subject, have the idea that one who has spent a number of years in designing special machinery should be so practical and expert in his line that experimental work would not be necessary to perfect his plans. These are mistaken ideas which will be quickly dispelled if the person having such views will visit one of our large manufacturing concerns and see how special machinery is developed. With these large manufacturing concerns the practice is to show on paper only general sketches of what is wanted. Then these sketches are turned over in the rough, to experts, who develop the idea into a satisfactory working machine. It sometimes requires months and years to get the degree of perfection required, and in certain cases the first plan is entirely discarded. If it were possible for a machinery designer to conceive an idea and work it out to satisfaction on paper, it would not be necessary for these large firms to maintain experimental departments, but as it is practically impossible for any designer to anticipate all the requirements of new machines, even though essentially simple, this department has been found necessary, and certainly is one of the most important of most large machinery manufacturing concerns. The need of experimental work, of course, applies to special machinery where definite data and information on the subject are lacking, and something new is being evolved.

* * *

LEARNING BY EXPERIENCE

A good workman will sometimes make a blunder, the exposure of which may cause him a great deal of unnecessary trouble or even hardship. If he is of the right sort the mere fact that he has blundered is punishment enough, and no second experience is necessary to teach him a lesson. A "trouble man," working for almost any machine tool builder or machine manufacturer has many opportunities to put men of all degrees from the machine operator to the superintendent "in the hole, bad," but most of them never tell the employers the whole truth about reported troubles. They feel that the chagrin of an employe at his own lack of perception is sufficient, and that he generally profits by the experience.

Some years ago a well-known machine tool builder sold a boring machine to a large concern, and soon received a report that the machine was working badly. The report of the trouble was vague and a personal visit was necessary, which was made by the manager. Investigation showed that the machine spindle *was running backward.* Simply twisting the driving belt stopped all trouble. The foreman stood in fear and trembling for his reputation with his employer, and timidly asked the manager what he was going to say about the cause of the trouble. The manager assured the foreman that his statement of the cause of the trouble would be so diplomatically worded as to cast no discredit—and it was. The manager paid his own carfare and smoked his own cigars, but everyone was pleased and happy. The manager's view was that though the foreman ought to be discharged, *his* company did not want any of the blame.

* * *

EDUCATION OF MUSCLES AND MIND

Enthusiastic educators who realize the great need of industrial education fully understand the important influence of well-trained muscles in making well trained brains. Mr. Edward Rumely, a Western manufacturer, deeply interested in balanced training of mind and body, says:

> The training of manual work, the keen discipline in learning any one of the skilled trades, is the schooling that is needed above all by the city boy; but all boys need it, not only because it goes to make efficient men of them, but because it is a necessity to their bodies. * * * Few realize how much muscle means to the brain, yet the brain is taught by the muscle as well as by the nerves of the ear and eye. Fully ninety per cent of our life is guided by muscular sensation. The baby depends upon it almost wholly for a long period of its early life. Its first education is a physical education—an education of the muscles. Its development and training through life and experience is a type of later education that is practical through its muscle, above all by its hands, in drinking in knowledge of the outside world. * * * We see iron, its crystals, its luster, but we must bend and break it, weld and hammer it, file and test it, and put it to mechanical uses with our hands before we can know much of that metal which has become the main carrier of our civilization.

A skilled mechanic, whose mind has been trained to think logically and to apply the forces of nature to the best advantage, is invincible and indispensable. He is worth many times more than the Greek professor with untrained hands and a mind filled with knowledge of the hoary antiquities of a dead past. An enlightened educational system that will train the mind through the muscles as well as fill it with useful information is one of the great improvements in our institutions that is rapidly developing, and its meaning is that the man who works will reap more benefit from what he produces.

CEMENT FLOORS IN MACHINE SHOPS

Probably there is no floor for machine shops and similar establishments as good as one made of selected hard maple, properly laid and supported. It is comfortable to work on, is free from dust, does not damage finished work dragged over it and, being somewhat elastic, a casting is not likely to break if dropped on it from a workman's hand. But the high cost of lumber and the fire risk, especially in screw machine departments, are against the wooden floors; and many modern plants have been built with cement or stone composition floors. These floors have a serious fault, being very uncomfortable for the workmen who have to stand all day. A reader in the Middle West writes as follows:

"Of late we have heard quite a good deal in our section against the adoption of cement floors in manufacturing establishments, and we know of some cases in our immediate vicinity where workmen have been crippled from standing on such floors, but in the face of this, we notice some of the recently constructed reinforced concrete buildings for industrial purposes are being built with this kind of flooring."

A cement floor has the same defect as stone, damp earth, iron and any material that is a good conductor of heat. It reduces the temperature of the workmen's feet and legs, which in susceptible subjects may set up serious derangements of circulation, resulting in rheumatism, sciatica or other painful troubles. If the cement floor is warmed, it will be found no more injurious than a wooden floor. The relative hardness of cement and wood is of no practical importance, being, if anything, in favor of cement. The greater solidity of foothold is in its favor for those who have to handle heavy materials. A springy floor is tiring, and contrary to the common opinion is not as easy to work on as a solid floor. That it is the lowering of the temperature of the extremities—cold feet—which causes the discomforts incident to cement floors, can be easily proved by laying boards in front of machines for the men to stand on. Although the boards rest directly on the cement and are practically inelastic the trouble complained of will disappear. We believe from the information received that it is necessary for the comfort and well-being of employes in establishments having concrete floors that the floors be either warmed in winter or covered with some heat non-conducting material where the workmen stand, such as boards, mats, etc. The workmen will find that cork-soled shoes will greatly promote their comfort if they must stand all day on the unprotected cement.

* * *

THE MACHINIST'S PROSPECTS

To say there are numerous opportunities for advancement in the mechanical field within the grasp of men in the works, is to make a statement likely to be received with skepticism by many. Nevertheless we make it, and the proof of its accuracy lies in the fact that almost invariably the machinist who devotes his spare time to study is advanced to positions of responsibility. This does not mean that success always follows study, nor that one can completely fit himself for a responsible position by reading and study at home or in school. Books give much that is essential, but cannot supply all. A man's personality, his character, his temperament, his judgment—all these are factors which determine the degree of his success; but without knowledge, these in themselves are insufficient. The foreman, draftsman or superintendent, each must possess the personal qualifications which fit him for his position. Nevertheless, the machinist whose ambition impels him to the reading and study of books and publications that explain the principles and practice of mechanics, usually is promoted; and this important fact deserves wider recognition than it receives, we think, among the young mechanics of the day. Many of our industries are still in their infancy, and innumerable enterprises are being developed, so that there will be a steady and ever-increasing demand for thoroughly competent foremen and superintendents; and these usually have been and almost always will be recruited chiefly among the men who have trained their minds as well as their hands, and are thoroughly familiar with the practical and theoretical problems which constantly arise in every works. The young machinist who intends to continue in mechanical work needs now, and will more urgently need in the future, all the book knowledge he can acquire. A correct understanding of the principles of mathematics—the ability, for instance, to utilize trigonometry with as much facility and as effectively as a hammer or other tool, means increased usefulness and efficiency.

But does the man who devotes his spare time to study usually receive any adequate recompense? This question can certainly be answered in the affirmative. We do not mean necessarily that the week after a man demonstrates his increased value to his employer, it will be recognized by an increase in wages; but it is true that there are many opportunities in the mechanical field for the machinist with some technical training, where there is hardly one for the man who is unable to use his head as well as his hands—to say nothing of the satisfaction that is derived just from *knowing*. Diligence is usually rewarded, and we are sure that any machinist who will devote even a half hour each day during the coming year to careful reading on mechanical subjects, or to study, will find that it pays.

* * *

NOTES ON STRUCTURAL STEEL DETAILING FOR MECHANICAL DRAFTSMEN

By HARRY GWINNER*

It is the intention of the writer to give some notes on the detailing of structural steel, with the hope that they may prove of aid to the young mechanical draftsmen who have not as yet gone into the subject. The subject of structural steel detailing is a growing one, and in the near future every draftsman will be expected to have some knowledge of it.

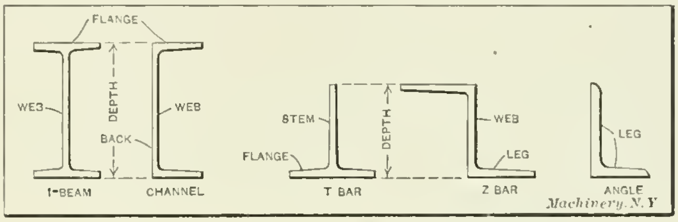

Fig. 1. Standard Shapes of Beams and their Names

By structural shapes are meant those shapes, in steel, which generally enter into construction work. Some of the standard shapes and their names are given in Fig. 1, and are designated as follows: I (Eye) Beam—Designation 12" I, 31.5#, means 12 inches deep, and weight per foot = 31.5 pounds. Channel—Designation 15" [33#, means 15 inches deep, and weight per foot = 33 pounds. T (Tee) Bar—Designation 3" x 3" x 6.8# T, means flange is 3 inches wide, stem is 3 inches deep and weight per foot is 6.8 pounds. Z (Zee) Bar—Designation 6" x ½" x ¾" Z means depth is 6 inches, flanges 3½ inches; and ¾ inch is the thickness of web and legs. Angle—Designation 4" x 3½" x ½", means one leg is 4 inches deep or wide, the other is 3½ inches wide, and the thickness of each is ½ inch.

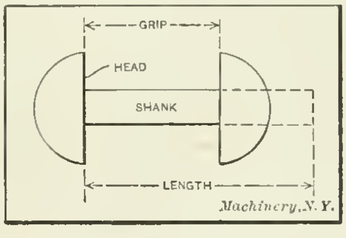

Fig. 2. Showing the Grip of a Button Head Rivet

These and a few other shapes with their properties or elements are given in the handbooks issued by the Cambria Steel Co., Carnegie Steel Co., Jones & Laughlin, Passaic Steel Co., and the Phoenix Iron Co., as well as the new book issued by the Bethlehem Steel Co. Some of these books are gratis while the others cost about one dollar each.

Rivets

The grip of a rivet, as shown in Fig. 2, is equal to the sum of the thicknesses of the pieces it is to join; but an additional amount, about 1/32 inch more for each piece, should be added to make allowance for the roughness of surfaces in contact.

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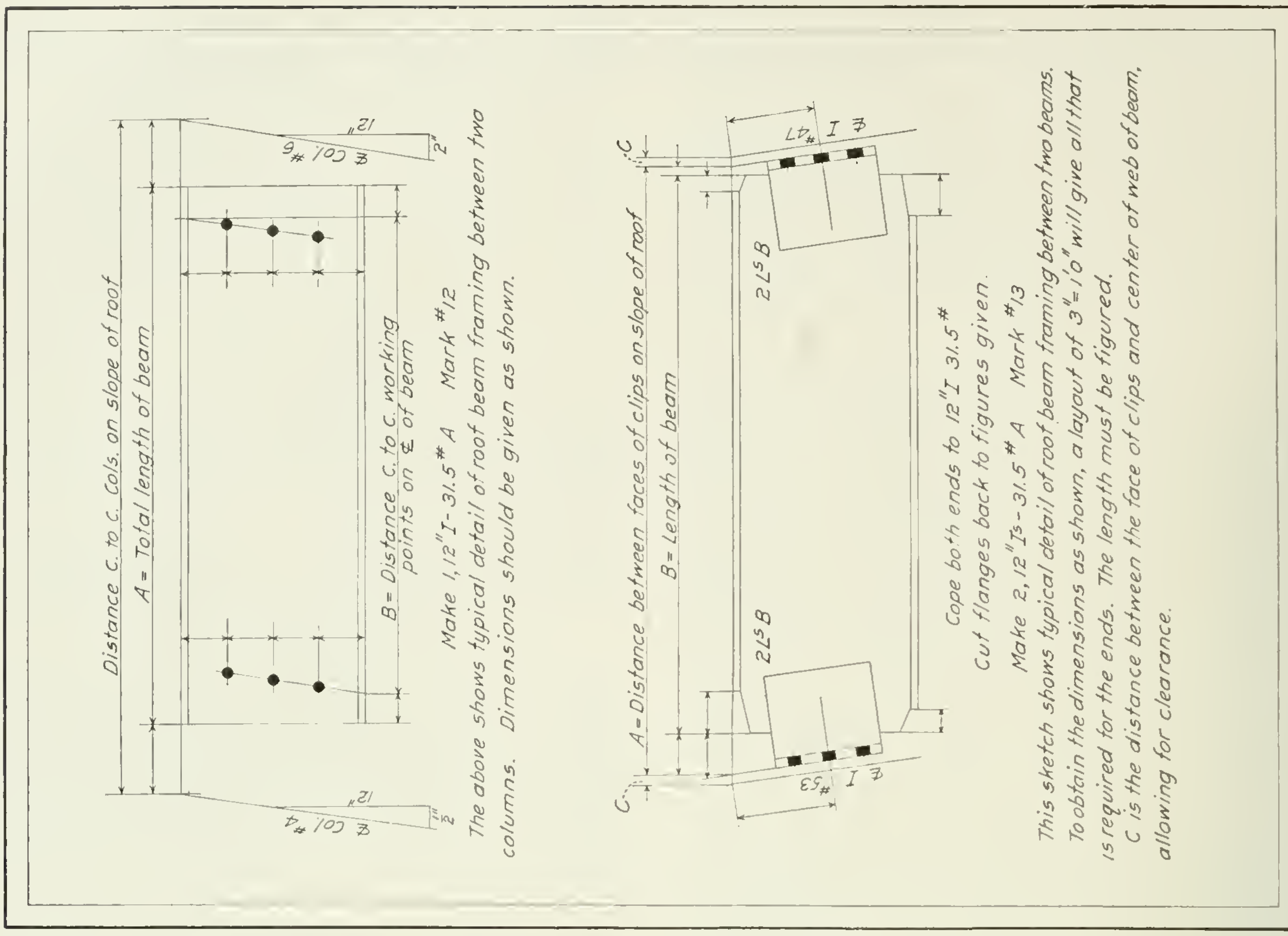


Fig. 4. Method of Detailing Roof Beam Framing

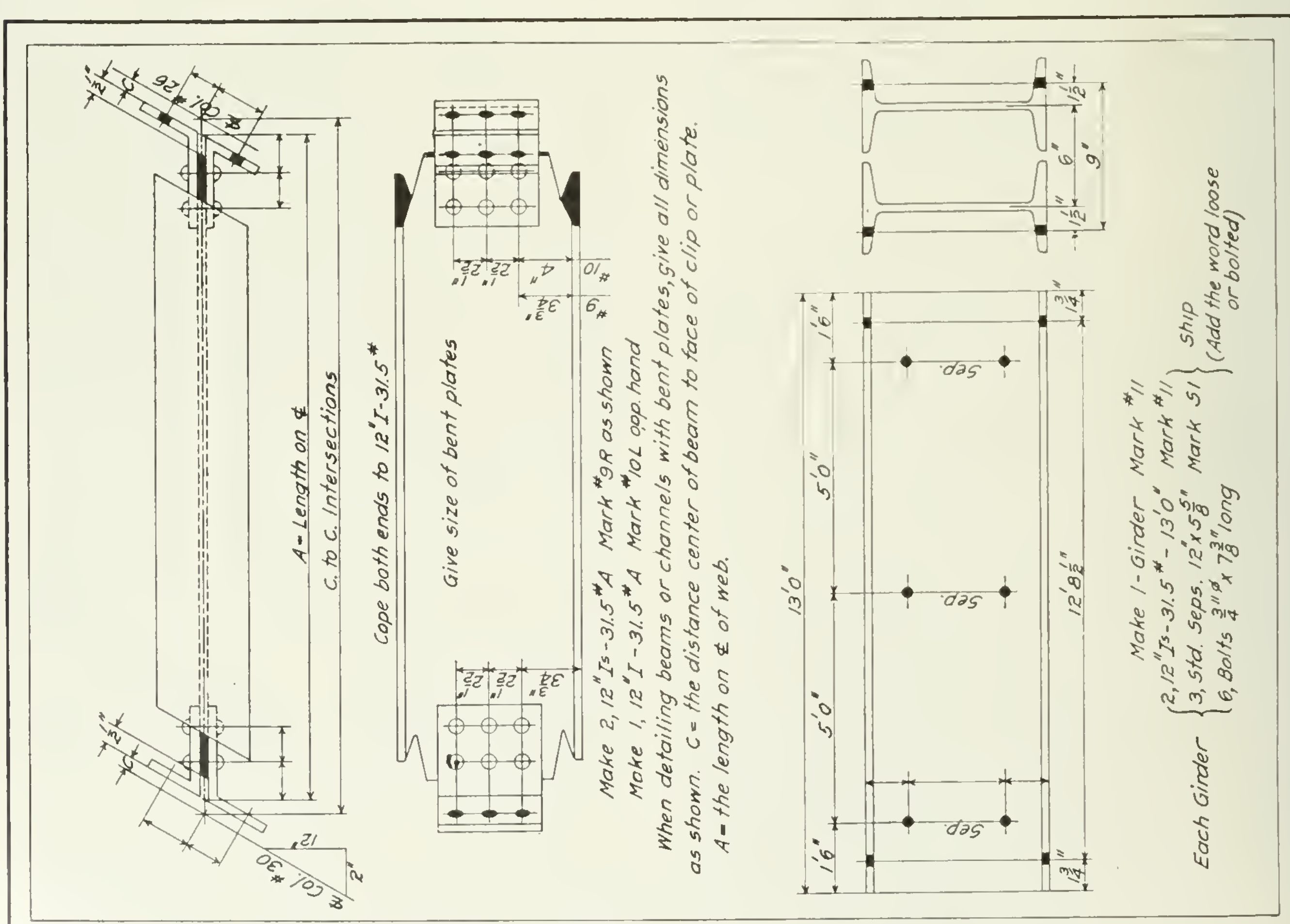
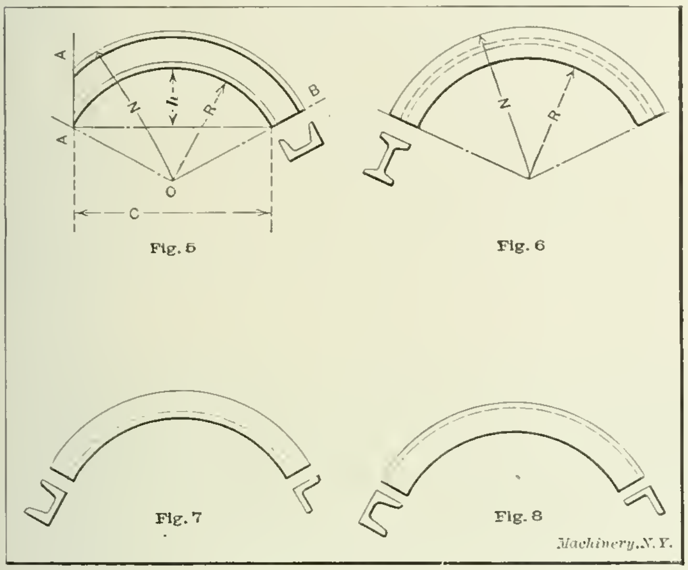


Fig. 3. Method of Detailing I-beam Work

The lengths for different grips to form the additional head, as well as the shearing and bearing values of rivets, are given in the above-named handbooks. By bearing, or bearing resistance, is meant the resistance of the rivet hole against elongation or crippling of the plate, causing it to buckle under the rivet head or crushing the rivet; it depends upon the safe unit compression stress and involves what is called the bearing area. The bearing value is then the product of the thickness of the plate, diameter of rivet and the safe unit compression stress as shown by the tables in the handbooks mentioned, under the heading of "Bearing Values of Rivets."

In testing or designing the joint for shearing and bearing, divide the total stress to be transmitted, by the smaller value,



Figs. 5 to 8. Methods of showing Curved Sections of Channels, I-beams, and Angles

to ascertain the number of rivets required. The handbooks give the allowable pitch for the different size rivets.

In compression members, the material cut away for the rivet holes is made good by the rivet filling the hole and resisting the squeezing of the metal on the sides bearing on the rivet; but such is not the case for tension members, as the amount of material cut away for the rivet hole is not made good, the stress being away from the hole on each side. It is important, therefore, to investigate the net section of tension members along the line of the rivet holes to see if there is sufficient metal in the net section to transmit the stress. In order to do this, it is necessary to determine whether one or more holes are to be deducted in ascertaining the net area. In the Data Sheets accompanying the article on "The Design of a Plate Girder" in the April, 1910, number of MACHINERY, engineering edition, are tables giving the net area after deducting one and two holes.

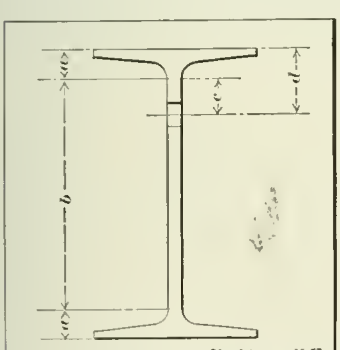


Fig. 9. Method of Spacing Rivet Holes to prevent Plates from encroaching on the Fillets and Slopes of Sections

Clearances for Rivets

The diameter of the rivet head is equal to 1½ times the diameters of the shank plus ⅛ inch; the depth or height of the head is equal to 0.6 of the diameter of shank and the radius of the head equals ¾ of the diameter of the shank.

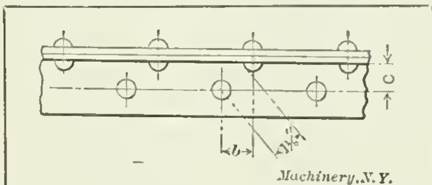
In general, in calculating for clearance for rivet heads, allow ⅝ inch for height of ¾-inch rivet heads, and ¾ inch for ⅞-inch rivet heads; also allow ⅜ inch clearance between the edge of the rivet head and any adjacent surface, to provide clearance for the heading tool. For ¾-inch and ⅞-inch rivets, allow if possible, 1¼ inch from the center of the rivet to the back of an adjacent surface at right angles.

Table I gives the clearances for the spacing of rivets and shows an angle section with one row of holes in one leg. The minimum spacing or staggering for two lines of rivets in one leg is given in the handbook issued by the Bethlehem Steel Co., page 258.

Beams

The four Data Sheets accompanying this article, and also Figs. 3 to 8 inclusive, give the method of detailing beams adopted by one concern which does a large amount of bridge and building work, and are very complete. They illustrate good practice and serve as excellent examples of beam detailing for rapid execution in the shop and checking in the drafting-room.

TABLE I. CLEARANCE BETWEEN RIVET HEADS FOR ANGLE SECTION HAVING ONE ROW OF HOLES IN ONE LEG

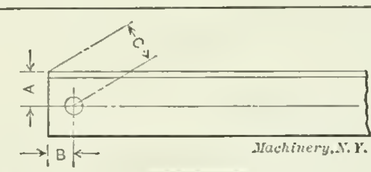


c	¾-inch Diam. b	⅞-inch Diam. b
1 1/8	1 1/4	1 3/8
1 3/16	1 3/16	1 5/16
1 1/4	1 1/8	1 1/4
1 5/16	1 1/16	1 3/16
1 3/8	15/16	1 1/8
1 7/16	7/8	1
1 1/2	3/4	15/16
1 9/16	5/8	13/16
1 5/8	3/8	11/16
1 11/16	0	1/2
1 3/4	0	5/16

Figs. 5 to 8 inclusive show methods of detailing curved sections of channels, I-beams and angles. When detailing the above sections the following method should be used: Give the length C and either N or R, and also state whether the ends are to be cut square to the chord, as to the line A-A, or whether they are to be cut radial, as to the line O-B. It should also be stated whether the web of the beam should be in a horizontal plane as shown in Fig. 5, or in a vertical plane as in Fig. 6.

In the case of channels or angles, state whether the web or leg is to be on the inside as shown in Fig. 7, or on the outside as shown in Fig. 8; and in the case of unequal leg angles, state which leg is to be vertical to the curve.

TABLE II. DISTANCE C FOR VARIOUS GAGES AND END DISTANCES



Gage A	End Distance B 1⅛-inch	1¼-inch	1½-inch	1¾-inch
3/4	1 3/8	1 1/2	1 11/16	1 15/16
7/8	1 7/16	1 9/16	1 3/4	2
1	1 1/2	1 5/8	1 13/16	2 1/16
1 1/8	1 5/8	1 11/16	1 7/8	2 1/8
1 1/4	1 11/16	1 13/16	1 15/16	2 3/16
1 3/8	1 13/16	1 7/8	2 1/16	2 1/4
1 1/2	1 7/8	2	2 1/8	2 5/16
1 3/4	2 1/8	2 3/16	2 5/16	2 1/2
2	2 5/16	2 3/8	2 1/2	2 11/16
2 1/4	2 9/16	2 9/16	2 3/4	2 7/8
2 1/2	2 3/4	2 13/16	2 15/16	3 1/16
3	3 1/4	3 1/4	3 3/8	3 1/2

The splicing of beams has already been excellently handled in the November, 1909, issue of MACHINERY.

It will not be amiss to call the reader's attention to the following points relative to all sections, as the writer has seen work rejected by inspectors more than once because plates and rivets have encroached on the fillets and slopes of sections. Observe notes relative to this typical section, as shown in Fig. 9.

The dimensions a and b are given in the handbooks—the distance b should not be exceeded in using splice plates, as the

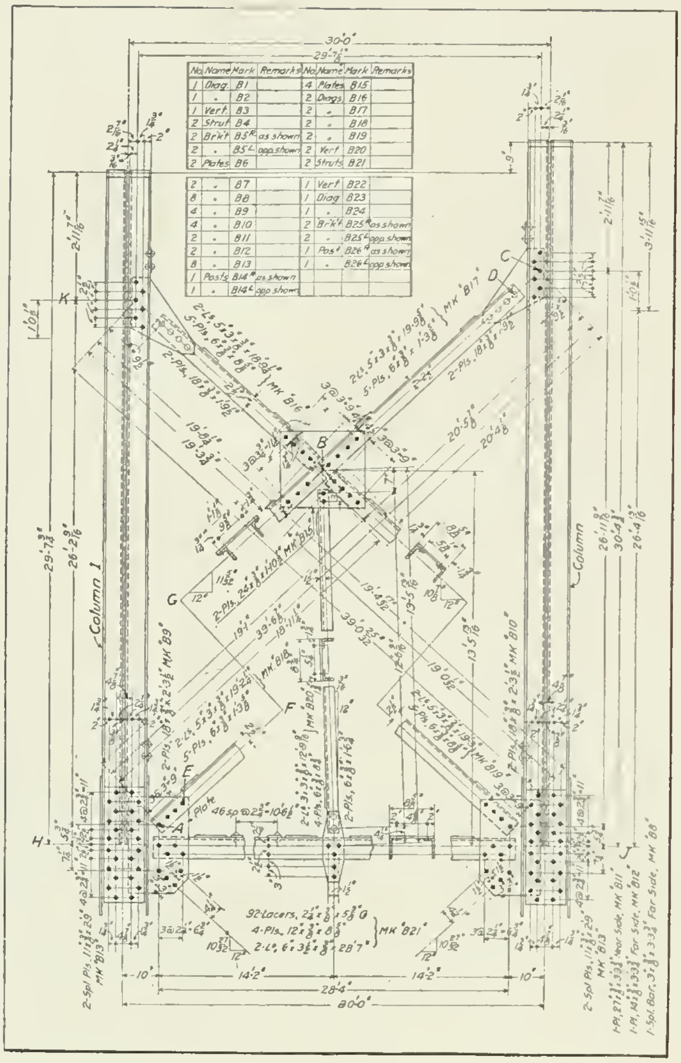


Fig. 10. Complete Shop Drawing of Trestle for Supporting Pipe Work

Assembled Details

In Fig. 10 is a complete shop drawing of a portion of a bent or trestle for supporting some heavy pipe work. It illustrates a method quite often used for detailing and is designated as the "chain" or "link" method of detailing. It is quite ingenious and enables one to make details of members in a small space to a comparatively large scale.

It will be noticed that the line *AC* is a broken or "chained" line and that *CG* is drawn to the proper slope or bevel as is also *AF*. The dimension *AC* is a calculated one, while dimensions *CD* and *AE* are determined by drawing in the rivet spacing according to the spacing given in the handbooks. This will enable us to decide upon the proper size of plates, and also to locate correctly the end of the members *AB* and *BD*. By adding ¼ inch for clearance between the columns and the ends *A* and *D* to distance *C*, as given in Table 11, we will be enabled to locate rivets *A* and *D* in Fig. 10 and provide sufficient metal at the ends of *AB* and *BD* as shown. The details are drawn to a scale of one inch to one foot, while no regard has been paid to scaling *H J* or *H K*, these being placed at sufficient distances apart to enable the details to be drawn in at a suitable working scale.

Fig. 11 is a complete shop drawing of one-half of a steel roof truss of a knee braced mill or factory building suitable for a machine shop, and is more fully detailed than is customary; the details were put on to make every point clear to a class in structural design as it was intended to have the pupils construct it in the shop attached to the college.

It will be observed that some of the web members, as *Q R*, have what are called clip angles attached to them. There are

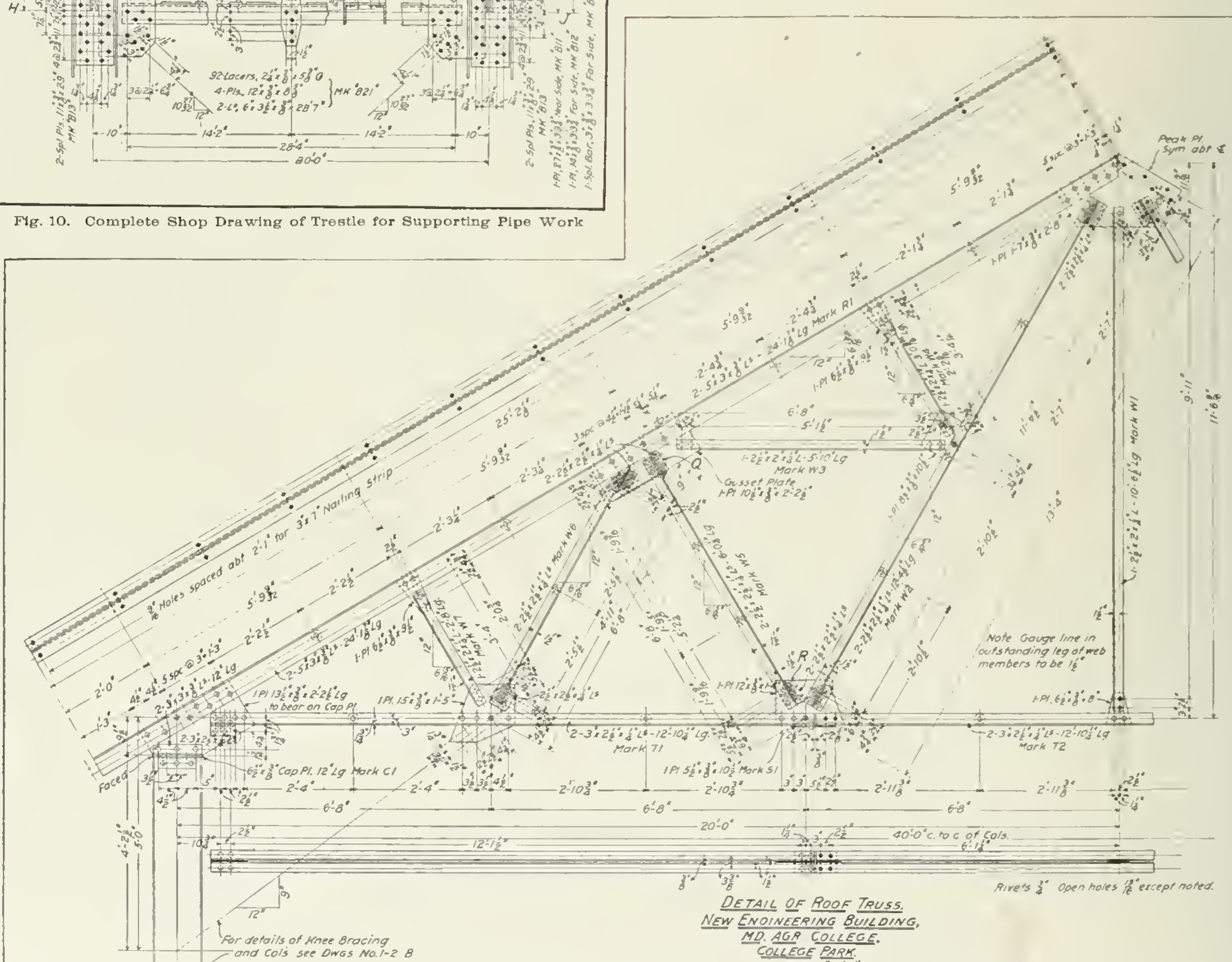


Fig. 11. Complete Shop Drawing showing One-half of a Steel Roof Truss

plates will ride the fillet and fail to fit properly, unless the plate edge is ground to fit the fillet, which is sometimes done. The distance *d* should be taken so that the center of the hole from the fillet as given by the distance *c* is not less than 1½ times the diameter of the rivet.

two objects in this—one is to dispense with such a wide gusset plate, and the other is that some engineers will allow only one leg of an angle to be counted as effective unless both legs are in some manner connected with the gusset plates.

The writer has observed that very little attention is given

to the thickness of gusset plates and that the favorite thickness appears to be ¼ inch and 5/16 inch. Except in very light trusses, economy and efficiency demand thicker plates than these sizes. A safe guide in this respect is to use a plate having such thickness that the bearing of the rivet on the plate is approximately equal to the rivet in double shear. The result of this will be to reduce the number of rivets and also the size of the plate.

Conclusion

In closing this article, the writer cautions against putting any joints in structural work under eccentric stresses; but when this is unavoidable, such cases may be handled as shown in the May and August, 1910, issues of MACHINERY, engineering edition, pages 739 and 980.

* * *

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—5

THE BRADFORD MACHINE TOOL CO.

By ETHAN VIALL*

Extreme care and accuracy are the watchwords of every one in the shop of the Bradford Machine Tool Co., from the superintendent down to the newest apprentice. Most of the men and foremen have been taught and trained in the shop by Superintendent Johnson and the "pull" is one great "all together."

Realizing to its fullest extent the importance of knowing what his competitors are doing, as well as other machine tool builders in allied lines, Mr. Johnson has a very convenient and complete catalogue filing case, Fig. 1, within easy reach of his desk. A supplementary card index shown at the left is also used in connection with the cabinet. Cases or glass frames in which are placed lists of employes and their clock numbers are shown in Fig. 2. The list is ruled into four columns: The first column contains the name; the second, the number; the third, the occupation; and the fourth, the name of the foreman in whose department the man works. A feature of the list is that while the entries in the last three columns are fixed, the names of the men may be easily changed, as they are written on slips of cardboard and inserted so that the name shows through a slot in the mat.

An exceedingly convenient and safe holder for rolls of blue printing paper is shown in Figs. 3 and 4. A roll is placed in the dark-box with the edge sticking out under the metal strip and any amount may be pulled out and torn off without exposing the rest. A view of the dark-box, open, is shown in Fig. 4.

One of the very important points of a lathe is the accuracy of the lead-screw, and Bradford lead-screws are guaranteed to be within exceedingly narrow limits. The lathe on which the lead-screws are cut is a specially-built machine with a thirty-two foot bed, and extreme care is taken to keep it in perfect condition. A view of the half of the machine next to the head is given in Fig. 5, and a view of the middle section, including the carriage and follow-rests, in Fig. 6. In roughing out, two tools are used and as Fig. 5 shows, the driving spindle has an adjustable extension on it, so that when short lead-screws are being cut they may be set at any part of the bed and the wear does not necessarily come all on one section of the lead-screw and bed as would otherwise be the case. A master screw, made by Pratt & Whitney especially for cutting the working lead-screws, is attached to the back of the lathe in such a way as to be easily geared to the spindle and it drives the tool carriage from the back. When not in use, the master screw is kept covered with sheet metal guards. Fig. 7 shows a section of the master screw in position, with some of the metal guards removed.

Great care is taken to perfectly balance the driving cones, and in order to get good results, the cones are machined both inside and out. The boring-bar used to turn the inside of the cones may be interesting and is shown in Fig. 8. The bar is held in carriage bracket A, in which it may be set to any position by loosening the cap-screws B. Bracket C is a guide and steady-rest for the bar and it may be moved along the bed and clamped in any position. This bracket has a cross-slide which permits a cross movement of the carriage, and the bar is not locked but is allowed to slide in the pillow-block. Previous to boring, the cones are roughed off on the outside with a gang of tools, as shown in Fig. 9.

Fig. 1. Catalogue Filing Case

Fig. 2. List of Employes giving Occupations and Names of Foremen

Figs. 3 and 4. Blueprint Roll-holder, Closed and Open

The spacing steps for the change-gear lever are milled as shown in Fig. 10, the end mill used having a special geared extension head A, which makes it possible to reach the spots to be milled without extending the shank of the mill so much as to make it springy. The gear box is held in a fixture so made that the box may be revolved on the axis of the gear shaft in order to keep the milled surface of each spot radial. The back of this fixture is shown in Fig. 11, B being the handle that revolves the gear box, a graduated collar giving the proper radius. In using this arrangement, the end mill is set to the proper height above the table by means of the height gage C. After the first spot is milled, the radial distance is measured by turning the handle B a certain number of thousandths, and the horizontal spacing is accomplished by using the set of plugs D, on the cross-slide, as at E.

Circular T-slots for compound rests are cut in a lathe fitted with a turret, the slotting tools being set into adjustable holders as shown in Fig. 12. An enlarged view of one of these holders is shown in Fig. 13. The first circular slot is cut by the tools A and B. Tool A is notched to break the chip, and

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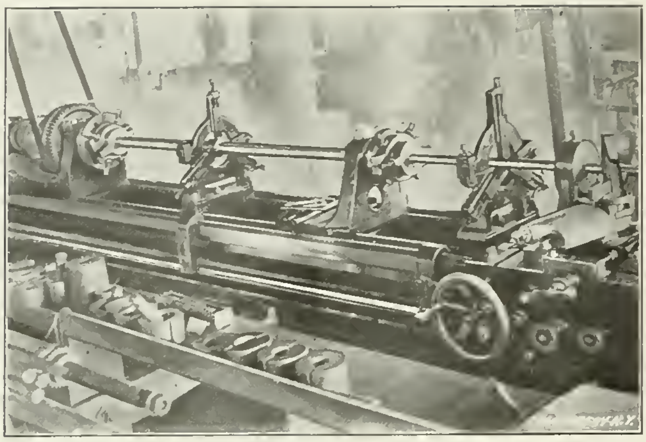

Fig. 5. One End of the Lead-screw Lathe—Note Extension Driving Head

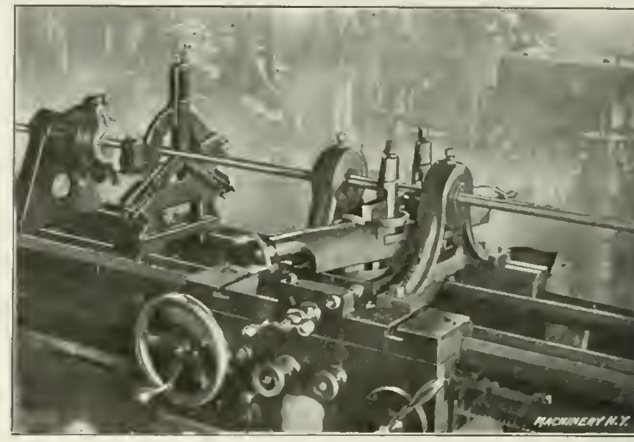

Fig 6. View of Lead-screw Lathe Carriage

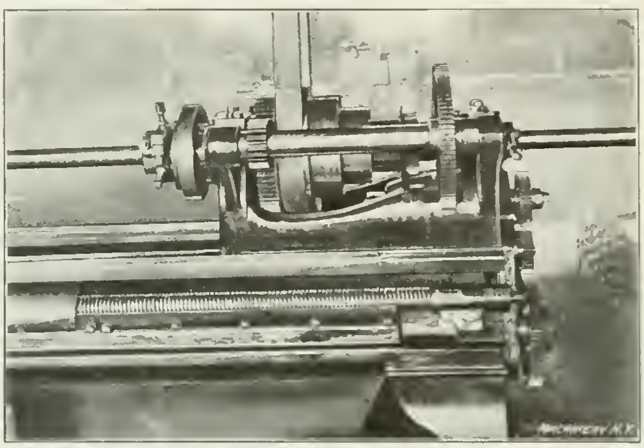

Fig. 7. Rear View of Lead-screw Lathe showing Master Lead-screw

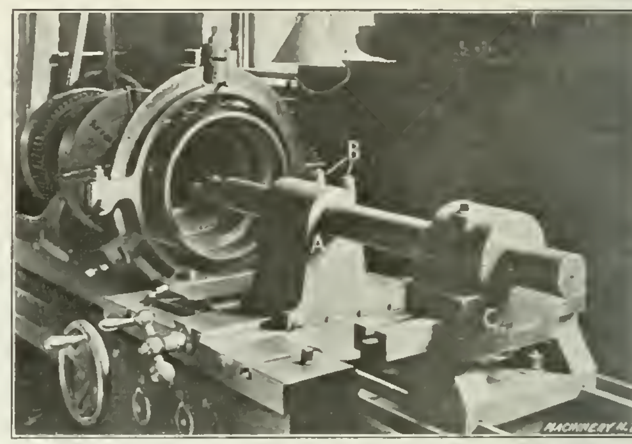

Fig. 8. Equipment for Boring the Inside of Cone Pulleys

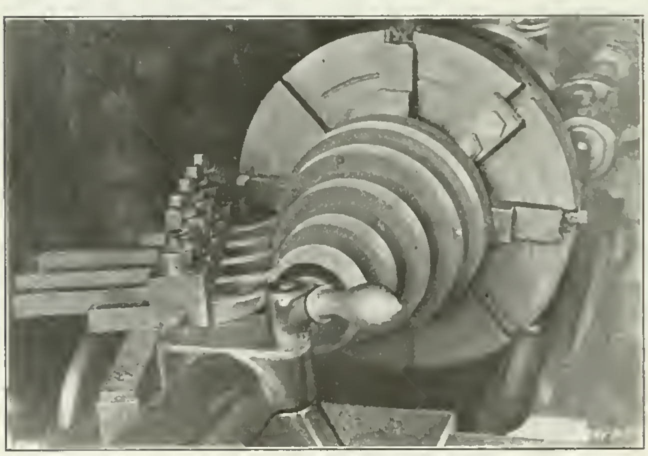

Fig. 9. Turning the Outside of a Cone Pulley with Gang Tools

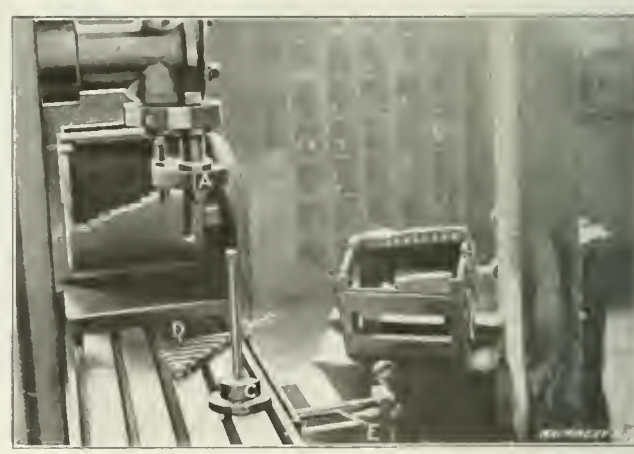

Fig. 10. Fixture, Extension Mill and Plugs used in Machining the Lever Steps of Change-gear Box

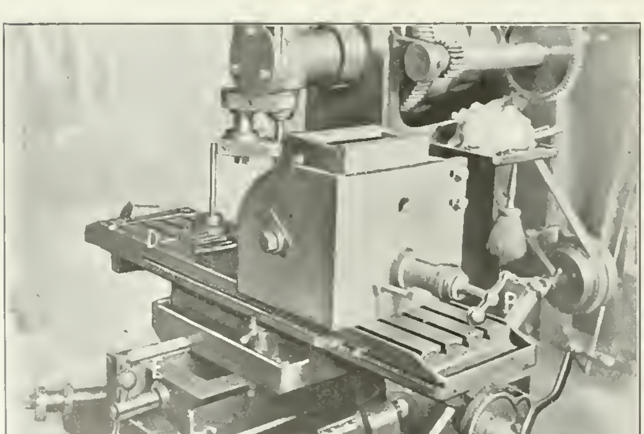

Fig. 11. Another View of Change-gear Box Milling Fixture

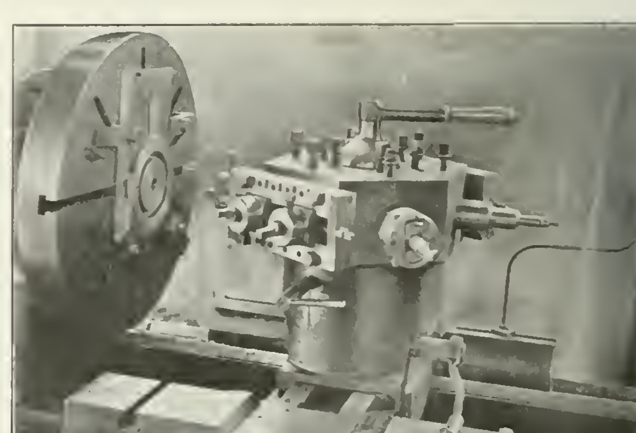

Fig. 12. Method of Cutting Circular T-slots

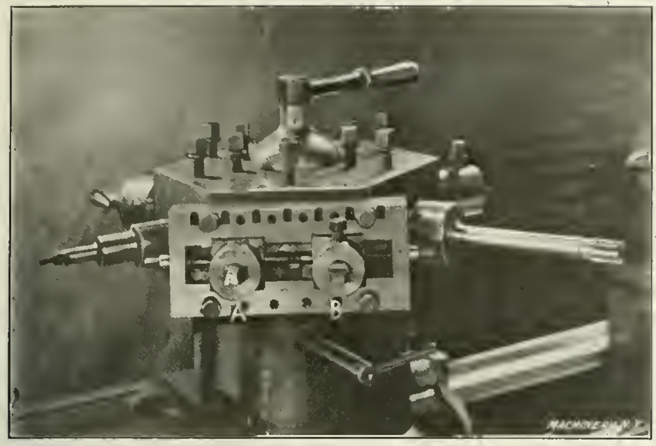

Fig. 13. Detail View of Adjustable Tool-holder used for Cutting Circular T-slots

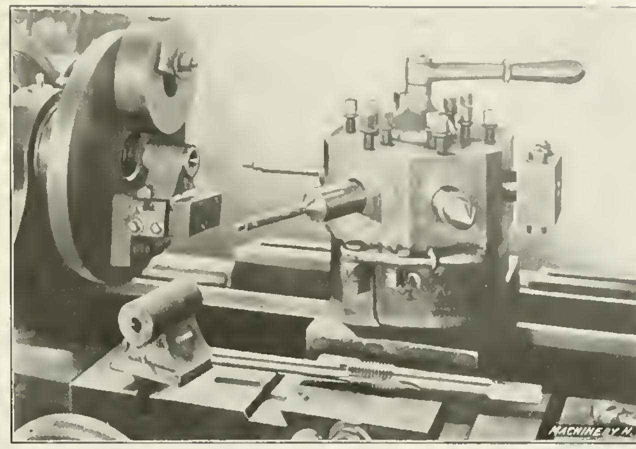

Fig. 14. Fixture and Tools used for Drilling, Boring and Tapping Apron Half-nuts

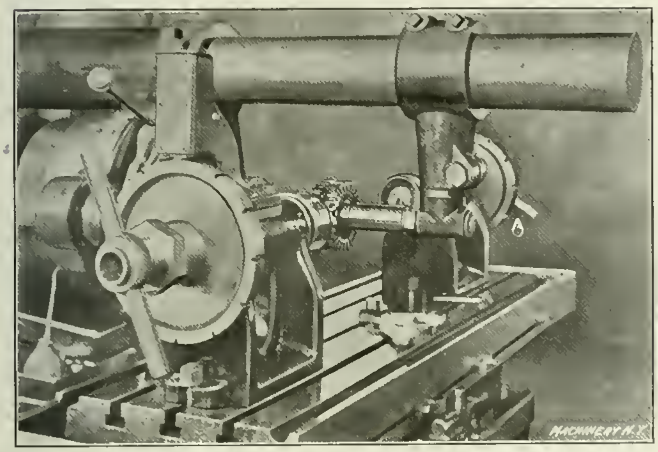

Fig. 15. Indexing Fixtures for Milling Bolt-heads

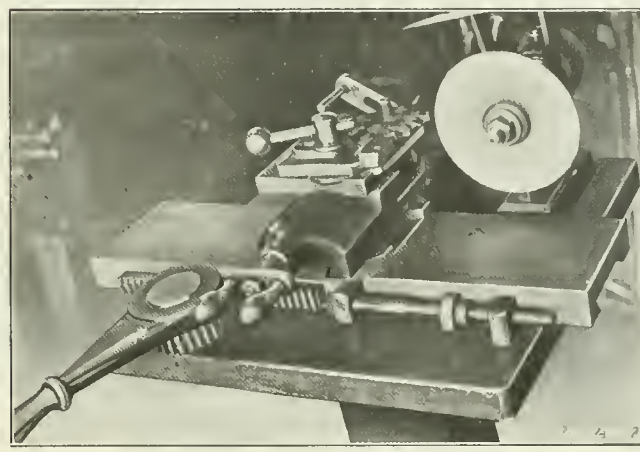

Fig. 16. Gear-cutter Grinding Fixture

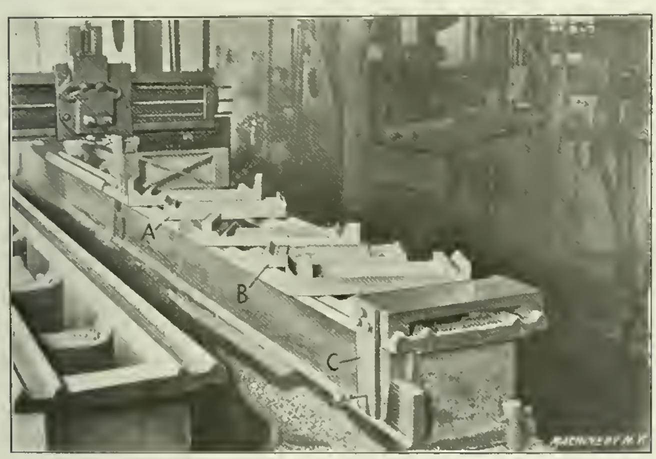

Fig. 17. Templets or Gages for Bed V's

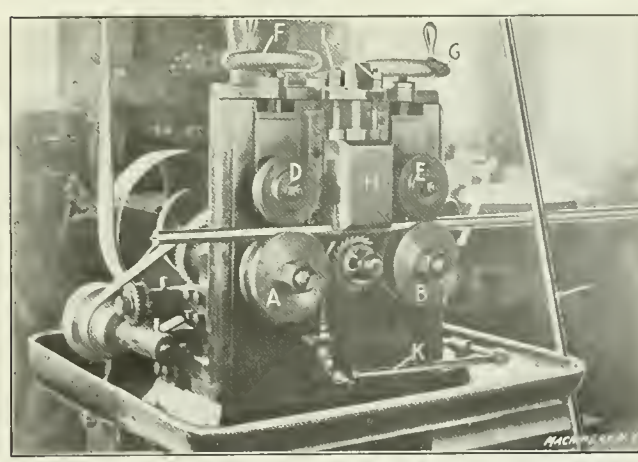

Fig. 18. Special Machine for Milling Splines in Lead-screws

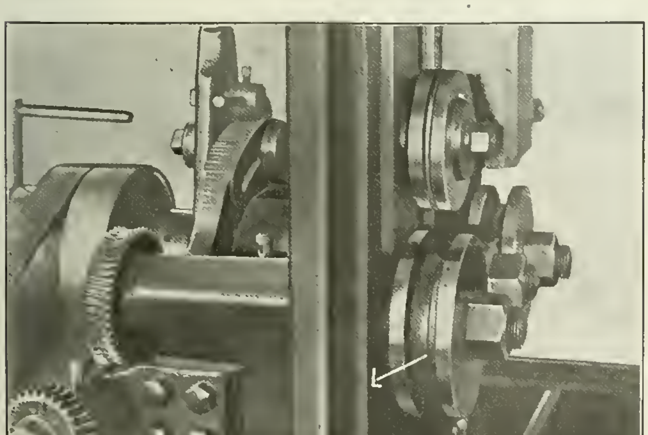

Fig. 19. Detail View showing Feeding Guide-rolls of Spline Miller

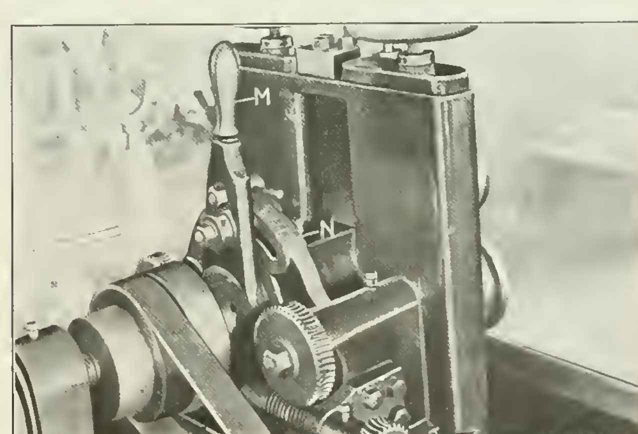

Fig. 20. Rear View of the Spline Miller

tool B cuts out the ridge left by the notch. After the circular slot has been cut to the right depth, the T is worked out by two L-shaped cutters in another holder in the turret (similar to the one shown) which are fed in by moving the turret along the cross-slide, after which the turret is brought back and located in a central position by the aid of a latch pin.

Apron half-nuts are drilled, bored and tapped while held as shown in Fig. 14, after which they are split in a milling machine.

Squares on bolt heads are milled with straddle mills while the bolts are held in the fixtures shown in Fig. 15, the spindle of which is fitted with a draw-in collet. Two of the indexing fixtures are used, one on each end of the table, so that work may be removed and inserted in one while the cut is being taken on the work in the other. Large indexing plates with twelve divisions are used, giving steadiness and accuracy and making them available for several classes of work.

Fig. 16 shows the gear-cutter grinding attachment used in the shop, and Fig. 17 shows the gages or templets used on the V's of the lathe beds. Gages A and B are of the half-V type, while C is a gage used to measure the height of a boss in relation to the position of the V's.

The long keyways or splines in lead-screws are cut in the special machine shown in Fig. 18. Rollers A and B are for feeding; C is the cutter; D and E are pressure rollers that are adjusted by the hand-wheels F and G; H is a steady-rest for the cutter and is also adjusted by a hand-wheel, stops being provided at I and J; and K is the pipe which carries oil to the cutter. The shaft being cut is kept from twisting as it feeds along by a circular guide key L, Fig. 19, which fits the milled keyway. Fig. 20 is a rear view showing the way the feed rollers are driven. In this engraving M is the handle used to feed in the cutter, the part N being graduated to show the depth of the cut.

* * *

ETCHING BRASS NAME PLATES HAVING BLACK BACKGROUNDS

The etching of brass name plates is a process of recent years which has succeeded in driving out the cast bronze or brass name plates to a great extent, on account of its cheapness. The etched plate can also be used in many cases where a cast plate would not do. The ordinary etched brass name plate as now made, is produced by coating a flat and polished sheet of brass with a thin layer of bichromated albumen, and by exposing it to the light for a few minutes under a glass negative upon which are a number of the desired name plate designs. The brass plate is then developed, which removes the albumen not exposed to the light (or that protected by the black portions of the negative) and leaves the brass free to be etched. The etching solution will not attack the parts protected by the albumen (or "resist," as it is called). Another way is to transfer a design to the brass from a master plate, or to use other materials, as for example, asphalt, for the resist. The ultimate effect in all cases is the same.

The etching is done by means of a solution of perchlorate of iron or by making the anode in an acid copper solution. When the required depth has been obtained, the sheet containing the number of name plates thus etched is washed, and, without removing the resist, it is treated in some manner to produce a black background. When this has been done, the resist is removed and the sheet is cut up to produce the individual plates, after which each plate is lacquered and is then ready to be sent to the customer.

After the brass plate containing the name plates has been etched the resist is allowed to remain on it. If the etched surface is tarnished, as it usually is when standing in the air after etching and drying, a solution made of 2 parts of water and 1 part of muriatic acid is spread over the surface which will immediately remove any stains and leave the etched surface clean and uniform. The plate should then be rinsed, but not dried, and the operation of producing the background should begin immediately. If allowed to dry stains will again appear.

Producing a Black Background

Three methods are in use for producing a black background on etched brass name plates; but whatever method is used, the preliminary operation of etching is the same. The methods in use for making the black background are as follows:

Black Nickel

The use of a black nickel deposit is the best method of producing a black color on the etched name plate. The solution does not affect any of the various kinds of resist used and a large number of plates can be treated in the tank at one time. The solution that is used is the well known black-nickel bath and is made as follows:

Water	1 gallon
Double-nickel salts	8 oz.
Ammonium sulphocyanate	2 oz.
Zinc sulphate	1 oz.

The solution is used cold with a weak current. The best results are obtained when a current of about 1 volt tension is used. If a greater voltage is used, the deposit will be streaked and gray. It will also become gray if the solution is too weak. As soon as the deposit is black, remove the plates, rinse, dry and cut them to the desired sizes, after which they should be lacquered immediately, in order to prevent the brownish discoloration which forms on the surface of the deposit after standing some time. As previously mentioned, black nickel is the most satisfactory black background for the name plates. It can be used on metals such as yellow brass, copper, bronze, etc.

Oxidized Acid Copper Deposit

An excellent method of producing a black background is to first give the etched plate a deposit in an acid copper solution and then oxidize in liver of sulphur. The acid copper solution is made as follows:

Water	1 gallon
Copper sulphate	2 lbs.
Sulphuric acid	1 oz. (fluid)

The etched plate is allowed to remain in the solution until a good copper deposit is produced on the background. This takes from 15 to 20 minutes, when a current with a tension of about 1 to 2 volts is used. The deposit gives a red and matt surface. The plate should then be removed, rinsed and oxidized immediately in the following solution:

Water	1 gallon
Liver of sulphur	2 oz.

This liver of sulphur solution should be used cold, and it will not act upon the resist. It is used as a dip and not with the current. A minute or two is required to produce the desired color, when the plate should be rinsed and dried. The color is a good black and as the copper deposit is matt or "dead," it is quite pleasing for many classes of work.

Ammonia Black

The ammonia black (so-called) is produced by oxidizing the name plates in a solution of copper carbonate in ammonia water. It is used as a dip, and it is not as easily done as the other methods previously mentioned. It must be done in a warm solution in order to obtain a good color and this is apt to attack some resists; in fact, not all resists will stand it. To use this method the following solution is made up:

Water	1 gallon
Strong ammonia water	1 gallon
Copper carbonate	an excess

By the word "excess" is meant that as much copper carbonate should be dissolved in the solution as can be taken up, and yet have a slight amount remain undissolved. Unless there is a slight amount undissolved, the dip will not work well. The solution then has a blue color with a green sediment in it.

In order to produce the black on the plates, they are dipped into it while warm. It has been found that while the solution will produce a color on the plates when cold, it is not uniform or black, but slightly brown, although it may be used for some classes of work. The solution will begin to work well when a temperature of about 120 degrees F. is obtained. It works better and more rapidly, of course, when a higher temperature is employed, about 160 or 170 degrees F. generally giving good results. This heat, however, is apt to melt the resist and a lower one is recommended. The dip is used in an earthenware jar surrounded with warm water.—*Brass World.*

A SYSTEMATIC SCRAP-BOOK

By R. E. ASHLEY*

A pile of technical publications, each one preserved because of perhaps but one article, and that only half a column in length, drawers and boxes full of clippings, blueprints, drawings, sketches, leaves and tables from old text-books and catalogues—this was the state of affairs which the writer found after some fifteen years in the engineering profession. This, also, is the condition of the accumulations of information and reference matter of hundreds of other engineers, and men of similar professions. Almost any one knows what it means to look for a particular reference, article, or information pertaining to a certain subject, among such a conglomerate mass of scraps. One can hardly pick up a technical publication without finding therein some article pertaining to his particular branch of the profession, or to a branch so closely allied that he feels the article is worth saving, and straightway proceeds to cut it out and lay it away in a box or drawer with years' accumulations of like scraps. Every engineer the writer has come in contact with has recognized the importance, yes, one might say, the necessity of saving those articles and papers which come to him from various sources.

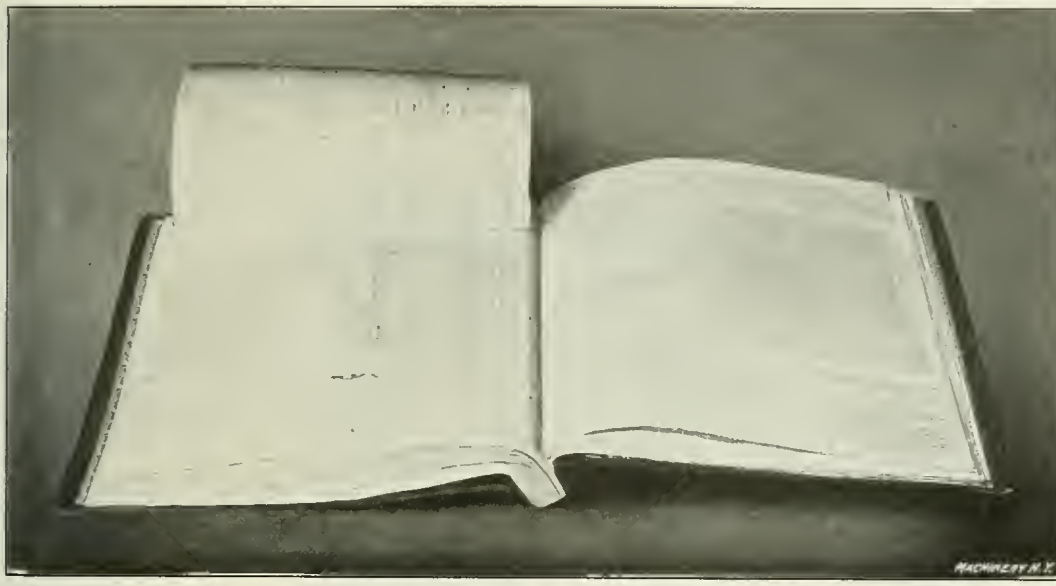

Fig. 1. Scrap-book for Holding Clippings

Fig. 2. Scrap-book for Holding Drawings, Prints and Sketches

The question of how to care for these scraps, arrange them in some systematic order, and index them so that any article or reference can readily be found when wanted, has always been a perplexing one. A great many have tried pasting them in an ordinary scrap-book, but this has never proved satisfactory, and in most cases is abandoned after a short trial. One of the former greatest objections to this method of keeping a scrap-book, was the inability to keep it properly indexed. Usually a book of considerable size was employed, and it was impossible to index the book in a satisfactory manner until the book was full. This meant that it might be two or three years that the scrap-book would have to be used without an index, making it necessary to look through it from beginning to end until the clipping or article sought was found. Those who tried to index the book as they went along, soon gave up in despair for they found that no matter how carefully and systematically they started out, sooner or later they found it necessary to index an article where not enough space had been left to enter the subject in its proper place. This meant that the index of any particular scrap-book soon became little more than a list of the clippings contained in it, and that it was nearly as easy to look through the book in the first place as it was to attempt to find the required articles in the index. Another objection to the scrap-books was that they were seldom large enough to accommodate articles which included several pages from large-sized publications.

The development of the loose leaf systems—books that can be made any size, both as to page and thickness—and the card index system, each with its unlimited expansibility, now make it possible for an engineer to take care of his clippings and miscellaneous information where it would not have been possible before the advent of these systems. The writer has recently completed the work of compiling, classifying and indexing his "scrap file," and it has proved so satisfactory that this article is written in the hope that it may help some one who is experiencing the same trouble and annoyance that the writer did before employing the methods about to be described.

In looking about for the most convenient forms and those that would be most likely to prove satisfactory and fulfill all conditions, the writer found it necessary to recognize the fact

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that before the "scrap file" could be satisfactorily taken care of, it must be divided into three classes:

1. That consisting of clippings which could be pasted in a book without altering them in any way.

2. That consisting of drawings, prints and sketches, which, because of their size, would be too bulky to put in a book with the clippings.

3. That which came to him in such a form that it had to be transposed or worked over before being applicable to his line of work; also that obtained in the solution of his daily problems.

To take care of the first class the writer ordered a 16 x 13 inch loose leaf flexible-covered binder, and a number of blank white sheets of heavy bond paper. On these sheets the articles were pasted in the most convenient manner, care being taken to so arrange them that the entire page could be utilized. Those articles which were printed on one side of the paper only, were trimmed and pasted in columns corresponding to the regular arrangement of a two or three column page. To do this it was often necessary to divide the article, cutting between the lines of printing as might be necessary to fill out the columns in the scrap-book. Lengthy articles which consisted of several pages of a publication were pasted on one edge only, so that both sides of the clipping would be accessible. In the case of such articles, either an entire leaf was utilized, or else one article would be pasted at the top of one page and another at the bottom on the opposite side of the leaf, in this manner building the book up evenly. Necessary fillers, of the same material as the pages, but only one inch wide, were employed in the binding to build to the thickness of the pages. No attempt was made to arrange different articles pertaining to the same subject on the same or adjacent pages, the size of the article being the only factor determining its position in the book. With a little planning it was found possible to arrange the articles in a neat manner and with little or no loss of space. Fig. 1 shows the loose leaf scrap-book in which articles of the first class are kept. On the right-hand page are shown articles pasted fully on the sheet, while the left-hand page shows the longer articles, each comprising several pages of a publication, the pages being pasted on one edge, leaving both sides available.

To take care of the second class, a cover the same as above described was used. The manufacturers of the covers furnished binding strips consisting of two pieces of cloth $1\frac{1}{2}$ inch wide, having a paper filler 1 inch wide, all being flush on the back edge. The inside of both pieces of the cloth, on the inner edge, was gummed so that by moistening it the edge of a print or drawing could be inserted and secured to the binder. The sheets were then folded to exactly 16 x 13 inches, the book in this manner being built up as true as any loose leaf book. The binder in this case served as a filler. Fig. 2 shows the loose leaf book for taking care of Class 2 and illustrates how well it is adapted to hold any sized drawing.

Fig. 3. Scrap-book for Holding Revised Matter and Solutions of Daily Problems

For the third class two flexible loose leaf covers were used, one $7\frac{1}{2}$ x $4\frac{1}{2}$ inches and the other 9 x 6 inches. Leaves for both books were procured from a local printer with the border lines printed on both sides. This saved ruling them by hand, and was a help in squaring work on the page. The small book was used for preserving tables, formulas, etc., collected from various sources or worked out by the writer in the execution of his regular duties, and the volume is intended to become a pocket- or hand-book which every engineer should compile for himself, containing that information most often used by him, and arranged with special adaptation to his own particular line of work. The larger book was used for preserving the more extensive computations, forming complete records of the calculations, step by step, of the design of a machine, or for instance a frame mill building as the illustration shows. The work in both books, thus far, has been put in by hand, although a typewriter could easily be used as each sheet is completed before being put into the book, after which the pages are given their proper number. A thin strong paper is used which will take ink readily, stand erasing, and from which, when India ink is used, blueprints can be made where but one side of the leaf has been used. Fig. 3 shows the two books in which information in Class 3 is entered.

The leaves for the different books were obtained, and then cut to size. Holes were then punched to the proper gage by a tool purchased for that purpose, and which can be obtained from any manufacturer of loose leaf outfits. This method of binding proved to be so easy and satisfactory, that it occurred to the writer that he might become his own book binder. He had the numbers of a technical magazine covering several years, which were scheduled to be bound, some time in the future, in the usual manner. Instead of binding, however, several stiff loose leaf binders of the correct size were ordered, the magazines taken apart, advertising matter discarded, and the balance punched and filed in the binder according to volume and page number. Each magazine as soon as received, read, and indexed is punched and put in the binder. In this way there are no loose numbers lying about—each one being in its place. The covers are bound in black leather, the name of the publication appears on the back in gold, and the covers as they stand in the case have every appearance of being so many volumes of a standard set of books. Each binder has a minimum capacity of two years, and a maximum of four. The cost per volume is considerably less than if bound in the usual solid form.

In compiling the index much time was spent at first, in considering just what would be required to make it complete and yet simple, so that the keeping up to date would not become burdensome. It was realized that the success and practicability of the index depended largely upon the subjects, and sub-headings into which it should be divided, and the extent to which the sub-headings should be carried was a question. However, as it afterwards proved, this matter worked itself out satisfactorily as the index was built up. The subjects chosen under which the index was divided were: manufactures, materials, machinery, boilers and accessories, fuel, hoisting machinery, laying-out problems, pneumatic, engines, structural, tanks, towers, pipe, electrical and miscellaneous. The subject machinery has twenty-six sub-headings such as stresses, shafts, couplings, flywheels, etc.; boilers and accessories has twenty-one, such as water-tube, fire-tube, vertical, in-

ternal fired, feed water, furnace, joints, draft, etc.; and all other subjects have sub-headings, the number depending upon the importance of the subject and the extent to which they would simplify the index. In addition, each subject has its alphabetical index for miscellaneous articles which would not come under any of the sub-headings.

The regular 3 x 5 inch index card was used, and filed in a two-drawer cabinet. Each subject has its distinctive color as far as possible, and where it is necessary to use the same color of card for two subjects, they are so widely separated that there is no danger of confusion. Each card, besides having its identifying color, has the subject written at the top, so that should the index become "pied" (such a condition is not an impossibility) it would be possible, even for a stranger, to replace each in its proper place.

Each book containing information has its number placed on the inside of each cover, and the index card refers one to book number and page. For instance if the writer were designing a special boiler, and because of certain limitations found it necessary to make the grate surface as small as possible, and desired to learn what various authors had to say on the matter, he would look under the sub-heading "furnaces" of "boilers and accessories," and on the card would find "Ratio—heating surface to grate surface 4-17, 7-39, 2-104, 10-43," which would mean that one article would be found in book number 4 page 17, another in book 7 page 39, etc.

The index at present contains nearly 2000 cards and so completely has it been carried out, that if necessary to look up information on any subject, and such information is contained in any of the loose leaf books above described, text-books, hand-books, bound volumes of magazines or catalogues owned by the writer, references can be found in a moment's time in the index, which will direct one to the several page numbers of the different books where such information is to be found. On several cards at the front of the index is given the number assigned to each book, and opposite a description of such book, consisting of the title, author, and volume number (should it be one of a set of books), these cards serving as a key to the index.

It may occur to the reader that the keeping of the scrap-book and index would involve too much time and labor—more than the average engineer could devote to it—but this is not the case. It must be borne in mind that only those articles are preserved and indexed that are valuable, and as a typewriter is used in writing the index cards, one or two evenings a month has been found sufficient to keep the "scrap file" in shape.

* * *

FLUX FOR COPPER AND BRASS

In melting copper for producing brass or bronze there is no flux better than common salt. Its value lies in the fact that it possesses the property of reducing any oxide of copper which may form during the melting. It has been used for years in the brass industry and the memory of the "oldest inhabitant" fails to indicate the date of its inception. About a handful of salt is used and is preferably put in the crucible after the copper has begun to melt. If introduced with the copper, it melts before it and is apt to volatilize and waste. The action on the crucible is also greater. Too much salt produces a liquid that is apt to penetrate the crucible like fluor-spar, although not as violently or as rapidly. The amount of salt previously given is used for a pot of metal holding about 150 pounds. The quantity need not be exact, as a variation either way does no harm as long as a sufficient quantity is used to do the work. Common salt is almost universally and exclusively employed as the flux in brass melting. The brass rolling mills in the Naugatuck Valley, Connecticut, and elsewhere as well, all use it, and one large company uses approximately half a ton a day. It is the universal and only flux used in making brass for rolling. It seems to give all that is desired and has the distinct advantage of being cheap. Any kind of salt will answer the purpose, a pure material being unnecessary.—*Edwin S. Sperry in paper read before the American Brass Founders' Association convention.*

INTERNAL CUTTING TOOLS—3

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

In this, the concluding article on the subject of internal cutting tools, recessing tools and recessing operations will be described. The practice given herein can be taken as standard and when used with discretion satisfactory results will be obtained. The speeds and feeds, of course, are liable to some variation on account of the conditions which govern them, but the feeds given herein are not exceedingly high and can be used to advantage in the majority of cases.

Three different types of recessing tool holders, commonly called swing tools, are described, but it will, of course, be seen that with slight modifications, tool-holders of the description given can be used for various classes of work. Three types of recessing tools are also shown. These are suited for three different conditions, namely, for chamfering and recessing operations, and for special conditions—that is, the third tool is used when the hole in the work is so small, as not to permit the use of either of the other tools. Explicit instructions are also given for laying out cams for chamfering and recessing operations.

Recessing and Recessing Tools

When it is necessary to chamfer a hole in each end of a piece, a recessing or so-called "internal" chamfering tool is used, which eliminates a second operation. A recessing tool which works on the same principle as an ordinary boring-tool is used for chambering or relieving a hole in the center, that is, just leaving a bearing surface at each end. The recessing or chamfering operation should always precede the reaming operation, so that all burrs thrown into the hole by the recessing tool will be removed by the reamer. A recessing or chamfering tool should be operated from the front cross-slide wherever possible, for the following reasons: In the first place it is generally more convenient to make the necessary adjustments; in the second place turning the tool upside down allows the chips to drop to the bottom of the hole where they are easily removed, thus allowing the tool to work with less obstruction; and in the third place, the forming is usually done from the front cross-slide, thus requiring the use of the rising block. This, the latter, is removed for the substitution of a special rising block which has a cam attached, used for operating the recessing tool holders. It is, therefore, obvious that this is generally the correct place from which to operate the recessing tool holder.

If, on the other hand, the recessing tool holder is operated from the rear cross-slide, the recessing will either have to be done when the spindle is running backwards or else it will be necessary to make a special circular tool holder, in which the distance from the hole through which the screw is inserted to hold the circular tool, to the top face of the cross-slide is of a less height than that ordinarily used on the rear cross-slide.

In cutting the finished piece from the bar after recessing, the feed should be decreased on the cut-off tool, so that the piece will be severed without leaving a burr where the two cuts meet. Decreasing the feed from 0.001 to 0.0005 inch per revolution is generally found sufficient.

At *A* Fig. 16 is shown a recessing tool which is used for chamfering, and at *B* is shown a tool which is used for chambering. This latter tool removes the superfluous material in a similar manner to an ordinary boring-tool.

The chamfering tool shown at *A* is not backed off, as it is smaller in diameter than the hole in the work, which gives it sufficient periphery clearance on the sides. For brass work, the cutting edge is cut on the center as shown and sometimes below the center when less clearance is necessary, as shown by the dotted line *a*, but for steel work it is cut above the center a distance equal to 0.10 of the diameter and given a top rake. The included angle of the cutting edge β is made as required, the angle usually being about 90 degrees.

* Associate Editor of MACHINERY.

The recessing or boring tool shown at B has its sides cut helically, giving a clearance angle of from 5 to 8 degrees which is found satisfactory for ordinary work. For brass work this tool is also cut on the center and below, as shown by the dotted line b, and for steel work the same as for chamfering tool A.

Where the hole in the work is of such a diameter, that a tool made similar to those shown at A and B would be too slender to do efficient work, one similar to that shown at C and D can be used. The diameter of the cutting end of this tool need only be about from 0.008 to 0.012 inch smaller than the hole. The distance a should be about 0.015 inch greater than the depth of the recess, and b, of course will equal $\frac{a}{2}$. The amount c that the cutting edge is cut below the center, should be enough to give the tool sufficient negative rake for brass, but for steel it should be cut 0.10 times the diameter above the center.

A good method of making this tool is as follows: Take a piece of drill rod of a diameter equal to the diameter of the shank required and insert it in a draw-in chuck held in a bench or other suitable lathe. Turn down the body of the tool equal to the diameter required, then remove the tool from the chuck replacing it with a narrow strip of sheet steel or brass alongside of it, the thickness of which will equal the dimension b Fig. 16. When the tool has been tightened in the chuck, light cuts can be taken until the desired amount of material is removed.

When the tool has been turned eccentric, as shown at C, a small groove is milled in it as shown at D, and the tool backed off for clearance. It is then hardened and drawn very carefully in oil.

If the amount of eccentricity required on the tool is such that the tool could not be held firmly in the chuck with a piece of sheet steel inserted alongside of it, a bushing should be made with the hole eccentric to the outside diameter, an amount equal to the amount of eccentricity required on the tool.

Chamfering and recessing tools should be made slightly smaller than the diameter of the drilled hole and the body should never be longer than is really necessary to clear the work, allow the chips to pass out and the oil to penetrate to the cutting edge. For general conditions the following proportions for chamfering and recessing tools will be found satisfactory.

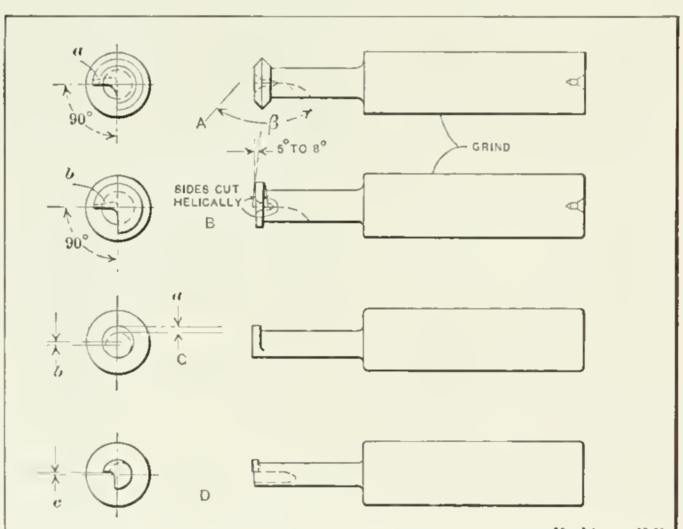
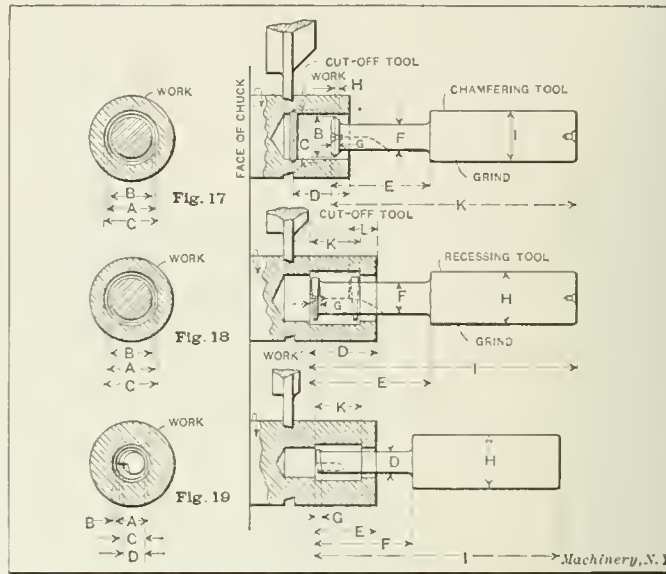


Fig. 16. Various Types of Recessing Tools

Proportions for Chamfering Tools (For Notation see Fig. 17)

Where A = diameter of hole before reaming or diameter of drill,
B = diameter of chamfering tool = A — 0.025 to 0.030 inch,
C = diameter of chamfered hole,
D = length of work or distance that tool projects in from the face of the work,
E = length of body of tool = 1.25 D,
F = diameter of body of tool = B — (2H — 0.025 to 0.030 inch) (when included angle = 90 degrees),
G = width of blade = 0.25 B = 2 H,
I = diameter of shank and is as follows:
When A = from ⅛ to ¼ inch I = ¼ inch.
A = from ¼ to ½ inch I = ½ inch.
A = from ½ to ⅞ inch I = 1 inch.
K = total length of tool and is as follows:
When I = ¼ inch K = E + ⅞ inch.
I = ½ inch K = E + 1¼ inch.
I = 1 inch K = E + 1½ inch.



Figs. 17, 18 and 19. Diagrams Illustrating Method of Determining Proportions for Chamfering and Recessing Tools

Proportions for Recessing Tools (For Notation see Fig. 18)

Where A = diameter of hole before reaming or diameter of drill,
B = diameter of recessing tool = A — 0.025 to 0.030 inch,
C = diameter of recessed hole,
D = distance in from face of work to extreme depth of recessed hole,
E = length of body of tool = 1.25 D,
F = diameter of body of tool = B — (C — B),
G = width of blade = 0.20 B,
H = diameter of shank and is as follows:
When A is from ⅛ to ¼ inch H = ¼ inch.
A is from ¼ to ½ inch H = ½ inch.
A is from ½ to ⅞ inch H = 1 inch.
I = total length of tool and is as follows:
When H = ¼ inch I = E + ⅞ inch.
H = ½ inch I = E + 1¼ inch.
H = 1 inch I = E + 1½ inch.

Proportions for Tools Used in Recessing Holes of Small Diameter (For Notation see Fig. 19)

Where A = diameter of hole before reaming or diameter of drill,
B = depth of recess,
C = diameter of cutting portion of recessing tool,
D = diameter of eccentric body of tool = B + from 0.010 to 0.020 inch,
E = distance in from face of work to extreme depth of recessed hole,
F = length of body of tool = 1.20 E,
G = width of blade = 0.20 B,
H = diameter of shank of tool and is the same as previously given for the other tools shown in Figs. 18 and 19.
I = total length of tool and is as follows:
When H is ¼ inch I = F + ⅞ inch.
H is ½ inch I = F + 1¼ inch.
H is 1 inch I = F + 1½ inch.

It will be noted that the lengths of the bodies E and F on chamfering and recessing tools will be governed to a con-

siderable extent by the character of the holder used, and the relative positions of the cross-slide tools during the recessing operation and also the depth of recessed hole required. Usually the proportions given will be found satisfactory for general work.

Recessing Tool Holders

In Fig. 20 is shown a recessing tool holder which is commonly called a swing tool. The swinging member *A* of this holder is held to the body *B* by a stud and screw *a*. The pin *b* held in the swinging member is kept tight up against the end of the set-screw *c* by means of a small coiled spring, not shown, which is held in the member *B*. The set-screw *c* is also used for bringing the tool concentric with the hole in the work. The set-screw *d* holds the recessing tool in the swinging holder. To operate this tool, the ordinary rising block which is used under the circular tool holder is removed, and the block shown to the right in the illustration is substituted in its place. This block is only for straight work, the cam *E* being adjusted longitudinally in a slot in plate *C*.

The rising block shown in Fig. 21 is made adjustable for taper work. Here it can be seen that the plate *C* has a longitudinal groove *c* cut in it in which the adjusting arm *D* can be adjusted in or out, as desired. When the desired position is obtained it is clamped by means of the screws *d*. On this adjustable plate *D* is fastened a swinging plate which rotates on the small pin *c* and is adjusted by the set-screw *f*. When this plate is set in the desired position it is locked by means of the screw *g*. This rising block can be used for a variety of

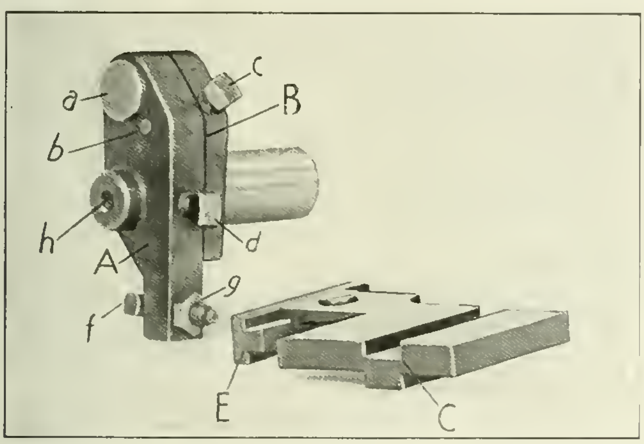


Fig. 20. B. & S. Swing Tool-holder and Rising Block for Operating it

work, as the setting and shape of the plate *E* will determine the shape produced on the work.

When it is essential to have a hole in the work concentric with the external diameter, a block as shown in Fig. 21 can be used in conjunction with the recessing or swinging tool holder shown in Fig. 20, the operation of truing the hole being similar to boring a hole in an ordinary lathe. For this class of work, of course, it is usually necessary to take only one cut, so that complicated cams are avoided, but, of course, this is only general and the work in hand will decide whether it would be advisable to take one or more cuts.

Returning to the swinging tool holder shown in Fig. 20, the set-screw *f* is also used as adjustment for bringing the recessing tool concentric with the hole in the work. A small clamping nut *g* is provided for locking it, when in the desired position. The size of the hole *h* in the holders for the various machines is as follows:

For the No. 00 machine, $h = 3/16$ inch,
No. 0 machine, $h =$ ¼ inch,
No. 2 machine, $h =$ ½ inch.

In Fig. 22 is shown another design of recessing tool holder which will sometimes be found very convenient. In the tool-holder shown the swinging member *A* is held to the body of the tool-holder *B* by means of the screw *C*. The body of this screw which passes into the holder *B* is turned eccentric to that part of the screw which works in the swinging member *A*. A detail of this screw *C* used in a holder for a No. 00 machine, is shown to the right in the illustration. It can be seen that a slight adjustment is given with this screw, so that the recessing tool can be located concentric to the hole in the work. This is found to be a very practicable addition in some cases, especially where the hole in the work is extremely small, not allowing the difference between the external diameter of the recessing tool and that of the hole to be very great. This screw also provides for any inaccuracy in the

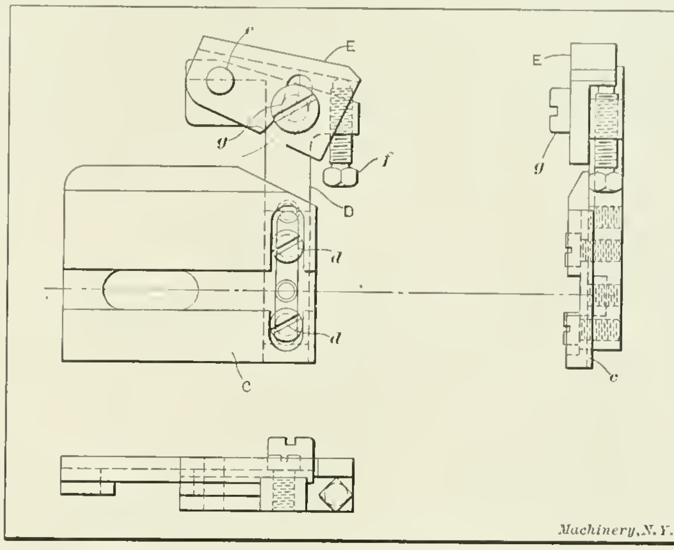


Fig. 21. Standard Rising Block used for Operating Swing Tools

making of the holder, as it is usually found a difficult proposition to get these tool-holders to line up exactly concentric.

The construction of this holder is somewhat different to that shown in Fig. 20, especially in the method of holding *A* to the member *B*. A shoulder-screw *E* is tapped into part *B* and is made a loose fit in the swinging part *A*, the latter having an elongated hole to allow the holder to swing. The head of the screw *E* allows the swinging part of the holder to slide easily underneath it. This holder has an adjustable stop *F* so that once the holder is set it will be brought into the exact position after having recessed one hole. The set-screw or stop *F* which bears against the body of the screw *E* is locked by means of a nut. *G* is the screw against which the operating cam attached to the rising block bears. This screw also has a shoulder which the small coiled spring operates, thus keeping the screw *F* held in the swinging member *A* up against the screw *E*. Split bushings are used for hold-

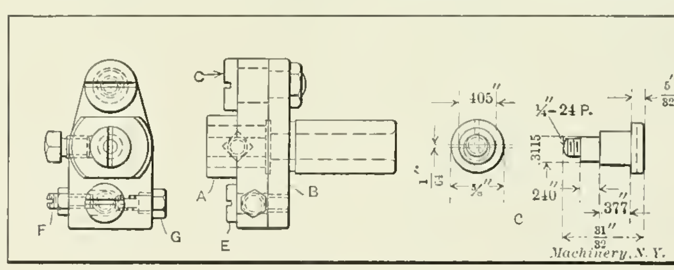


Fig. 22. Another Type of Swing or Recessing Tool Holder

ing the recessing tools in this holder. This tool can be made very accurately and can be used for fine and delicate work.

Performing Facing Operations with Swing Tools

Swing tools are not only used for recessing and chamfering operations, but can also be used for straight, taper, irregular turning operations, and when necessary may be used for facing.

It is sometimes found necessary to cup out a piece of work which leaves a very thin wall. Now, if the ordinary facing tool were used in the turret, the cutting pressure would force this thin wall back, and as soon as the pressure was removed it would spring back again to its normal position, or nearly so, thus making it difficult to produce a perfectly square face in the work. For this class of work a swing tool as shown in Fig. 23 is found advisable. In use the facing tool *C* shown in the holder is brought up, of course, until the cutting edge is in line with the center of the work. When it is in this position it is fed a slight amount into the work

equal to the depth of the cut to be taken. Then the cross-slide advances, forcing the tool forward which turns the face similar to an ordinary facing operation in the lathe. If one cut is not sufficient to true up the face, of course a second cut can be easily taken. This method of turning will be found satisfactory when all others fail. This swing tool is constructed somewhat similarly to those previously described with a slight modification, of course, to suit the requirements. The turning tool C is made from a square section of either carbon or high-speed steel and is adjusted by means of the two set-screws A. The turning tool rests on the small pin B which acts as a fulcrum. By means of this pin and the two

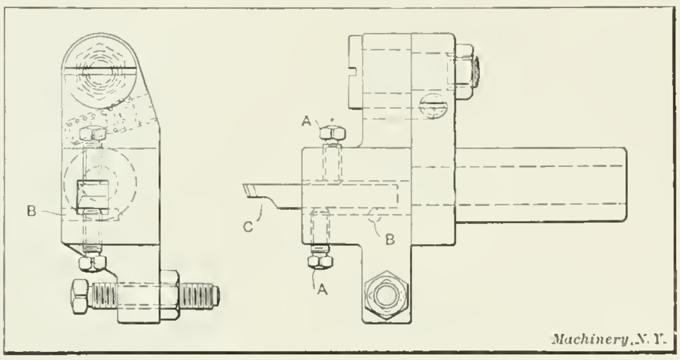


Fig. 23. Swing Tool used for Facing Operations

set-screws the tool can be set to the correct height, so that the objectionable teats can be removed with ease.

When making a cup-shaped piece of work similar to that shown in Fig. 24, usually the best procedure to follow, is to first drill, rough counterbore and form all at the same time. A rough counterbore can be used similar to that shown at B,

TABLE VI. FEEDS FOR FACING TOOLS MADE FROM HIGH-SPEED AND CARBON STEEL

(For Notation see Fig. 24)

Value of C	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
	0.002-inch Chip		
12.0	0.0008	0.0007	0.0005
11.0	0.0010	0.0009	0.0007
10.0	0.0020	0.0015	0.0010
9.0	0.0030	0.0025	0.0015
8.0	0.0040	0.0030	0.0020
	0.005-inch Chip		
7.0	0.0040	0.0030	0.0020
6.5	0.0050	0.0038	0.0022
6.0	0.0055	0.0040	0.0025
5.5	0.0060	0.0045	0.0028
5.0	0.0070	0.0050	0.0030
	0.010-inch Chip		
4.5	0.0048	0.0030	0.0030
4.0	0.0050	0.0034	0.0034
3.5	0.0055	0.0037	0.0037
3.0	0.0060	0.0040	0.0040

Fig. 13 in the preceding installment of this article. Following the counterboring operation, a swing tool similar to that shown in Fig. 23 is used to square up the inside face which has become slightly concave, due to the heat generated between the side of the form tool and the work causing the work to spring away from the tool.

If it is necessary to have the back face of the piece square as well as the inside face, a revolving support can be used in the turret, following the rough counterboring operation or the first facing operation, as the case may be; preferably it should follow the facing operation. This support is used in conjunction with a shaving tool carried on either cross-slide, as may be necessary, and is brought up against the inside face of the work. The shaving tool is then fed across the back face of the work, taking a light shaving cut. If necessary it can also take a light cut off the shank, if it is desired to hold the diameter closer than 0.0015 inch. Care should be taken to have the spindle adjusted so that there is no end play, and to have the dwell on the cam uniform, because if the lobe for the revolving support is not uniform but has slight rises on it, it will produce an uneven finish on the back face of the work, thus defeating the object of the shaving operation.

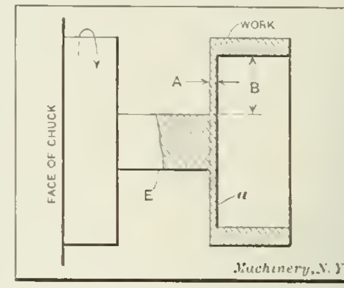


Fig. 24. Diagram giving Notation used in the Derivation of Feeds for Facing Operations

When the wall is very thin, that is when the distance B equals about ten times the dimension A, two facing cuts should be taken. It is also preferable when performing facing operations of this character to operate the swing tool from the front cross-slide and start the cut from the center of the work out to the full diameter.

Operating the swing tool from the front cross-slide permits the tool to be turned upside down (when the spindle is running forward) thus allowing the chips to be removed easily. Moreover when high periphery velocities are used on steel it is generally practicable to have the swing tool operated from the rear cross-slide or else run the spindle backward, so that a good supply of oil can reach the cutting edge of the tool.

Feeds for Facing Operations

The feeds and depths of chip for facing operations are given in Table VI. The values of C in the first column equal B di-

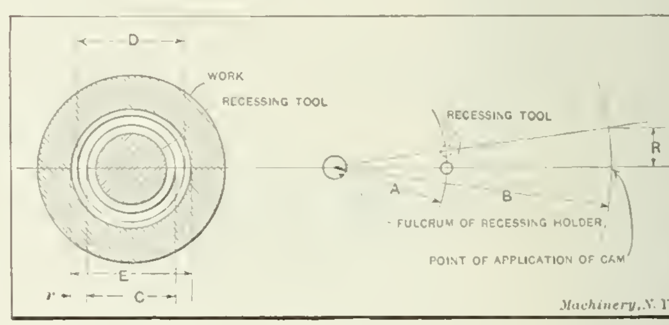


Fig. 25. Diagram for Finding Rise on Cross-slide Cam for Recessing and Chamfering Operations

vided by A (see Fig. 24). For example, assume that $B =$ 0.25 inch. Then when $A = 0.025$ inch, $C = \frac{0.250}{0.0250} = 10$, or in other words $B = 10$ times A.

It will be noted that the feeds given are approximately the same for brass rod and machine steel. This has been found satisfactory, as the resistance to the cutting pressure and the bending moment of the work approximately equals one another in cases of the materials mentioned. When the distance B is greater than 12 times A the form tool, or other means of supporting the thin wall against the pressure of the cut should be provided. Where the form tool is used for this purpose it should be made perfectly straight, that is, without side clearance, and it should be ground and lapped. In operation the form tool is dropped back from the shank E of the work to a distance about 0.010 inch and allowed to dwell in this position until the facing operation is completed. Care should be taken to have no end play in the spindle bearing when work of this description is being performed. A copious supply of good lard oil should also be supplied to the tools. The feeds under these conditions can sometimes exceed those given in Table VI, depending of course, upon the various materials being worked, depth of cut and the ratio of B to A.

Rise on Cross-slide Cam for Recessing and Chamfering

When using the recessing holders previously described it is obvious that the rise on the cam will be greater than the distance which the tool is fed into the work. To illustrate the method of finding the rise on the cam refer to Fig. 25, where

A = distance from center of the fulcrum to center of the recessing tool,

B = distance from center of fulcrum to point of application of cam or center of screw f (see Fig. 20),

C = diameter of recessing tool,

D = diameter of drilled hole in the work,

E = diameter of recessed hole,

r = travel of the recessing tool $= \dfrac{E-C}{2}$,

R = rise on the cam,

then $R : r :: B : A$. To illustrate this more clearly we will take a practical example. Let r equal 0.040 inch, B equal $2\frac{1}{4}$ inches, A equal $1\frac{1}{8}$ inch; then R equals $\dfrac{0.040 \times 2\frac{1}{4}}{1\frac{1}{8}} =$ 0.080 inch.

Care should be taken in setting the recessing tool to have it exactly in the center of the hole so that it will not strike the side when being forced into or backed out of the work.

Cam Lever Templets for Laying out Cams

In Fig. 26 are shown the cam lever templets for the Nos. 00, 0, 1 and 2 Brown & Sharpe automatic screw machines. These templets are used for laying out cams when it is necessary to have the starting or finishing points of the lobes on the cross-slide and lead cams in a certain definite relation to each other.

In operation these templets are used as follows: The center A as designated, is pivoted on the center of the cam by a pin or other pointed instrument which is inserted in the center hole provided in the lever. The main body of the templet B can then be rotated in any desired position so that the rolls of the cam levers can be set in their respective relations to each other. In this way the starting or finishing points of the lead and cross-slide cam lobes can very easily be obtained.

These cam lever templets are made from sheet celluloid, thus making them transparent so that any marks placed on the drawing can easily be detected, such as the location of the roll, whether on the top of the lobe, on the rise of the lobe or on the drop of it. The templets are manufactured by

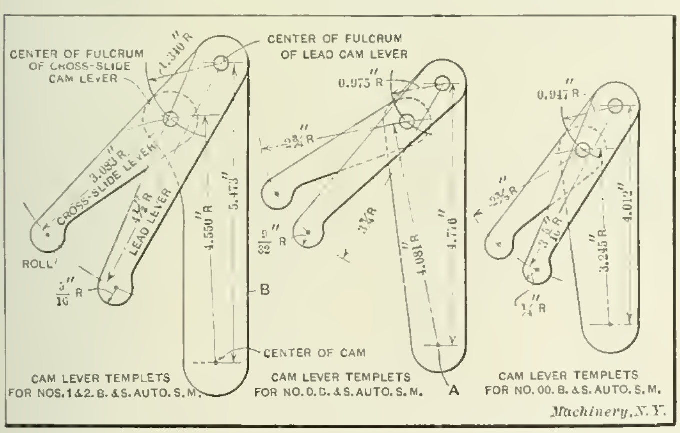


Fig. 26. Nos. 00, 0, 1 and 2, B. & S. Automatic Screw Machine Cam Lever Templets for Finding the Starting and Finishing Points of the Lobes for the Cross-slide and Lead Cams

the Brown & Sharpe Mfg. Co., Providence, R. I., and may be purchased from them.

Method of Laying out Cams for Chamfering

In Fig. 27 is shown a method for finding the starting and finishing points on the lobes of the cross slide and lead cams for chamfering. These points can very easily be obtained by means of the cam lever templets shown in Fig. 26. As was previously explained in regard to these templets the center A (see Fig. 26) is pivoted on the center of the cam.

There are two methods used in laying out a set of cams when it is necessary to obtain clearances or definite starting points for the lead and cross-slide lobes. The first one is to obtain a rough estimate of the total number of revolutions required to complete one piece, after which the revolutions are transferred into hundredths, and the location of the lobes laid out on the cam circles. Then the rises and drops are constructed and the amount of clearance obtained by the cam lever templets. This method usually requires considerable experience in this line of work, as an extra amount of work is necessary if sufficient clearance has not been allowed when making the rough estimate.

Another method and one which the writer considers superior to that given is to first find the rise on the cross-slide cam for chamfering (see Fig. 25). Then make a diagram as shown in Fig. 27. Circles should then be drawn representing the largest diameter of the lead cam, the largest diameter of the cross-slide cam, and the amount of rise on the cross-slide cam. It is obvious that, in chamfering operations, the tool should be located in the work before the cross-slide cam starts to operate on it. Therefore, the lead cam roll should be on the highest point of the lobe before the cam on the

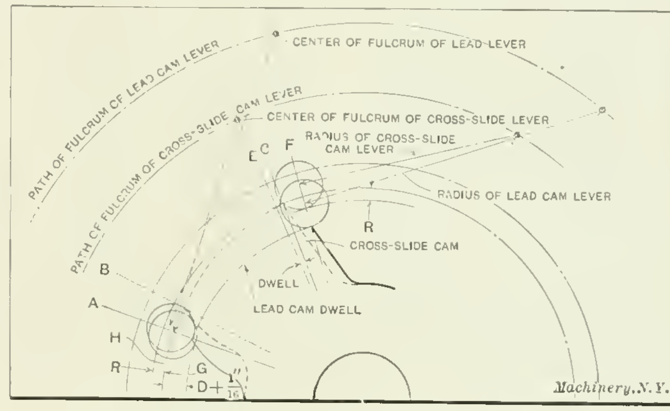


Fig. 27. Diagram for Finding the Starting and Finishing Points of the Lobes of the Cross-slide and Lead Cams for Chamfering Operations

cross slide used in forcing in the tool, touches the toolholder. The circle, therefore, should be drawn representing the distance D (see also Fig. 17) and an amount added to it varying from 1/16 to 1/8 inch to allow for clearance. After the circles have been drawn, we can then find the starting and finishing points of the lobes.

The cam lever templet is now brought into position, and the lead cam roll placed so that its circumference touches the lobe on the lead cam and its center coincides with the hundredth line A. Then the cross-slide lever is swung down so that the circumference of the roll touches the circle G as shown, and with a sharp pencil a line is scribed around the circumference of the roll, which is to represent the quick rise of the cam. The compasses are then set to the desired radius for the quick rise of the cam which is described so that it will cut the circle H, representing the start of the rise on the cross-slide cam, and also cut the line which has been previously marked by scribing around the cross-slide lever roll. Where the quick rise of the cam and the circle R meet, will be the starting point of the rise on the cross-slide cam, or the hundredth line B as shown.

When we have found the starting points the next thing is to obtain the finish points of the lobe. It is obvious that the lead cam should hold the tool in position until the cross slide cam has dropped back an amount equal to the distance which it has forced the tool into the work or the rise on the cam. A hundredth line F is taken in any convenient position for the finish of the lead cam, and the cam lever templet is then brought into position so that the roll of the lead lever touches the circle and the center coincides with the line F as shown. The cross-slide roll is then swung down until its circumference touches the circle H and a mark is scribed around the circumference of the roll. Where this mark cuts the circle representing the largest diameter of the cam would be the finishing point of the lobe, that is, if the distance from the outside diameter was not exceedingly great or in other words not greater than the radius of the roll. If greater than this the drop should be constructed and where the mark representing the drop cuts the outside circle this will be the finishing point of the lobe, or the hundredth line C. The space from E to C represents from one to two revolutions for dwell on the cross-slide cam.

Now it can be clearly seen that the advantage of this method is that the amount of clearance between the starting and finishing points of the lead and cross-slide cams is known in hun-

dredths of the cam circle before the cams themselves are laid out, thus facilitating the operation of laying out the cams.

Methods of Laying out Cams for Recessing

In Fig. 28 a method is shown for finding the starting and finishing points on the lobes of the cross slide and lead cams for recessing. To determine these points the cam lever templets are again brought into operation. The starting point of the lead cam is first drawn and a circle is drawn equal to

TABLE VII. FEEDS FOR CHAMFERING TOOLS MADE FROM HIGH-SPEED AND CARBON STEELS

Diameter of Chamfering Tool in Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed, per Revolution	Tool Steel, Feed per Revolution
1/8	0.0010	0.0008	0.0005
3/16	0.0015	0.0010	0.0008
1/4	0.0018	0.0015	0.0010
5/16	0.0020	0.0020	0.0012
3/8	0.0030	0.0022	0.0015
7/16	0.0040	0.0025	0.0018
1/2	0.0048	0.0030	0.0020
9/16	0.0055	0.0035	0.0021
5/8	0.0060	0.0038	0.0022
11/16	0.0065	0.0040	0.0024
3/4	0.0070	0.0045	0.0026
13/16	0.0075	0.0048	0.0028
7/8	0.0080	0.0050	0.0030

the distance K from the maximum diameter of the cam. Before this is done, of course, a maximum diameter of the cam should be obtained which will suit the length of the toolholder used in the turret. After this is found the various circles can be drawn representing the starting point of the rise on the cross-slide cam and also the distance K as before mentioned, when the cam lever templets are brought into operation and the lead roll is brought so that it touches the lead cam as shown and its center coincides with the hundredth line A. The rise on the cross-slide cam is laid off as was mentioned regarding the chamfering operations, and the distance $L + 1/16$ (see also Fig. 18) is also laid off. The cross-slide roll is then swung down until its circumference touches the line M as shown, and a mark made around its circumference as before described. The quick rise is then constructed and where it intersects the rise of the cam and the mark representing the circumference of the roll would be the starting point B on the cross-slide cam. The hundredth line C, which is to represent the finishing point of the rise on the cross-slide cam for feeding the tool in to take the desired chip, is then laid off and the cross-slide roll swung into position. The lead roll is then swung down until it touches the line as shown, and it will be seen that the starting point of the rise on the lead cam is slightly in advance of the finishing point on the cross-slide cam or the hundredth line D.

The finishing points of the lobes are the next things that require attention. Any hundredth line, as G, is taken at a convenient distance and the cam lever templets are then brought into operation. The lead roll is brought into the position shown, the cross-slide roll is swung down from the outside diameter of the cam equal to the distance R, and the drop laid off as before mentioned in regard to chamfering operations. The finishing point of the cross-slide lobe would then be on the hundredth line E. The space from C to E on the cross slide cam would be for dwell, while the space from D to G on the lead cam would be the rise. The space from F to G is for dwell on the lead cam, which is about equal to one or two revolutions.

Speeds for Chamfering and Recessing Tools

The surface speeds used for recessing tools can be slightly greater than those used for counterbores on account of the light feeds and small amount of cutting surface in contact

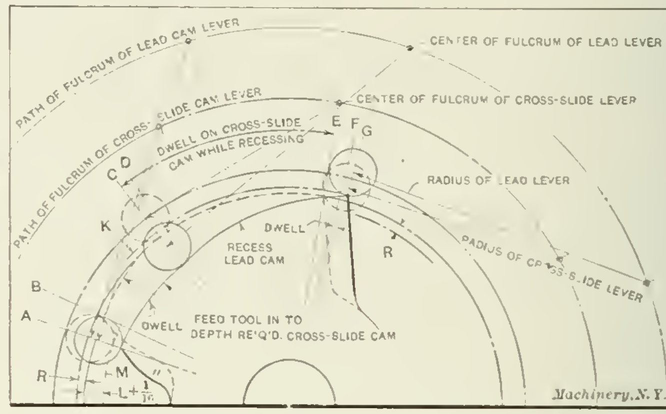


Fig. 28. Diagram for Finding the Starting and Finishing Points on the Lobes of the Cross-slide and Lead Cams for Recessing Operations

with the work. As a rule, the following surface speeds can be used on the materials specified with satisfactory results:

SPEEDS FOR RECESSING TOOLS MADE FROM CARBON STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality),	170-180
Gun screw iron,	60-70
Norway iron and machine steel,	45-55
Drill rod and tool steel,	35-40

TABLE VIII. FEEDS FOR RECESSING TOOLS MADE FROM HIGH-SPEED AND CARBON STEEL

0.010-inch Chip				1/32-inch Chip			
Diameter of Recessing Tool in Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Diameter of Recessing Tool in Inches	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/8	0.0020	0.0012	0.0010	3/8	0.0040	0.0025	0.0015
3/16	0.0030	0.0018	0.0015	7/16	0.0045	0.0030	0.0020
1/4	0.0040	0.0025	0.0020	1/2	0.0055	0.0040	0.0025
5/16	0.0080	0.0040	0.0040	9/16	0.0075	0.0050	0.0030
3/8	0.0120	0.0060	0.0050	5/8	0.0085	0.0060	0.0035
7/16	0.0160	0.0090	0.0060	11/16	0.0100	0.0065	0.0038
1/2	0.0200	0.0100	0.0070	3/4	0.0120	0.0070	0.0040
0.020-inch Chip				1/16-inch Chip			
1/4	0.0025	0.0015	0.0010	1/2	0.0030	0.0020	0.0010
5/16	0.0035	0.0020	0.0015	9/16	0.0040	0.0028	0.0015
3/8	0.0050	0.0030	0.0020	5/8	0.0050	0.0030	0.0020
7/16	0.0080	0.0050	0.0040	11/16	0.0060	0.0035	0.0023
1/2	0.0120	0.0070	0.0050	3/4	0.0075	0.0040	0.0025
9/16	0.0160	0.0090	0.0055	13/16	0.0080	0.0045	0.0028
5/8	0.0190	0.0100	0.0060	7/8	0.0085	0.0050	0.0030

SPEEDS FOR RECESSING TOOLS MADE FROM HIGH-SPEED STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality),	200-225
Gun screw iron,	90-100
Norway iron or machine steel,	75-85
Drill rod and tool steel,	50-60

Feeds for Chamfering

In Table VII are given the feeds to be used for chamfering tools when cutting the various materials and when the tools are of the diameters specified. It is obvious that the greater the length of the body of the tool in proportion to its diameter, the smaller will be the feed. This should be taken into consideration when using the feeds given. These feeds are

for chamfering tools having the proportions given in Figs. 17 to 19 inclusive.

Where the diameter of the body is smaller in proportion to its length than those previously given, it would be advisable in most cases to use a slightly decreased feed. No definite rule, however, can be given for this as the conditions vary so much. Therefore, the feed to be used will practically be a matter of judgment and can be found in no other way than by experience.

Feeds for Recessing

In Table VIII are given the feeds to be used when a chip from 0.010 to 1/16 inch thick is being removed. The same feeds as given in Table VII are used for feeding the recessing tool into the depth of chip required, while the feeds given in Table VIII are used for feeding the tool longitudinally into the depth required. As was previously mentioned regarding chamfering tools it is also necessary to take into consideration the length of the body of the tool in proportion to its diameter. This will govern to a considerable extent the feed to be used. For general conditions and for the recessing tools as made to the proportions given, the feeds in Table VIII will be found satisfactory.

In steel work especially it is usually found advisable to decrease the feed as the tool approaches the end of its cut when a chip varying from 1/32 to 1/16 inch thick is taken. This same rule is followed when a finish cut is taken with a box-tool up to a shoulder.

* * *

PROTAL—A NEW RUBBER SUBSTITUTE

The rapidly increasing price of rubber has greatly stimulated the activity of chemists to find a satisfactory substitute. The announcement therefore, of the discovery of a new compound with properties making it suitable for use as a rubber substitute has aroused considerable interest.

In 1844 Goodyear announced to the world his discovery that by the addition of sulphur and the agency of heat, there could be obtained from rubber, plastic, semi-plastic, and hard bodies suitable for use in the arts. This was the birth of a new industry. To-day there is invested in the rubber business approximately $150,000,000 of capital, and it employs 100,000 men.

Many compounds have been announced purporting to be satisfactory substitutes for rubber; but so far, none has had sufficient merit, apparently, to come into general use. Some valuable bodies have been found, such as celluloid, and certain shellac compounds. The composition of many of these substitutes is based upon the use of a body and a binder, the binder usually employed being some resin. The objection to resinous bodies is that they are readily oxidized, and then lose the binding property. They exaggerate the one great objection to the use of hard rubber in the arts, for, as is well known, hard rubber deteriorates rapidly when exposed to oxidizing influences.

In the announcement of the discovery of "protal," the inventor, Dr. F. G. Wiechmann states that the objections above stated have been overcome. The base of protal is a vegetable compound; it is vegetable-albumin derived from the seeds of certain South American palms. One variety especially, the Phytelepha Macrocarpa, produces hard, fine-grained seeds, so-called "taqua nuts." These have been used for almost a century in the production of buttons and sundry small articles. This base of vegetable-albumin, an admixture with an animal albumin and a suitable solvent, produces protal. Apparently a chemical compound has been found, for all the physical properties of protal, such as tensile strength, electrical resistance, and solubility, are different from those of the original constituents, and the new compound cannot be separated again by any known chemical process into its constituents. This material may be loaded with any materials commonly used in loading rubber; also with elastic bodies, resinous, or non-resinous including rubber.

When first produced protal is plastic, but soon acquires the hardness of stone; on rewarming, is becomes sufficiently plastic to be molded, taking sharp and clear impressions. It is odorless and resilient; it may be cut, sawed, filed, polished, drilled, tapped and countersunk, like hard wood. It may be colored by dyes and pigments incorporated with it. Heated in a flame it only chars and smolders. In some forms, protal is a good electric insulator; 134 protal compounds varied in mean dielectric strength from a minimum of 512 volts per millimeter, up to a maximum of 10,276 volts per millimeter. In tensile strength, pure protal compounds ranged from 1000 to 2110 pounds per square inch. Under compression tests of 100,000 pounds three samples showed no compression; two a compression of 8.3 per cent and four a compression of 16.7 per cent.

Protal compounds with asbestos, shellac, and resins are plastic and moldable, and some harden to stone when immersed in water. Protal compounded with linseed oil and pigments proves well adapted to make linoleum.

The most important limitation to the usefulness of some protal compounds is their susceptibility to the solvent influences of water and other chemical agents. The inventor at first tried to overcome this by incorporating a material designed to act as a coating and filler for the pores of the material. Resins were used for this purpose. These of course are open to the objection of oxidation and consequent deterioration. A way was found, however, of entirely obviating the difficulty by combining with protal another synthetic product, *viz.*, "baekelite." The latter body is the invention of Dr. L. H. Baekeland, of velox fame. It is a condensation product of phenol and formaldehyde, and apparently supplements perfectly the shortcomings of protal as mentioned above. The new material has been named protal-baekelite. This material like protal alone, may be combined with a great variety of substances. For example, to produce insulators, mica and asbestos may be incorporated; where the material is to be molded, it may be combined with paper pulp, wood flour, cellulose, etc.

Among the properties claimed we note a specific gravity of about 1.36, tensile strength 2000 pounds per square inch; crushing strength over 60,000 pounds per square inch. On immersion in water, steam, machine oil, cylinder oil, acetone, alcohol, sulphuric acid, acetic acid, turpentine, benzine and dilute solutions of sodium carbonate and ammon-hydrate, this material shows absolute indifference to these reagents.

Protal compounds are made by the American Protal Co., 24 State St., New York. The information of the preceding article is taken from a paper read by the inventor of protal before the American Institute of Chemical Engineers at its Niagara meeting, June 22, 1910.

* Abstract by Dr. H. M. Goettsch, assistant professor of technical chemistry, University of Cincinnati, Cincinnati, Ohio.

* * *

Maine is the chief center of the spool manufacture. Its factories turn out 800,000,000 spools yearly, chiefly birch. Few woods as hard as this can be worked with as little dulling of the tools; its principal recommendation lies in that fact. It is handsome in color, and, after the wood becomes seasoned, it shrinks and warps very little. That is also an important consideration, because the delicate machinery that winds the thread would fail to work if the spool changed its shape to a perceptible degree. The birch wood for spools must be selected and handled with care. The tree's red disk heartwood is objectionable because it will not turn smooth in the lathe, and the color is not desired. Few industries waste more wood, in proportion to the quantity used, than spool making. Heartwood, knots, and all other defects, frequently amounting to more than one-half of the tree, are rejected. From one half to three-fourths of the remainder may go to the refuse heap in sawing the bars and turning the spools.

* * *

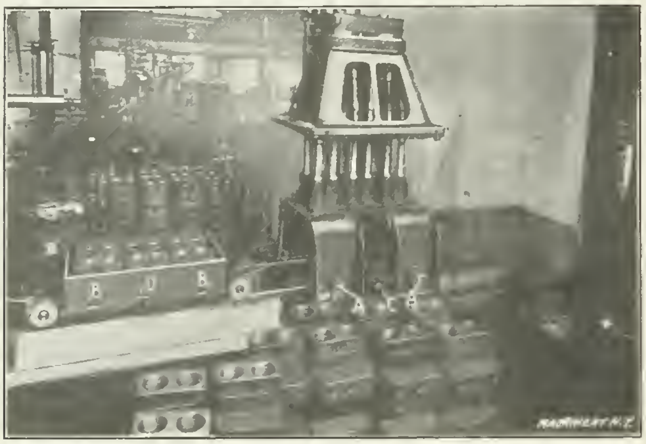
The name on steel knife blades is etched on the surface by means of the rubber-stamp method. The surface is coated with gumguaiacum-varnish. The rubber-stamp coated with a thin layer of potash solution, is then stamped on which removes the varnish leaving the steel free to be etched by dilute nitric acid. The rubber-stamp method is the cheapest of any of the processes.—*Brass World.*

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

BORING AUTOMOBILE CYLINDERS

The accompanying engraving shows a Pratt & Whitney multiple-spindle drilling machine used in one of the large automobile shops for boring out six pairs, or twelve, cylinders at one time. The jigs for holding the units are mounted on

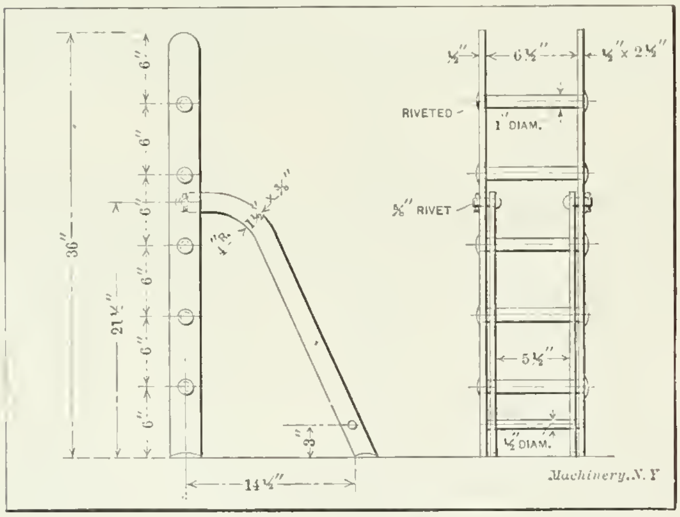


Boring Twelve Cylinders at one time in a Pratt & Whitney Multiple-spindle Drilling Machine

rollers and run on a track, so that they are easily handled, one jig being emptied and loaded again while the other is in the machine, making the boring operation practically continuous. When the jig is in position in the machine it is held in place by the straps *A*, which fit in the slots *B* in the jig. The plunger *C* locates the jig in the correct relation to the spindles, fitting in the slot *D*. The cylinder castings are held to the jig base-plate by bolts passing through the holes which are used in fastening the cylinders to the crank-case. E. V.

FULCRUM STAND FOR THE RAILWAY SHOP

As those familiar with locomotive work know, one of the operations connected with "wheeling" an engine consists of putting up and bolting to the frame the pedestal braces or binders, which are attached to the frame jaws beneath the



Device used as a Fulcrum when Erecting Binders or Pedestal Braces

driving boxes. The wheels are, of course, first placed in position, after which the binders are put up. Three men are usually employed for this work, two being beneath the engine to raise the binder and wedge while the third man outside supports it by a bar, thrust between the spokes of the driving wheel. As soon as the binder is caught by the bar, it is pried up far enough to permit entering nuts on the binder bolts. Ordinarily, a jacking block is used as a fulcrum for this bar, but such blocks are heavy and cumbersome so that moving them from one wheel to another is not only laborious work but consumes unnecessary time. A substitute for these blocks which is both light and convenient to handle, is shown in the accompanying engraving. This device is in the form of a ladder, the rungs of which give fulcrums of various heights. The sides are made of 2½ by ½ inch flat iron and these are held together by five rings, 1 inch in diameter, that are riveted over at the ends. A pivoted support keeps the stand in an upright position when in use. The advantages which this stand has over the old method can only be fully appreciated by those who have had to carry the heavy wooden jacking blocks from one wheel to another and from one side of the engine to the other. CHARLES H. WEEKS

Elizabethport, N. J.

MAKING ADDING MACHINE STOPS

The manufacture of the sheet-metal stop shown in Fig. 1 was at one time considered by the management of an adding machine company a serious problem, as one hundred of these pieces are used on each machine.

As great accuracy was necessary in making the stops, the usual precautions were observed, *i. e.*, the piece was blanked,

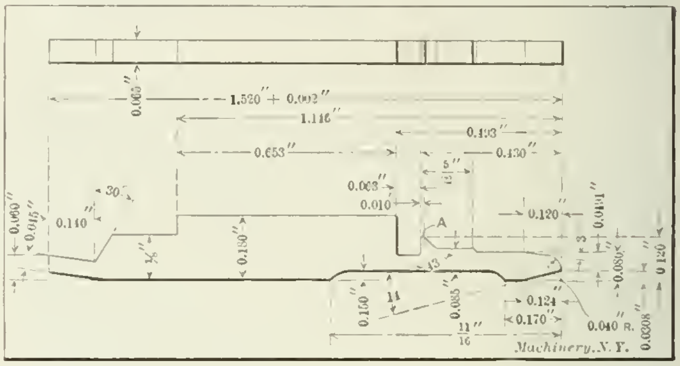


Fig. 1. Adding Machine Stop

flattened and shaved with good tools, but it was found impossible to maintain an accurate point at *A* (see Figs. 1 and 3). This point would turn over and have a rounded appearance and also a bad break, which was detrimental, as this same point was a working face. Therefore, the production by die work was abandoned and the method shown in Fig. 2 was tried.

This scheme consisted in milling with form cutters, six strips of steel at one time. The strips were held by flat

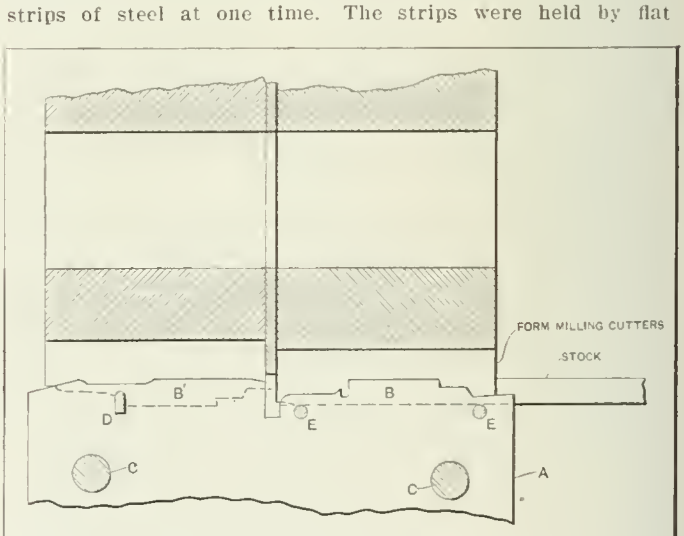


Fig. 2. Method used in Milling the Stops with Form Cutters

plates *A*, fitted to a special vise, the rods *C* passing through and holding them in the proper place. The strips to be milled are located on the rods *D* and *E*. The rod *D* is flattened on both sides to locate the cuts in the correct relation to each other. The illustration shows how the operation is performed. The first cut is taken at *B*, and the strip is then reversed

and carried forward; then a cut is taken at *B'* and at the same time the stop is cut off to the desired length, thus completing it. This method also proved to be a failure, as only about 50 per cent of the pieces were accurate and the operation was very slow. In addition, the upkeep of the fixture—grinding form cutters to correct diameters, etc.,—made the cost of production prohibitive.

At the writer's suggestion the method shown in Figs. 3, 4 and 5 was resorted to and finally solved the problem. The

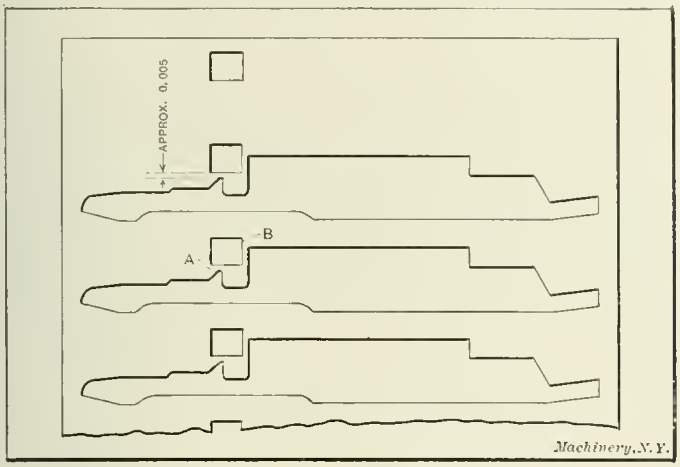


Fig. 3. Condition of Scrap as it comes from the Blanking Die

idea in preserving the point mentioned is clearly illustrated at *A* in Fig. 3. The scrap is here shown as it comes from the blanking die. A small section is cut out of the stock at *B*, leaving enough metal around *A* so that when the punch pierces the stock the resistance is very little—hence a clean cut and no break at the point.

A plan and a sectional view of the die are shown in Fig. 4. The die *A* is made in two parts fastened together with screws. *B* is the guide plate. The stripper *C* is on the punch and is

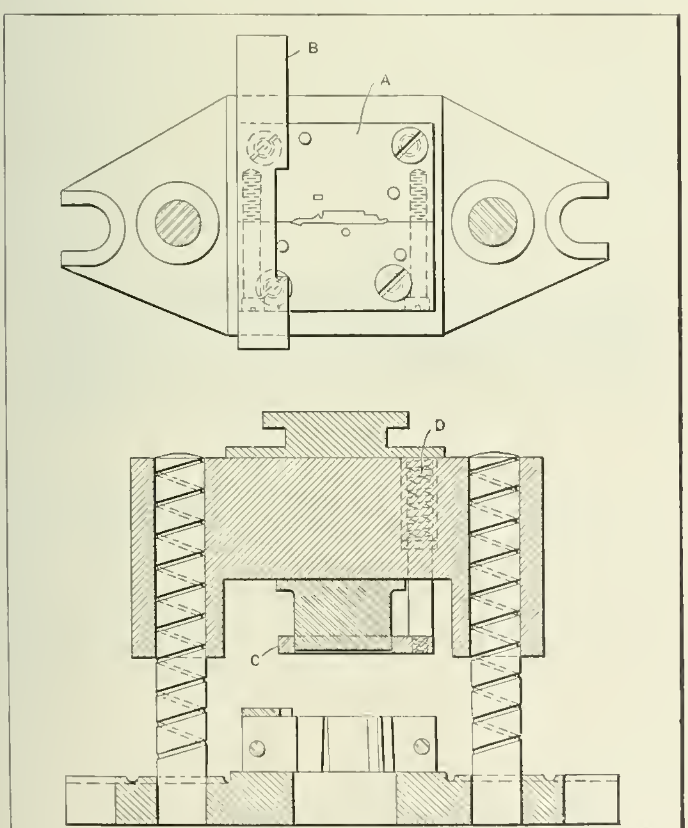


Fig. 4. Improved Blanking Die which worked successfully

fastened to the upper member of the frame with a screw as shown; it is actuated by the springs *D*. This construction leaves an open die, easy to operate and keep clean. The stock is fed in from the rear, so that the operator pulls it toward him. The die is of the post type as shown, as is also the shaving die shown in Fig. 5.

In the shaving die shown in Fig. 5, the blank is placed in the swinging nest in the upper part of the engraving. This nest has a bushing *B* inserted in it which is hinged or swings on the post *A*. A bushing *D* is fastened in the nest and as the punch descends the pilot *C* enters into it, and locates the nest in the correct position relative to the punch and die. The blank is ejected by the shedder *E*, actuated by the springs *S*. The construction of the shaving die is shown plainly and needs no further explanation. A. C. Lindholm

New Haven, Conn.

LEVELING A HEAVY LATHE

"I chanced to be passing our testing floor just as the head inspector was going over the 42 inch lathe recently shipped to the X. Y. Z. Railroad Co.," the trouble man was saying on his return from a recent trip, "and as a matter of curiosity stopped to see how the alignment was on that particular machine. The tail spindle measured 0.002 inch high and the

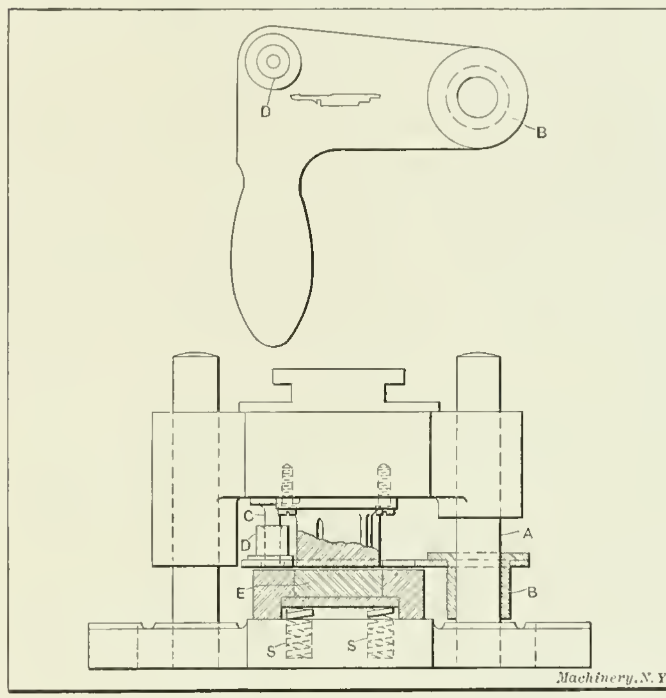


Fig. 5. Shaving Die used for Finishing the Stops

indicator with a 36 inch test bar, showed that the head and tail spindles were in perfect alignment.

"You can therefore imagine my surprise when, some two weeks later, the master mechanic of that road called me up on the long distance 'phone and said that he was trying to bore the hub of a 42 inch car-wheel on this new lathe, and that the best he could do was to get a hole which was 0.011 inch small at one end in a hub only 4 inches long. I asked him if his boring-tool had not sprung; he was sure it had not. I then asked him if the lathe was level; he was sure it was, as he had seen that attended to very carefully. Apparently it was necessary for me to go and try to straighten out the matter.

"When I went to the shop the next morning I found the lathe resting on wooden wedges. The floor was of boards laid on top of concrete. The machine looked rather shaky.

"I asked the master mechanic if he would get his level so that we could test the leveling at all points of the bed. He brought a carpenter's level and laid it across the V's. Just as he expected, it showed that the machine apparently was set all right. Fortunately I had a sensitive level with me and laid my own alongside of his. In my level the bubble was not even visible in the glass, so badly was the bed out of level. I then showed the master mechanic that it was possible to raise one end of his level a full one-quarter inch without making an appreciab'e difference in the location of the bubble.

"Then I had the blacksmith make a number of wide iron wedges; we moved the lathe to one side and took up the floor

where the machine was to stand so as to get down to the concrete bottom, laid 2 inch by 4 inch timbers on the concrete with the iron wedges spaced at intervals along the timbers, and placed the lathe on top of these wedges. It was then a simple matter with the sensitive level to set the bed perfectly level both across the V's and lengthwise of the bed. Having done this, I had a batch of concrete mixed up and poured into the space enclosed by the 2 inch by 4 inch timbers underneath the lathe. This gave an absolutely solid foundation right up to the bottom of the bed.

"We let the cement set over night and the next morning I again tried the level on the machine. There had been no change and the setting was perfect. I then told the machinist to put in the car-wheel and bore the hub again; he did so and on trying the hole with internal micrometers, could not find a particle of difference in diameter at the front and back." H. M. Wood

Cincinnati, Ohio.

SQUARE VS. SPLINED CHANGE-GEAR SHAFTS

The writer has read with interest the article in the October number, engineering edition, on the design of automobile transmission gears by Mr. M. Terry, and while from a point of general information this article is valuable, yet there are certain conclusions reached by the author, which, had a more detailed consideration been given to them, would probably have resulted differently.

Referring particularly to the discussion of the advantages of the square and spline shafts for sliding gears he arrives at the apparent conclusion that of the two the square shaft possesses greater advantages than does the spline, hence we would be led to believe that the undoubted preference which he himself states to exist among automobile users as well as manufacturers for the spline shaft, is but a whim and that no real advantage accrues to the purchaser or user of this, and that its use degenerates to the mere "talking point" of the salesman. There are, however, certain technical considerations entering into the matter, which have caused many manufacturers to use the more expensive construction.

In the first instance, as he himself stated, the resisting moment of the spline shaft is, as a rule, greater than that of the square occupying the same space. It is true that the splines on the shaft must resist shearing stresses. This, however, need not be a condemnation of their use as they can readily be made of a sufficient circumferential width to easily withstand the same. To offset this shear there is the advantage that in the spline shaft the torsional forces are tangential and induce shearing only in the gear hub while with the square shaft these forces are largely deflected from a tangential toward the radial in the gear hub, tending to burst the hub and thus finally to enlarge the hole. This enlargement in actual practice proceeds rapidly until the usefulness of the gear is destroyed owing to its wobbling on its shaft and producing that undesirable concomitant of the ancient motor car and the bane of all careful manufacturers—noise.

Granting that both types of shafts are casehardened, it may be true that the square shaft is more cheaply ground, but of what avail is this when the gears sliding on it are also casehardened, and how is it proposed to overcome the distortion of the square hole? It cannot be ground. [?] Hence this can be overcome in only one way, that is, to allow sufficient tolerance in this hole so that the gear will slide fairly well and possibly hit some spots on its shaft. Reverting to the spline shaft, the tops of the splines are easily ground, but that this shaft can be ground only there is not true, for the writer knows of at least one manufacturer of thousands of these shafts with integral splines, every one of which is ground to a cylindrical surface between the splines. As for the gears sliding on this type of shaft owing to the circular hole therein, even though they do distort in hardening, it is possible, and indeed common practice, to grind the bore; hence, we find in the transmission assembly in which the spline shaft and the sliding gears have been treated in the above manner, gears that at the outset and for all time are accurately centered and closely fit their shafts; gears that run true and never wobble; gears that always slide easily because the hubs thereof are not distorted by any ill-disposed line of pressure and are as quiet in their second year of running as in their first.

Thus we see that the preference of the buying public for the spline shaft gear set is not based on our author's "talking point," but is backed by their experience with noisy second-year square shaft transmissions and moreover by sound technical logic. Frederick Hughes

Sharon, Pa.

MILLING FIXTURE FOR CUTTING WORMS

In Fig. 1 is shown a simple fixture for cutting worms in the milling machine. The body *A* of the fixture is made from cast iron and is held in the vise of the machine. A hole is bored through the casting *A*, a bushing *B* is inserted in one end, and shaft *C* having a thread the same pitch as the worm to be cut is screwed into this bushing. The handwheel *D* is

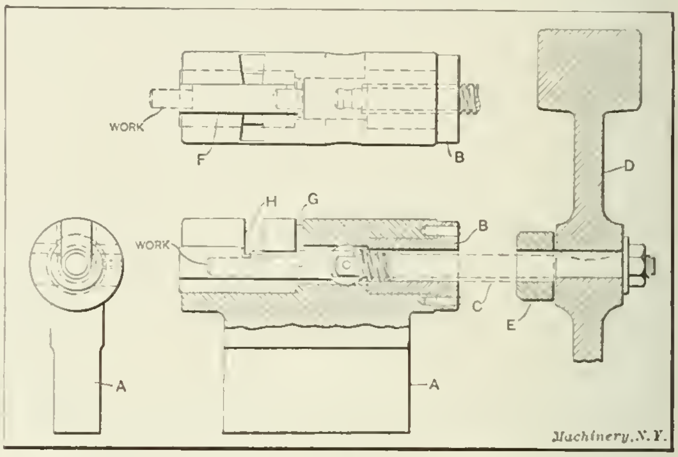


Fig. 1. Milling Fixture for Cutting Worm shown in Fig. 2

fastened onto the end of the shaft *C* and held with a key and nut. A washer *E* acts as a stop, determining the length of the thread to be cut. The piece to be cut is shown by the dotted lines in the lower view in position where the milling cutter starts to operate; and in the upper view it is shown in position at the end of the stroke. Slots *F* and *G* are cut in the top part of the fixture to allow the work to be easily re-

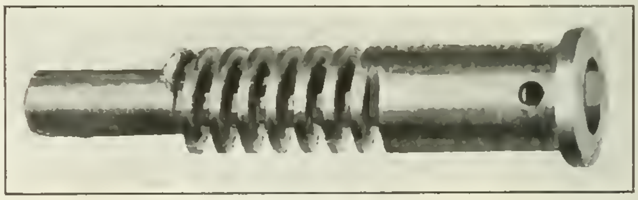


Fig. 2. Worm to be milled

moved. The slot *H* is cut at an angle to clear the milling cutter when the fixture is set at the required angle. When cutting the worm, the milling vise is set off at an angle corresponding to the pitch of the worm.

The worm to be cut is shown in Fig. 2. The finish is not all that could be desired, but the cutter used was 3/8 inch pitch. If good results are to be expected, the pitch of the cutter should not be greater than 5/32 inch on a worm of this diameter which is 0.620 inch. The feed also should be slight as this method of holding the work is not very rigid.

Buffalo, N. Y. Charles Weslow

CUTTING A MULTIPLE-PITCH WORM

To cut a multiple-pitch worm in the lathe, multiply the pitch by a whole number and divide the number thus obtained into as many parts as the worm has starting points. The number of inches thus obtained indicates the distance to which the saddle must be brought back after each cut. For example, if a worm is 3½ inches in diameter by 4½ inches long, and is 2⅝ pitch with a triple thread, then $2\frac{5}{8} \times 8 = 21$,

and $\frac{21}{3} = 7$. Now to cut the worm, take the first cut, stop the lathe and bring the saddle back 7 inches. Engage the nut on the lead-screw and take the second cut, and so on until the worm is finished. If the worm were 11 inches long, then the distance would be double so that it would insure the tool coming clear of the end of the worm for each cut. If the worm had a double thread, then the distance to which the carriage must be brought back for each cut would equal $\frac{21}{2} =$ 10½ inches. This has been found a quicker and more accurate method than by marking the gears. S. H. C.

ADAPTERS FOR HOLDING LARGE THIN WASHERS WHILE TURNING

The large washer shown in Fig. 1, 6½ inches diameter, was first blanked out in a punch press, but as this left a ragged edge and did not give the desired finish, it was deemed advisable to turn the external and internal diameter. For this operation two adapters were made, as shown in Figs. 2 and 3,

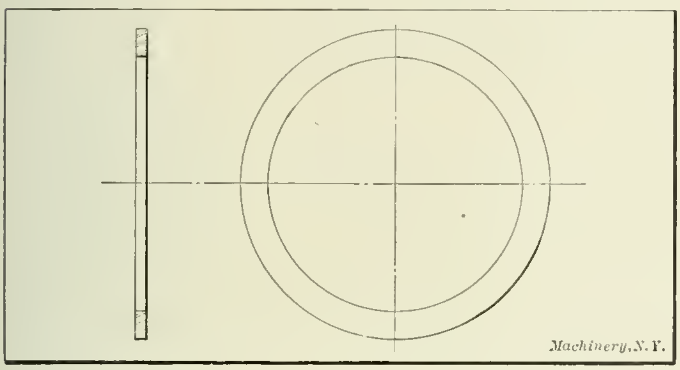


Fig. 1. Large Thin Washer to be turned

which were found to be very satisfactory. These adapters were threaded in the rear end to fit on the nose of the spindle of a No. 6, Warner & Swasey turret screw machine. Of course, it is obvious that the same design of adapters could be used on any screw machine having a wire feed by simply changing the thread in the rear end to suit the nose of the spindle. These adapters have a great advantage over the ordinary chuck owing to the fact that no wrenches are required to tighten the work in them as the work is tightened by means of the sleeve passing through the spindle which operates the spring collet. The amount left on the outside and inside diameters of the rings for finish turning in the screw machine was 1/32 inch, which was found sufficient to true them up and

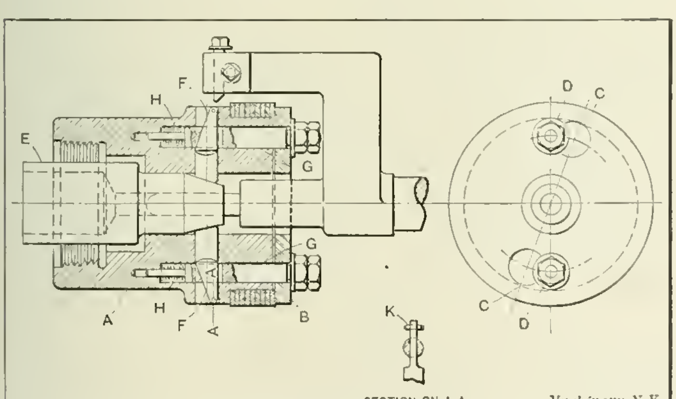


Fig. 2. Adapter used in Holding the Washers while Turning their External Diameters

give them a good finish, it only being necessary to take one cut inside and out.

The body A of the adapter Fig. 2 is made of cast iron, finished all over and drilled and reamed as shown. The clamp B which holds nine of the rings in place is made of machine steel, and the holes C are drilled large enough to pass over the lock-nuts D. The hole C is elongated so that it can be locked under the lock-nuts simply by turning the plate B to the left. The plunger E is of tool steel, hardened and ground on the outside diameter, and the hole for the leader of the turning tool is also ground concentric with the outside diameter. The plunger is bored out large in diameter at the back to reduce its weight, and is made a sliding fit in the casting A. The operating and locking pins F and G are made of machine steel and casehardened. G has a slot through its center similar to that shown in section AA. The rear end of the slot has the same angle as the edge of the operating pin F which passes through it. The small pin K shown in the top end of the operating pin F, prevents it from dropping out when the plunger E is removed. The first operation on the rings is to remove 1/32 inch from the outside diameter in the adapter shown in Fig. 2. Nine rings are placed in this adapter as shown. The clamp B is put on by placing the large holes C over the nuts; then by turning the plate to the left it is locked underneath the lock-nuts D. To clamp the rings in the adapter proceed as follows: After loading and placing the clamp B in position trip the lever, which operates the closing of the chuck by forcing the sleeve in the spindle forward. This comes in contact with plunger E which, in turn, forces the clamp pins F outward, thus drawing back the clamping bolts G. After the cut is taken, the lever for opening the chuck is again operated and the small coil spring H forces the clamping bolts G outward, thus releasing the pressure on plate B, when it can be easily removed. This finishes the first operation, after which the rings are ready to be finished inside.

The adapter for holding the rings while turning the inside is shown in Fig. 3, and is constructed somewhat similarly to

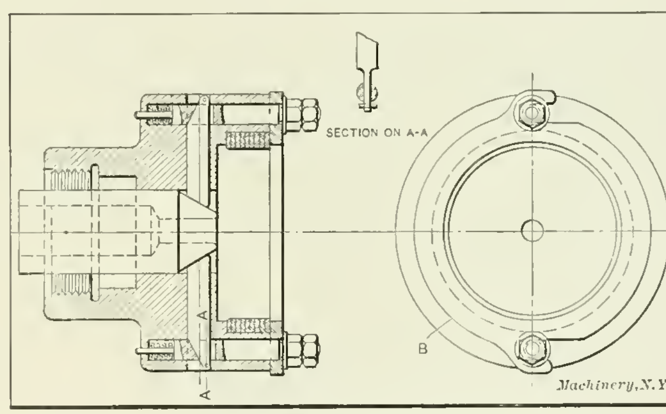


Fig. 3. Adapter used in Holding the Washers while Turning their Internal Diameters

that just described, with the exception that it is bored out to receive the rings. The method of opening and closing this adapter is similar to that shown in Fig. 2, but the cap B is removed by pulling it out instead of twisting it around to bring it over the nuts. A tool-holder with a leader, not shown in the illustration, is also used for the second operation on the rings. Ralph E. McCoy

Cleveland, Ohio.

SPACING THE CUTTING EDGES OF REAMERS

In the August number of Machinery there was an editorial note asking for information regarding the irregular spacing and the spiral fluting of reamers. In regard to this the writer would say, that the first and possibly the more common method is to stagger the flutes in pairs, and the second method is to stagger the flutes all but one pair, using this pair to measure up by. The best method to prevent chattering where a suitable measuring instrument can be obtained, is to make the reamer with an odd number of flutes, generally 5, 7, 9 and 11, the number of flutes depending, of course, on the size of the reamer; but this method involves difficult measuring. As regards the spiral fluting, there is very little advantage to be gained except in the case of taper reamers, but as the conditions under which a reamer is used govern to a considerable extent the spiral to be given, no definite rule

can be given for this. It is safe to say, however, that in nearly all cases the spiral should be left-handed, especially if they are to be used for machining, otherwise they will bite into the work and cause considerable trouble. For large taper hand reamers which are used in cast iron, especially where the taper is very great (over 2½ inches per foot), a right-hand spiral will make it much easier for the man who is doing the pushing. If reamers are to be used on all classes of work, the writer would much prefer to cut them central or radial, though it is much better practice to give a negative rake for brass and a positive rake for steel, while for cast iron a reamer cut radial will give better results.

H. M.

DEVICE FOR FACING MITER AND BEVEL GEARS

In one of the largest factories in the Middle West small gears are roughed out in large quantities in an automatic machine, and have to be sized correctly in a lathe, that is bringing the peak in the correct relation to the face, before cutting the teeth. This ordinarily requires careful work and also a frequent use of the gage, and even then a gear is frequently turned too thin, as expert workmen cannot be employed on this class of machining, apprentice boys usually getting the job.

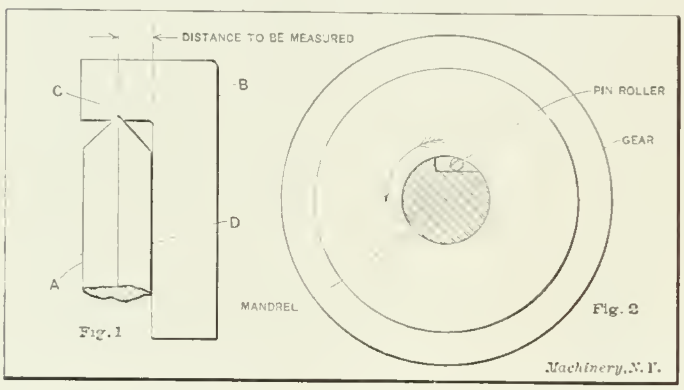


Fig. 1. Method of Measuring the Distance from the Peak to the Side of the Gear

Fig. 2. Cross-section of Pin-roller Mandrel showing how Gear is locked by the Roller

The type of gage used and its application is shown in Fig. 1, *A* representing the gear; *B* the gage, and *C* and *D* the parts to be gaged, while in Fig. 3 is shown the device used to do away with the too frequent use of the gage. It must, of course, be understood that only a single cut is taken across the outer side in this operation. The attachment used on the lathe cross-slide to correctly locate the tool is shown in detail in the upper part of the engraving, and in the lower part in position on the cross-slide. In the detail view *A* is a cast-iron clamp wide enough to fit easily over the cross-slide; *B* is a post made of cold-rolled steel, which is drilled and tapped as shown, and *C* is a strip of sheet steel, in the end of which a notch has been filed corresponding to the shape and angle of the outside of the gear blank. In using this attachment, a gear blank is first placed on a pin-roller mandrel, a cross-section of which is shown in Fig. 2, and up against a collar as shown in Fig. 3; when it is carefully faced off correctly by measuring the distance from the peak to the side with the standard gage shown in Fig. 1, the templet *C* is run up to the blank as shown and the tool set so as to just skim the surface previously faced, which insures the proper relation between the cutting tool and the notch in the templet. After this all that is necessary is to place the gear blanks on the mandrel tight against the collar, as the tool has been correctly located by setting the templet, and then all the gears are faced off on one side. The mandrel is made small on the outer end so that the cut may be run completely across the side. After all of the blanks have been surfaced off on one side they are again placed on the mandrel with the finished side next to the collar and the carriage stop *D* is used to retain the correct distance for the total thickness after the tool has been set from a finished gear blank.

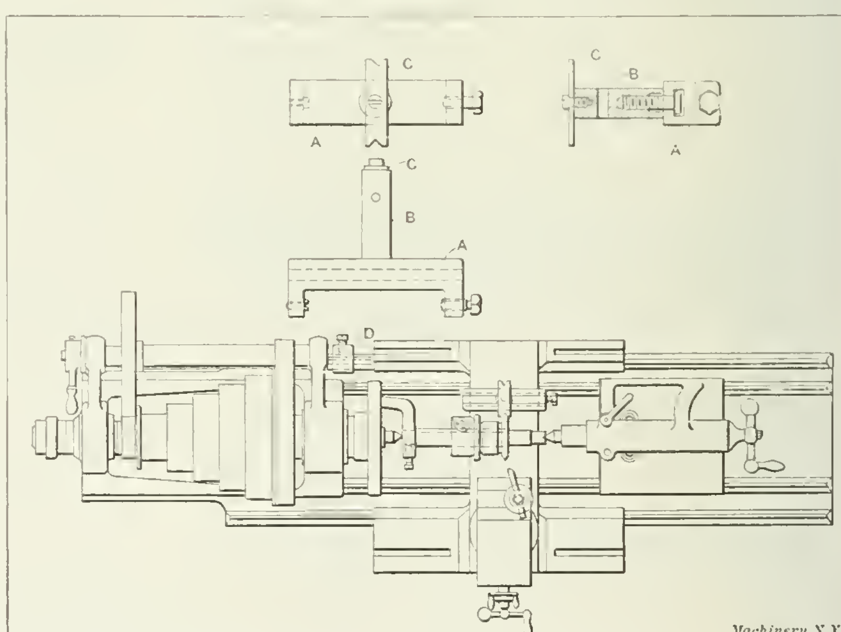


Fig. 3. Method used in Facing Miter and Bevel Gears

A stub-roller mandrel and collar could be used in some cases to better advantage than the one shown.

Cincinnati, Ohio. J. E. Emig

PERTINENT POINTS ON JIG AND FIXTURE DESIGN

Under this heading in the October number of Machinery is a criticism of an article which appeared in the August number.

As far as any rule, guide, standard or system in regard to bushings is concerned, the only one to follow is "horse sense." Theory does not work out in practice in all cases, and methods, like everything else, change locally to such an extent that there is no hard and fast rule which can be laid down. By changing around from one shop to another, you find that certain methods which are called impractical in one place, are used with success in another place.

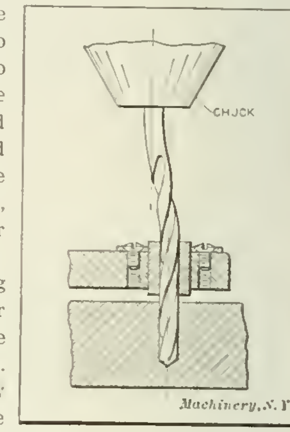


Illustration showing how Drill is straightened by the Drill Bushing

The length and style of bushing has to fit the particular case. For example, you would not use the same length of bushing for a No. 60 drill, in a jig weighing a few ounces that you would in one weighing two or three pounds. With the small jig, the drill could move the jig into line, and a short bushing would answer very well, but with the larger jig, the bushing would naturally have to be longer.

As the writer sees it, the length of a bushing does not have much to do with a drill drilling true, but it should have length for wear. The drill is held in the chuck at one end, and the bushing guides the other. If the hole in the bushing is not in line, of course it deflects the drill, but when the drill is once entered, the bushing will straighten it up, that is, the part that is in the bushing, as shown in the accompanying illustration. It is the same as a plug in a hole. It is impossible to cramp a plug that fits a hole, and the high speed of a drill serves the same purpose.

As regards the clearance between the bushing and the work, this is also a matter of choice. In cast iron, the chips

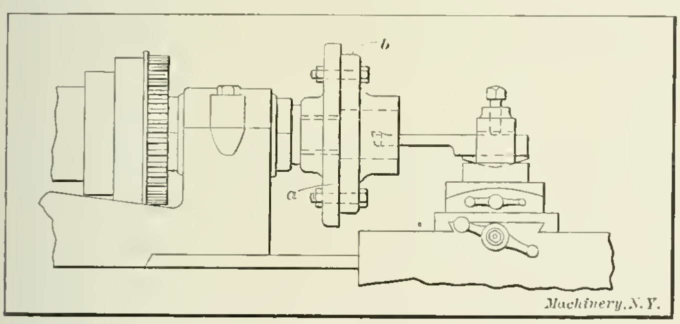
will crumble away under a bushing very close to the work, but in steel the longer chips are apt to give trouble. In many shops the bushings are made with a head on the inside of the jig to serve as a support for the piece to be drilled, which is good practice in several ways. It makes small bearing points to keep clean, the chips follow the drill grooves and never clog, and it means that the hole must start accurately. This method is only used when the piece to be drilled has a smooth face which comes in contact with the bushing.

The question of heads to prevent drilling holes in the jig, is another one that has its different points. Mr. T. Covey says that the man who drills holes in the jig cover or lid should be discharged. This is all very true, but let Mr. Covey work in a part of the country where press hands are as scarce as "hen's teeth" and you have to educate all your help or else import them from another part of the state, and if this were followed up, he would soon close up shop.

A method which is cheaper and better than using a head on the bushing is to make the bushing just a plain straight one and use a plate of 1/32 inch machine steel pack-hardened, to protect the jig. This plate is screwed on with small flush-head screws. The advantage is a cheaper bushing, and by stamping the drill size on the plate, in case the size is changed the plate can easily be replaced, while if stamped into the jig you have to cut out the marking, providing, of course, that it is not already drilled out by the operator. C. A. T.

BORING AND TURNING A CHUCK PLATE CASTING

In the Shop Operation Supplement of MACHINERY, September, 1910, with reference to boring and turning a chuck plate casting in the lathe, it was shown that the casting was held in a three-jawed chuck. This the writer does not consider the best method of doing the operation, as he has done the same



Improved Method of Machining a Chuck-plate Casting

job several times in this way, and found it both slow and tedious. Usually the job is done on the lathe to which the chuck plate is fitted. Every time it had to be tried on the spindle, it was necessary to take the chuck off with the plate in it, reverse it, and hold it on the arm, which was a very tiresome and tedious operation, and there was also danger of the plate shifting in the chuck, owing to its weight. When the chuck was taken off and replaced the unfinished thread in the chuck plate did not always run true, which resulted in a poor job.

An improved method of machining a chuck plate casting is shown in the accompanying illustration. Here the chuck plate is bolted to the dog or driving plate of the lathe instead of being held in the chuck. The machining of the chuck plate is as follows: First the chuck plate is set up in the chuck and a roughing cut taken across the face *a*, and also the edge *b*. A line is then "spotted" with the tool on the face of the casting, the same size in diameter as the diametral distance between the centers of the bolt holes in the chuck which the plate is to fit. When this is completed the chuck plate is taken out and fastened onto the dog plate as shown, the bolts passing through the holes which were previously drilled in the plate. The weight of the dog plate is comparatively trifling and it usually runs true when replaced. The chuck plate is trued up on the dog plate by the outside diameter *b*. The remainder of the work, after the inside is bored and threaded, is turned in the usual way on the lathe spindle.

New York. H. ROBINSON

DIMENSIONING DRAWINGS

The writer offers the opinion that the article in the October number of MACHINERY entitled "Improved Method of Dimensioning Jigs and Fixtures," by Jig and Tool Designer, is very misleading to say the least.

It is stated therein that some dimensions are important to 0.0005 inch and to meet other conditions must be indicated from an established hole, surface or line while others are near enough if laid out with the ordinary tools. To mix up such dimensions on a drawing is to force the toolmaker to spend much more time on a piece of work than the requirements demand. If all dimensions are given from the center lines the only way to distinguish between those intended to be correct and those approximate is to give the former as decimals and the latter as common fractions. This seems absurd because on a milling machine with correct screws it is just as easy to get a measurement accurate as approximate.

Now suppose a hole is located 2.603 inches on the left of the vertical center line and the next hole in the series of operations is 1.937 inch to the right of the center line, it is safer to give one dimension as the total distance between the holes than to leave the addition to the workman, for they must be added in some manner to get from one side of the center to the other. This would be especially true if there was no milling machine in the tool room and the work had to be done on a lathe, for on a lathe it would be imperative that dimensions be given from one hole to the next. To one familiar with indicating on a faceplate the truth of the above statement will be readily apparent. In making drawings, the shop equipment must be taken into consideration.

The writer feels safe in saying that to get accurate results on small automatic machinery it is many times absolutely necessary to work to radial and angular dimensions. To say that one method is correct and another incorrect shows poor judgment, for in drafting as, perhaps, in no other profession, each case must be settled on its own individual merits and it is the draftsman who recognizes this fact rather than the one who tries to follow fixed rules, who meets with the greatest success.

It would be interesting to know the experience of others in regard to the methods used in dimensioning drawings.

Roslindale, Mass. WILLIAM C. GLASS

THE MACHINIST VS. THE DRAFTSMAN

The machinist knows his biz,
Full of ginger and wisdom is.
To teach the draftsman, hand him one,
Correct his blunders, one by one
Is fondly dreamed in the shop,
In this reform one may not stop,
But gamely push on to the end
Or scribblers all to Hades send.
No let up, the machinist knows
In handing to the draftsman blows,
All figures wrong, all lines awry,
"Correct this lively, quick, step spry,
You nothing know of methods true
To do work right is not in you,
Go to it, man, and something learn."
Such the machinists' mandate stern.

But wait, another day rolls round.
"This job's a tough one, I'll be bound,"
To drawing-room he goes in sorrow,
That figure-fellow's wits to borrow.
"Come, lend your head, I'm in a fix.
That work went wrong, your figures, nix.
There's nothing mean about you folks,
The things we said were meant for jokes.
How can we figure out the angles?
These sine and tangent things are tangles.
Not meant for shop men, such as us,
They only get us in a muss,
Come, set us straight, we all are friends,
For wrong that's done we'll make amends.
We know full well your lines are true,
For figures we must look to you."

"Now look here, you machinist fellow,
Before again you boldly bellow,
Consider not the things you know,
Sum up all wisdom here below.
Your hasty thoughtless roar of brass
Is fully equalled by the ass.
Each to his part with equal care,
Your skill, our wit may well compare.
When lines confuse your woolly pate,
Our task is to elucidate.
Fault-finding let us leave to boys,
But newly weaned from childhood toys,
Our mutual efforts all must trend
To swell the boss's dividend."

Cincinnati, Ohio. GEORGE W. HART

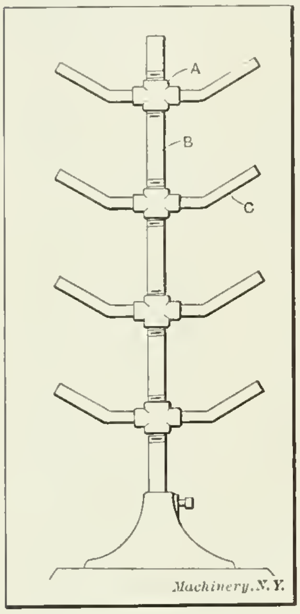
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

STOCK RACK

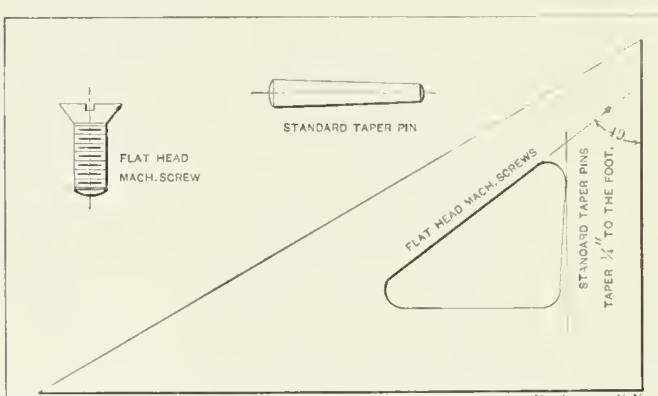
A rack that is designed for holding long rods of bar stock is shown in the accompanying sketch. This rack is particularly adapted to the screw machine department where, in many instances, stock is left on the floor for lack of sufficient room on the rack usually furnished with screw machines. Standards or racks of this construction can also be used in connection with the screw machine as supports, by adding a suitable supporting piece to the top. The number of arms or brackets can, of course, be made to suit requirements. The cost of this rack is comparatively small as all parts can be purchased ready to assemble. Part *A* is a ¾-inch by ½-inch malleable cross; *B* is a ¾-inch by 6½-inch nipple, and the arms *C* are also made of pieces of pipe, ½ inch in diameter by 8 inches in length. The nipples and pipe are extra heavy. The base may be obtained from the Brown & Sharpe Mfg. Co. These racks can also be used to good advantage in the stock-room for holding either rods or sheet metal.



Detroit, Mich. WILLIAM F. HOFFMANN

DRAWING TAPER PINS AND FLAT-HEAD SCREWS

Take a 60-degree celluloid triangle and cut away on the edge of the opening near the base or short side of the triangle an angle suitable for standard taper pins; and on the edge of the opening near the longest side of the triangle cut the proper angle for flat-head machine screws. This will be found a handy templet in drawing taper pins and flat-head machine or wood screws, and not only saves the time necessary to get out a protractor, but cuts down the number of extra pieces lying around on the board. FRED. G. KENYON



Pawtucket, R. I.

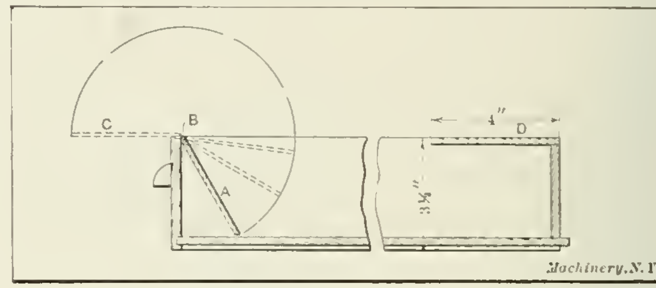
A KINK FOR THE DRAWING CABINET

The ordinary cabinet used for the filing of tracings and blueprints, is, at times, a source of annoyance and expense; the ends of the drawings have a tendency to curl up, with the result that in opening a drawer which provides for no protection to the contents, tracings and prints are sometimes caught and torn or creased—possibly ruined.

A cabinet equipped with the simple devices shown in the accompanying illustration will be found a decided improvement over the conditions found in many drafting rooms. Interference with the contents in opening a drawer cannot occur, and the usual bar of scrap iron need not be in evidence.

At the front of the drawer a thin wooden strip *A* is hinged at *B*, and extends the entire width of the drawer. In cabinets holding drawings up to 42 inches wide, two 1¼ inch back flaps will be found most suitable. When the drawer is opened and in use, this strip is flung back as shown at *C*, leaving the contents unobstructed. The dotted positions of *A* show that the strip will keep the drawings flat and protected to the capacity of the drawer.

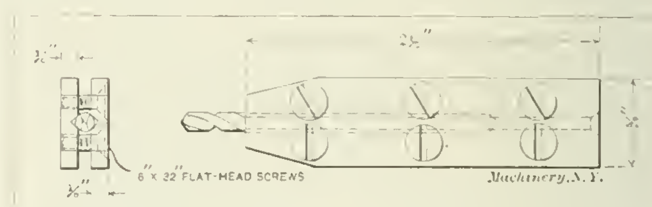
At the rear end of the drawer a fixed strip *D*, of suitable stock and about 4 inches wide, is fastened. This protects the contents at this point from working over the back. These additions can be applied to any size of drawer, and, while they can be more conveniently added while a cabinet is in the course of construction, they are also applicable to a constructed case. The slight expenditure involved is amply repaid by the usefulness and protection afforded to the drawings.



Los Angeles, Cal. L. R. W. ALLISON

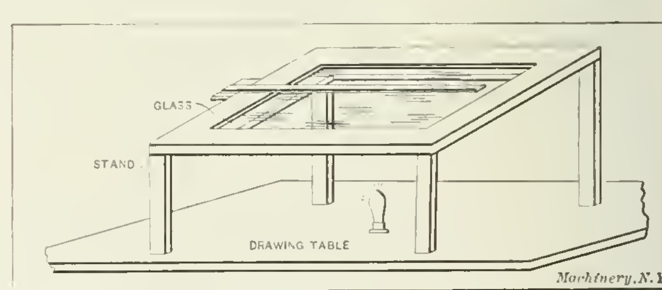
CHEAP DRILL HOLDER

The accompanying illustration shows a cheap and simple drill holder for holding small drills when drilling in the lathe. As will be seen, this will hold a drill very securely if well made, and very small drills can be held in this manner. If the grooves are cut 1/32 inch deep it will hold a drill from 1/16 inch to 3/16 inch in diameter. S. C.



TRACING THROUGH THICK PAPER

The writer was once called upon to make a number of show drawings. These were to be made on Whatmans hot pressed paper and were to be duplicates of tracings we had on hand. At first it seemed quite a task to draw these off in pencil and then ink them in, as considerable scaling would be necessary. A shorter method than this was devised and is as follows: A piece of glass was set in a frame and used as a drawing-board By putting this on a stand over an incandescent light as shown in the illustration, and putting the tracing paper under the heavy paper, it was found an easy matter to follow the outlines of the tracing. This was a very simple arrangement and saved considerable time. D. F. HUDDLE, JR.

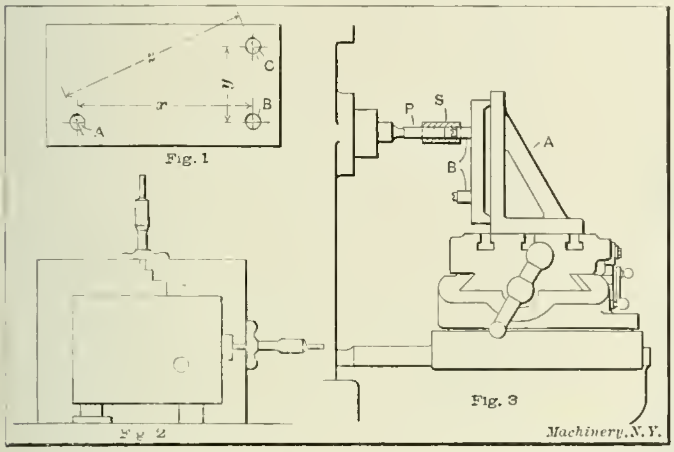


Wilkinsburg, Pa.

MACHINE SHOP PRACTICE*

SETTING WORK FOR BORING ON THE MILLING MACHINE

It is often desirable to perform boring operations on the milling machine, particularly in connection with jig work. Large jigs, which because of their size or shape could not be conveniently handled in the lathe, and also a variety of smaller work, can often be bored to advantage on the milling machine. When such a machine is in good condition, the necessary adjustments of the work in both vertical and horizontal planes can be made with considerable accuracy by the direct use of the graduated feed-screw dials. It is good practice, however, when making adjustments in this way, to check the accuracy of the setting by measuring the center distances between the holes directly. For example, if holes were to be bored in a jig-plate, as shown in Fig. 1, hole *A* would be finished first; then after the platen had been moved a distance x as shown by the feed dial, hole *B* would be bored



Figs. 1, 2 and 3. Illustrating Methods of Setting Work to be bored

slightly under size. Plugs should then be accurately fitted to these holes, having projecting ends, preferably of the same size. By measuring from one of these plugs to the other with a vernier or micrometer caliper, the center distance between them can be accurately determined, allowance being made, of course, for the radii of each plug. If this distance is incorrect, the work can be adjusted before finishing *B* to size, by using the feed-screw dial. After hole *B* is finished, the knee can be dropped a distance y as shown by the vertical feed dial, and hole *C* bored slightly under size; then by the use of plugs, as before, the location of this hole can be tested by measuring center distances y and z. This method of testing with the plugs is intended to prevent errors which might occur because of wear in the feed-screws or nuts that would cause the dials to give an incorrect reading. On some jig work, sufficient accuracy could be obtained by using the feed-screw dials alone, that is, without testing with the plugs, in which case the accuracy would depend largely on the condition of the machine.

For the purpose of obtaining fine adjustments in connection with milling machine work, the Brown & Sharpe Mfg. Co., makes special scales and verniers that are intended to be attached to the machine so that the table may be set by direct measurement. By attaching a scale and vernier to the table and saddle, respectively, and a second scale to the column with a vernier on the knee, both longitudinal and vertical measurements can be made quickly and accurately.

The use of the button method as applied to the milling machine is illustrated in Fig. 3 where a plain jig-plate is shown set up for boring. The jig, with buttons *B* accurately located in positions corresponding to the holes to be bored, is clamped to the angle-plate *A* that is set at right angles to the spindle. Inserted in the spindle there is a plug *P*, the end of which is ground to the exact size of the indicating buttons, and closely fitted to this end there is a sliding sleeve *S*. When the work is to be set for boring a hole, it is adjusted until the sleeve *S* will pass over the button marking the location of the hole, which brings the button and spindle into alignment. After the button is set by this method, it is removed and the plug in the spindle is replaced by a drill and then by a boring tool or reamer for finishing the hole to size. In a similar manner the work is set for the remaining holes. The plug *P* for the spindle must be accurately made so that the outer end is concentric with the shank, and the latter should always be inserted in the spindle in the same relative position. With a reasonable degree of care, work can be set with considerable precision by this method, providing, of course, the buttons are properly set. Some toolmakers use, instead of the plug and sleeve referred to, a test indicator for setting the buttons. This indicator, which is similar to the kind used in a lathe, is attached to and revolves with the spindle, while the point is brought into contact with the button to be set. The difficulty of seeing the pointer as it turns, is a disadvantage, but with care accurate results can be obtained.

Another method which can at times be employed for accurately locating a jig-plate in different positions on an angle-plate, is shown in Fig. 2. The angle-plate is, of course, set at right angles to the spindle as before, but in this case, depth gages and size blocks are used for measuring directly the amount of adjustment. Both the angle-plate and work should have finished surfaces on two sides at right angles to each other, from which measurements can be taken. After the first hole has been bored, the plate is adjusted to the required distance both horizontally and vertically by using the standard size blocks in conjunction with the micrometer depth gages, which should preferably be clamped to the angle-plate.

A method that is a modification of the one previously referred to in which plugs were used to test the center distance is as follows: All the holes are first drilled with suitable allowance for boring, the location being obtained directly by the feed-screw dials. A special boring-tool, the end of which is ground true with the shank, is then inserted in the spindle and the first hole, as at *A* in Fig. 1, is finished, after which the platen is adjusted for hole *B* by using the dial as before. A close-fitting plug is then inserted in hole *A* and the accuracy of the setting is obtained by measuring the distance between this plug and the end of the boring-tool, which is a combination tool and test plug. In a similar manner, the tool is moved from one position to another, and, as all the holes have been previously drilled, all are bored without removing the tool from the spindle.

When a vernier height gage is available, it can often be used to advantage for this kind of work, and this method is one which requires little in the way of special equipment. The work is mounted on an angle-plate or directly on the platen, depending on its form, and at one end an angle-plate is set up with its face parallel to the spindle. An accurately finished plug is inserted in the spindle and this plug is set vertically from the platen and horizontally from the end angle-plate by measuring with the vernier gage. After the plug is set for each hole, it is, of course, removed and the hole drilled and bored or reamed.

By the use of a vertical attachment on a horizontal machine, jigs can often be conveniently bored by strapping them directly to the platen, thus doing away with angle-plates.

The proper method to employ for setting a given piece of work depends on the refinement required. In general, the best method would be one by which the necessary accuracy could be obtained with the least expenditure of time.

* * *

An ingenious scheme for overcoming the brittleness of the tungsten lamp filament when not burning has been devised by E. M. Fitz, the electrical engineer of the Pennsylvania Lines West of Pittsburg. This method consists in having a small current pass through the lamp when extinguished. On cars using 63 volts (32 cells), the two end cells of the battery, giving four volts, are connected to the lamps when extinguished. This keeps the filament at a faint dull red and makes it as strong as that of a carbon lamp. Recent tests show that the life of a tungsten lamp will vary from 1500 to 2000 hours when this system is used.

* With Shop Operation Sheet Supplement.

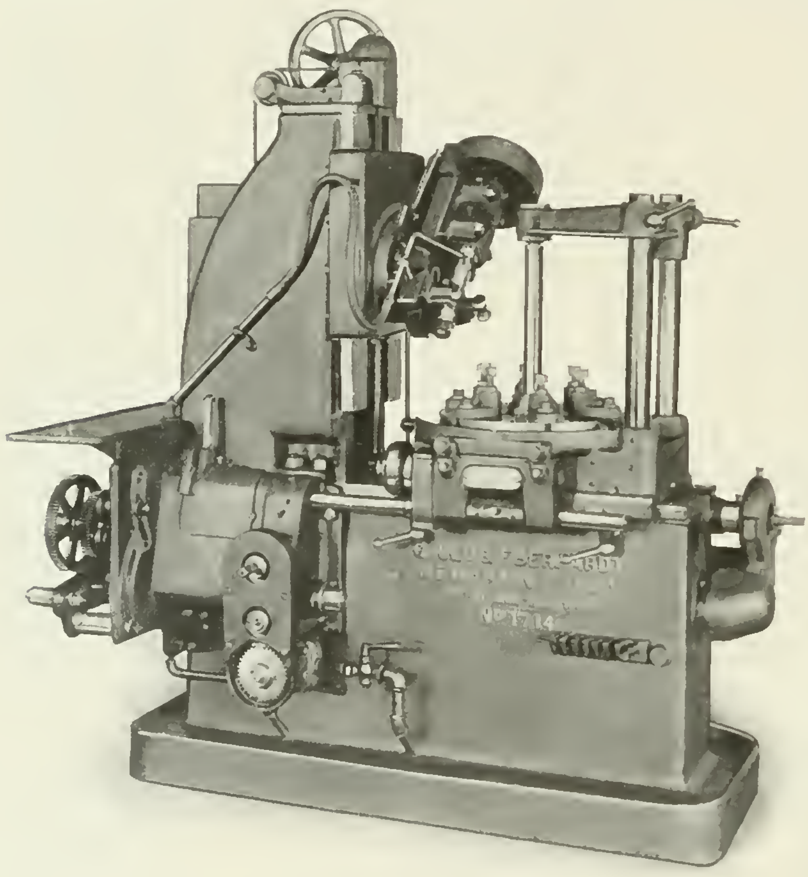
NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

GOULD & EBERHARDT'S GEAR HOBBING MACHINE

One of the latest additions to the line of gear hobbing machinery manufactured by Gould & Eberhardt, Newark, N. J., is shown herewith. This machine is designed for cutting spur, helical and worm gears, and it has been the aim of the builders to so construct it that modern high-speed steel hobs could be driven to their maximum of efficiency; particular attention has also been given in the design to convenience of operation. The following description applies to two sizes of this machine, the 12- by 6-inch size with a capacity of 5 diametral pitch in cast iron and 6 diametral pitch in steel, and the 24- by 10-inch size with a capacity of 4 diametral pitch in cast iron and 5 diametral pitch in steel.



Gould & Eberhardt Automatic Gear Hobbing Machine for Spur, Spiral and Worm Gearing

The Work-table

The faceplate or revolving work-table of this machine is integral with the worm-wheel through which it is driven, thereby giving a rigid construction and reducing torsion to a minimum. The table is supported at its periphery by a bearing on the work-slide and it also revolves upon an anti-friction washer. The drive is so arranged that the table can be rotated in either direction to accommodate right- and left-hand spiral gears. The work-slide on which the table is mounted can be adjusted longitudinally on the bed or base, which adjustment is necessary when setting for different diameters or for the required tooth depth, and it is also used when cutting worm-wheels. The amount of adjustment is shown by a graduated dial reading to thousandths, and also by a scale and vernier which may be used to read the center distance between the work and cutter spindles. This vernier scale will also be found useful for obtaining the desired center distance when hobbing worm-wheels. The work-slide is adjusted by hand on a standard machine, but at a slight additional cost an automatic adjustment can be applied, with means for stopping the feed automatically when the teeth on the gear being cut have been hobbed to the correct depth. This arrangement is known as an automatic "in feed" and it is shown attached to the machine in the illustration. The indexing worm-wheel by which the table is driven, is of the split type and it is hobbed in place to insure accuracy. The driving worm is made of a high-grade of machinery steel and it is of coarse pitch, hardened and accurately ground. The worm runs in an oil bath and the bearings are so arranged that it can be conveniently disengaged from the worm-wheel so that the work-table may be revolved by hand to ascertain if the mandrel and gear blanks run true. This test is made by bringing an indicator, attached to the cutter-slide, into contact with the periphery of the blanks while they are being rotated. Means are also provided to always maintain a good running fit between the worm and wheel. By means of a micrometer adjusting device that is attached to the worm-shaft, the work can be adjusted circumferentially without disconnecting any mechanism. The work-table is surrounded by a guard cast integral with the slide, which forms a channel into which the lubricant and chips are deposited and from which they are carried to the front of the slide where they fall into the base of the machine.

Work Arbor Support

The work arbor is supported at its upper end by a rigid triangular arm which is mounted on two uprights. This support is a very important feature, particularly when long and slender mandrels are used; it is also essential to accuracy when helical gears with extreme angles are being cut, or when a number of blanks are mounted on the arbor at a time. A bearing sleeve of extra length, with which the support is provided on one side, makes it possible to swing it easily around for removing finished gears or placing new blanks on the work arbor. By removing the two uprights which carry the supporting arm, gears of a larger diameter than the machine is regularly rated for, may be cut.

Resetting Device

It is frequently desirable to take two cuts in helical gears, particularly when cutting the first gear of a given size to obtain the correct tooth thickness. To facilitate this work, a patented device is furnished with this machine which saves considerable time and eliminates experimental adjustments. When a helical gear is to be finished in two cuts, the resetting attachment is first set in a zero position. After taking the first cut, a re-cut may be taken through the same helices by merely returning the machine to the original or zero position to which it was set. Without such an arrangement it would be necessary either to cross the belt and run the machine backwards until the cutter slide had returned to its original position, loosen the gear on the mandrel, or take off the change gears in order to have the cutter cut uniformly on each side of the tooth.

The Cutter Slide and Spindle

The cutter slide, which may be swiveled to any angle, is mounted on a saddle that is vertically adjustable on the face

of the column. This saddle is counterbalanced, and it may be traversed either by hand or power, the handwheel being shown at the top of the column. The cutter spindle is powerfully geared and is so arranged that it always swings above the horizontal or across the top of the saddle when being changed for gears cut to the opposite hand. Means are provided so that when the cutter spindle is swung from one side to the other it will revolve in the proper direction. The cutter spindle has an axial adjustment for bringing the different hob teeth into action, and by means of a special gage that is located in the slide, the hob may be quickly and accurately set central with the blank, though it is not necessary to have the work in the machine at the time. This gage is located just back of the hob and it is moved out for testing by means of a small knurled thumb-nut.

Cutter Feeds and Speeds

The feeding mechanism of this machine is arranged in the base and it may be conveniently engaged and disengaged by means of a handle located at the side. The amount of feed is in accordance with the rotation of the work, regardless of the number of teeth or diameter of the blank. In other words, there is a definite amount of feed for each rotation of the blank. The feed change gears are located at the rear of the machine, as are also the change gears for obtaining the proper ratio between the hob and work. The required cutter speeds are obtained by means of a stepped driving cone. This cone runs on a patented sleeve bearing which takes all strains from the pull of the belt so that they do not come on the cone shaft itself. This arrangement makes an outer support for the cone shaft unnecessary and insures the proper meshing of the driving gears on this shaft. The proper speed for the cone may be selected from an index furnished with the machine. The countershaft is arranged so that there is a great variety of speeds obtainable at the cutter spindle.

Miscellaneous Features

A complete set of indexing gears is furnished to cut all numbers of teeth ranging from 10 to 100, and some numbers up to 400. The machine is so arranged that by special calculation, spiral gears having prime numbers of teeth may be cut without the use of special gears. An efficient oil pump is supplied with each machine to allow the use of a lubricant when cutting steel. This pump is attached to the side of the machine, as shown in the illustration, and it is driven by gears which may be easily disconnected when the pump is not in use. Any lubricant which drips from the machine is caught by an oil pan which extends around the base.

This type of gear cutter is adapted to the cutting of all classes of small and medium gears, such as change gears, gears for textile machinery, cream separators, automobile transmission and timing gears, herring-bone gears when made in halves, steering gears, lathe and drill-press feed worm-gears, etc. If desired, an electric motor drive can readily be attached and a variable speed motor with a ratio of 3 to 1, and a maximum speed not to exceed 1500 revolutions per minute, is recommended.

ADJUSTABLE BEARINGS FOR STURTEVANT BLOWERS

In the department of New Machinery and Tools for February, 1906, we described the high-pressure blower manufactured by the B. F. Sturtevant Co., Hyde Park, Mass. This company is now equipping large blowers of the type previously illustrated with the design of adjustable bearing shown in Figs. 1 and 2. This bearing is simple in its construction and greatly facilitates making the necessary adjustments.

The sleeve in which the shaft is mounted, is carried in a bed-block that is chambered out to form an oil reservoir. The four corners of this block are accurately beveled, as shown in Fig. 2, to fit the adjusting wedges. There are four of these wedges and each pair is connected by a right- and left-hand screw so that the turning of this screw in one direction, causes the wedges to separate, while a movement in the opposite direction draws them together, thus moving the bearings. If only one screw is turned, the bearing will move in a direction at 45 degrees with the horizontal, whereas by the manipulation of both screws, it can be adjusted in any direction. As most of the pressure, and consequently wear, is at an angle of about 45 degrees, ordinarily the required adjustment can be made by simply manipulating one screw. These screws are turned by applying a wrench to the squared ends which extend outside the housings. When the bearing is to be moved upward, care should be taken to loosen the nuts holding the bearing cap, before attempting to adjust the wedges.

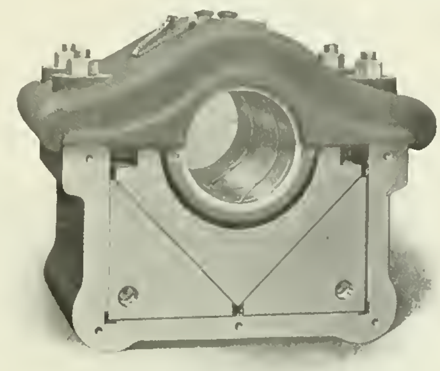


Fig. 1. Adjustable Wedge Block Bearing for High-pressure Blower

This type of bearing has proved very efficient in service, as the construction is solid, notwithstanding the adjustable feature. Medium-sized blowers built by this company are equipped with the type of bearing sleeve here illustrated, but the bearing, instead of being adjusted by wedges, is mounted in a bracket which is shifted to the required position by means of set-screws.

These bearings are lubricated by chain or ring oilers and they are provided with oil reservoirs which contain an ample supply. The bearings are of generous proportions, and they are lined with Sturtevant white metal, which is carefully hammered and accurately bored and scraped to a good running fit. On very small blowers the bearings consist of solid bronze sleeves which are lubricated by grease cups and which may easily be replaced when worn.

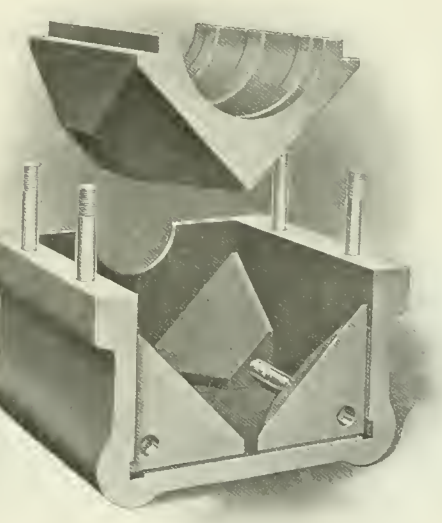


Fig. 2. View showing Construction of the Wedge Block Bearing

PRYIBIL BAND SAW MACHINE

A band saw machine that is an excellent example of modern machine design has been brought out by P. Pryibil, 512-524 West 41st St., New York City. This machine has not only been designed to work efficiently as a saw, but it is so constructed as to protect the operator, as far as possible, from injury.

As the accompanying illustrations show, the wheels are covered in front by hinged cast-iron doors which can be opened, as shown in Fig. 2, when this is necessary for inspection or for replacing saws. Any possibility of coming in

contact with the saw on the slack side, has been overcome by running the saw through a channel on the frame. This channel or guard also prevents the saw from being thrown off the wheels in case it should be accidentally struck in the rear. This machine is further safeguarded by a positive locking device which holds the belt shifter firmly in position after the belt has been shifted to the loose pulley. By this means the belt is prevented from accidentally running on the tight pulley and starting the machine while the saw is being adjusted. After stopping the machine, it is again started by releasing a spring pin which allows the belt to be shifted.

Fig. 1. Pryibil Band Saw Machine with Hinged Covers or Guards

As Figs. 2 and 3 indicate, the table of this saw can be tilted either to the right or left for taking angular cuts. The angular adjustment of the table is effected by a handwheel located just beneath it. This wheel is mounted on a sleeve carrying a pinion which engages a cut-steel rack that is hinged to the table. The second handwheel, mounted on a shaft that passes through the sleeve of the clamping wheel, serves to lock the table securely after adjustments have been made. The table can be tilted to the right to any angle not exceeding 45 degrees, and it has a maximum adjustment to the left of 5 degrees. A scale located on the semicircular segment on which the table swivels, indicates the exact angle. When the table is set at right angles to the saw, the left side is supported on a spacing block that is inserted between the under side of the table and the main frame. When the table is to be tilted to the left, as in Fig. 2, this spacing block is disengaged by a lever which is fulcrumed under the table. The throat disk through which the saw passes is located in a recess in the table so that it can easily be taken out for renewing the wooden lining with which it is provided.

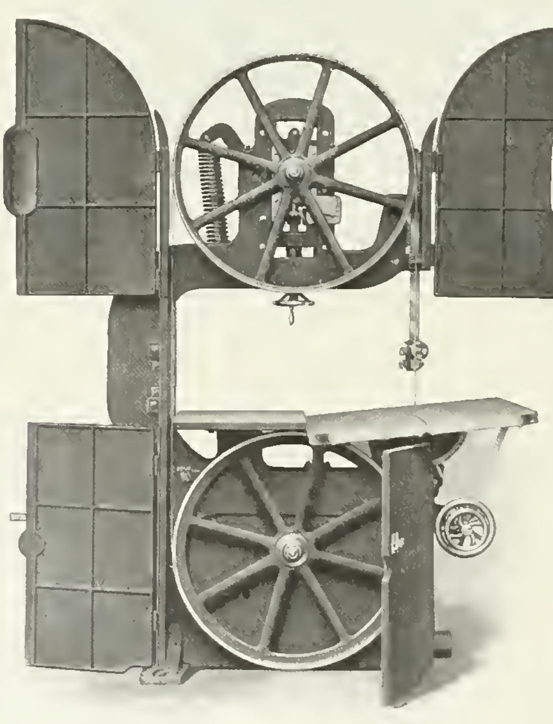


Fig. 2. View of the Saw with Guards Opened

The wheels of this machine are turned outside and inside and the inner faces of the rims between the arms are milled in order to obtain a running balance. The rims of both these wheels are threaded so that the rubber bands which are vulcanized to the rims will have a firmer grip. The lower wheel has been made extra heavy so that it acts as a flywheel. The reason for this construction is as follows: Whenever the saw encounters hard spots or knots, the speed of the lower or driving wheel tends to be momentarily reduced so that the saw will have to act as a brake for the upper wheel with the result that the tight side of the saw becomes the slack side, thus causing it to quiver and often to slip on the upper wheel under the reverse and additional strain. This action will, particularly if repeated, tend to break the blades. To overcome this defect, the lower wheel has been made heavier so that any additional load can be carried without an appreciable speed reduction. Within the housing for the lower wheel there is a dust collector which throws the sawdust to the front and directly into a suction opening which can be connected with an exhaust system. The upper wheel is comparatively light and it is mounted in a pivoted bearing, which, by means of a hand-screw, can be tilted so that the saw will run in its proper position. The shafts on which these wheels are mounted are of large diameter, and both bearings are lined with genuine babbitt metal and reamed to a perfect fit. They are self-oiling, there being large reservoirs and soft felt wicks for supplying lubricant.

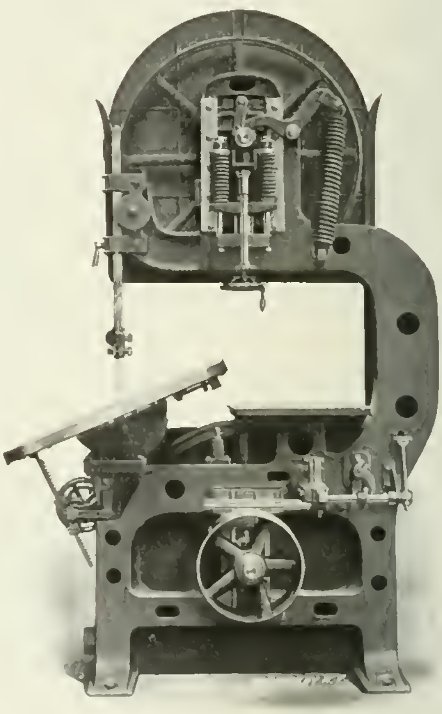


Fig 3. Rear View of Band Saw

The saw guides are of the Pryibil anti-friction type, there being one fitted to the guide-bar and another to a seat in the frame beneath the table. The guide-post is a finished square steel bar and it is counterbalanced by a coiled steel spring set in an iron casing. This guide-post can be clamped in position at any required height.

If a saw is to operate satisfactorily, it must run steadily and without quivering at a high velocity, and to obtain these results it is essential that the tension be correct and remain absolutely uniform under varying conditions. The mechanism for tensioning this saw is very sensitive and the correct tension for all sizes of blades is indicated by a graduated dial. The tensioning mechanism is mounted on a slide that is fitted into plain guides on the upper part of the frame. This slide, which is shown in the rear view of the machine, Fig. 3, is adjustable for saws of different lengths as well as for tensioning, the adjustment being obtained by operating the handwheel shown. This wheel is easily turned, as the weight of the slide with its mechanism is balanced by a large spring. The bearing for the upper wheel shaft is pivoted near its front end on a pin held in a secondary slide that is fitted in guides on the main slide. This secondary slide is connected by suitable levers to a piston which operates in a cylinder that is

suspended from the main slide by two guide shafts as shown. The piston has arms that extend on each side and embrace the guide shafts, and between these arms and the brackets on the main slide, springs are interposed which are compressed to give the saw the required tension. Inside the springs shown, a second set is located, which only comes into action after the outer springs have been partly compressed. The outer springs alone give sufficient tension for blades up to ¾ inch in width, while those ranging from ¾ to 2 inches in width are held in tension by both springs. When a saw is to be placed under tension, the compound slide is moved upward by the handwheel previously referred to. As this upward movement takes place, the secondary slide (located in the main slide) remains inactive until the wheel comes into contact with the saw. The secondary slide is then held in position by the saw, while the other slide continues to rise against the tension of the springs. This vertical adjustment is continued until the dial indicates the proper amount of tension. If the saw should break for any reason, the springs, being under compression, would immediately expand and cause the secondary slide and wheel to be forced upward with a jar, were it not for the air piston and cylinder which acts as a dash pot and allows the springs to expand to their original position without the slightest jar.

The main table of this machine has a width of 34 inches and a length of 40 inches, while the auxiliary table has a width of 20 inches and a length of 27 inches. Saws having a maximum length of 20 feet, 3 inches and a minimum length of 18 feet, 6 inches can be used. There is a maximum sawing space of 18½ inches under the guide, and from 3 to 5 horsepower is required for operating the machine.

WILMARTH & MORMAN LATHE CENTER GRINDER

The importance of keeping lathe centers ground true is generally appreciated, but centers are often neglected because of the time that is required to re-grind them with some of the

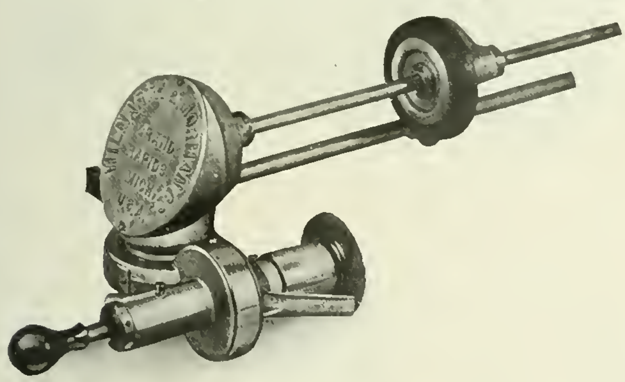


Fig. 1. Wilmarth & Morman Lathe Center Grinder

appliances that are used for this purpose. The Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., is now manufacturing a grinder for truing lathe centers which is simple in construction and easily attached to a machine; in fact, it may be applied so quickly that centers can be trued with practically no loss of time.

In Fig. 1 this grinder is shown complete, while Figs. 2 and 3 indicate the method of setting it in the lathe and its position when in use. The grinder consists of a casing *C* which is mounted on a base *B* that is attached to the toolpost by a shank or holder. The casing *C* is free to swivel on the stationary base so that the driving shaft *S*, on which is mounted a rubber friction disk *D*, can be swung in a horizontal plane. This driving shaft is held rigid by an auxiliary supporting shaft to which it is connected by a casting which also provides a bearing for the friction driving disk. The drive is taken directly from the lathe cone by swinging the grinder around until disk *D* is in contact with it. The power from the driving shaft *S* is transmitted through a bevel gear and pinion, located in casing *C*, to a pair of spiral gears in the base which, in turn, drives the grinding spindle and wheel *W*.

It is this bevel gear and pinion drive in casing *C* which makes it possible to swivel the upper gear housing to any angle, as this angular movement merely rotates the bevel gear on shaft *S*, around its pinion.

When the grinder is to be set up in the machine, the locating lugs *L* on the main base casting are placed between the head- and tail-stock centers. These jugs are provided with hardened tool steel centers which are set at an angle of 30 degrees with the center line of the wheel spindle, so that the latter is located at the correct angle for grinding. While the grinder is accurately located in this way, the toolpost holder

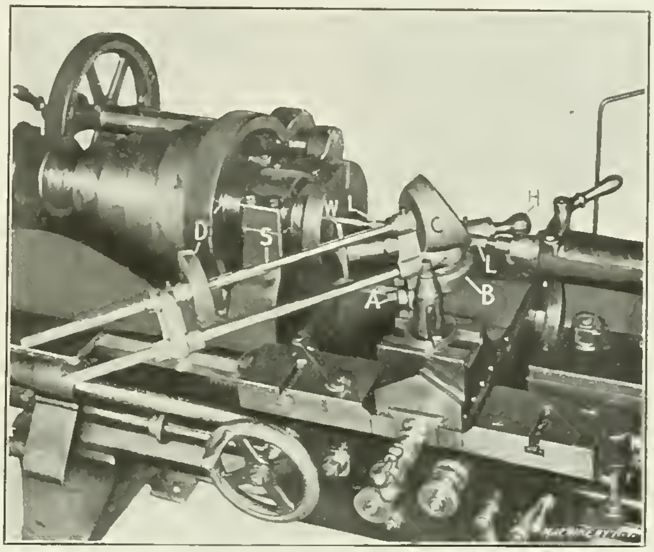


Fig. 2. Method of Setting the Lathe Center Grinder

is clamped in place. Before tightening this holder, however, the two set-screws *A* which hold it to the base are loosened to prevent the grinder from being thrown out of the position in which it has been located by the centers, which might be the result if a rigid connection were employed. After the shank is clamped, screws *A* are tightened, thus fixing the grinder in the correct position.

In Fig. 3, the attachment is shown in position for grinding, the tailstock center having been withdrawn and the grinding wheel moved up to the headstock center by manipulation of the lathe carriage and cross-slide. The wheel is traversed to and fro across the center by means of the handle *H* (Fig. 2) which is attached to the end of the sliding wheel spindle. Fig. 3 also shows the friction driving disk moved

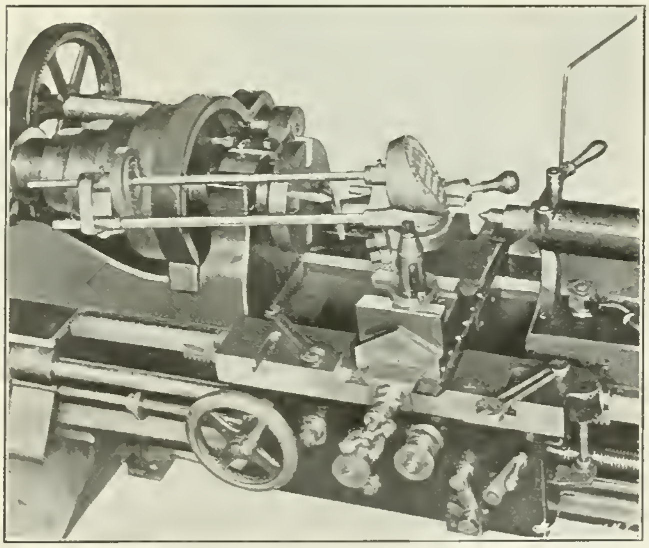


Fig. 3. Center Grinder in Working Position

around in contact with the lathe cone against which it is held by means of a handle, formed on the casting connecting the driving and supporting shafts.

By means of carefully lubricated bronze bearings and the use of ball thrust bearings where needed, the friction of this grinder has been eliminated as far as possible. Aluminum

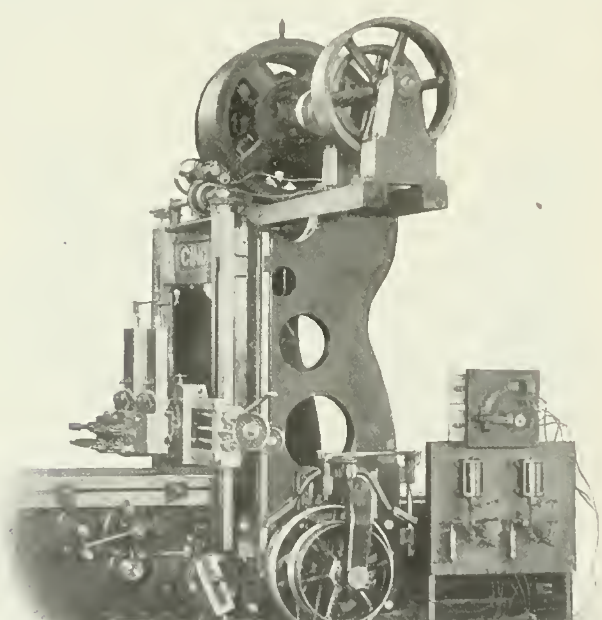
is used for the main casting and for other parts where practicable, so as to make the grinder light and easy to handle. By means of a telescoping sleeve at the rear of the wheel, the bearing is protected from grit and dust. The toolpost holder is of ample size and is made of cast steel to give the required rigidity.

Some idea of the time required for truing a center with this device, may be had from the fact that but 1 minute and 5 seconds, was required for transferring the grinder from the floor to the lathe, making all necessary adjustments, grinding the center, and removing the attachment from the machine. In this particular instance, however, only a moderate amount of grinding was necessary. As the actual time of grinding a center is governed, of course, by its condition, the time for actually setting up the machine to the correct position for grinding would be a better measure of its efficiency. The time required for placing this grinder in the machine, locating it, starting and then stopping the lathe, and removing the grinder, is said to be less than one minute.

CINCINNATI VARIABLE-SPEED PLANER DRIVE

An interesting type of electric speed controller has recently been applied to a 36-inch forge planer built by the Cincinnati Planer Co., Cincinnati, O. This controller, which is shown attached to the planer in the accompanying illustration, is so arranged that either the cutting or return speeds can be varied independently, thus enabling the operator to change the speed of either the cut or return stroke to suit conditions.

The motor by which the planer is driven, is mounted on top of the housings in a manner similar to the regular plain motor drive. As the illustration shows, the motor is coupled direct to the countershaft, thus doing away with all gearing. A 2 to 1 variable-speed type of motor is used, and its speed is governed by the two electric controllers shown mounted on the switchboard that is located at the rear of the housings. By means of one of these controllers, any desired cutting



Cincinnati Planer equipped with Electric Variable-speed Controlling Mechanism

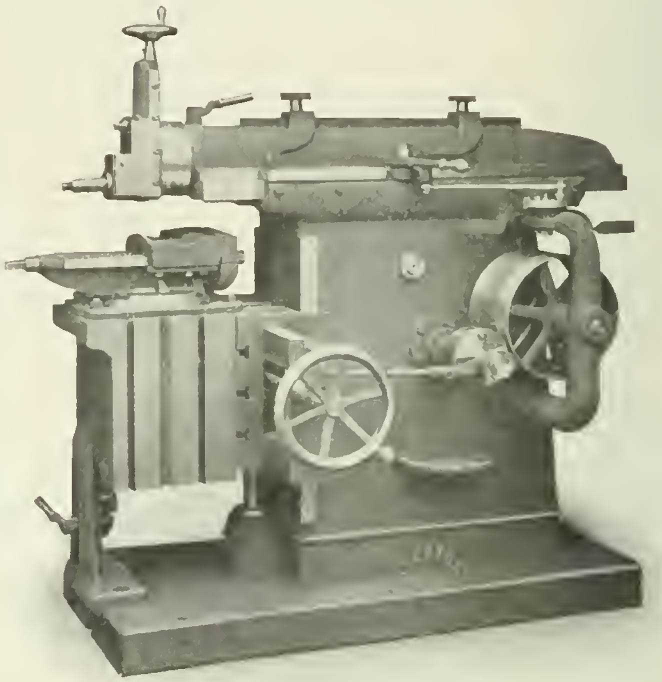
speed ranging between 25 and 50 feet per minute can be obtained for the cutting stroke, without in any way altering the return. The other controller is for the return speed and it enables variations ranging between 50 and 100 feet per minute to be made without affecting the speed of the cut. It is evident then that with this new speed controller, it is possible to operate with a cutting speed of say 40 feet and a return speed of 60 feet, or a cutting speed of 20 feet with a return speed of 90 feet, etc., the different speeds being varied to suit the requirements.

Just in front of the housing, a limit switch is located which operates the controlling levers so that after they have been set for any particular speed, they will automatically return to that speed at each stroke. It will be noted that a standard type of starting box, which is shown mounted on top of the switchboard, forms a part of the equipment. The wiring, illustrated in the engraving, is only temporary. This method of control does not need any more wiring than a regular drive except that wires have to run to the limit switch.

STEPTOE 26-INCH TRIPLE-GEARED SHAPER

The accompanying halftone shows a new 26-inch triple-geared shaper that has recently been brought out by the John Steptoe Shaper Co., 2951 Colerain Ave., Cincinnati, O.

The ram of this machine is driven by two gears of large diameter which mesh with racks that are cut from a solid



Steptoe 26-inch Triple-geared Shaper

steel bar. The teeth in the racks are staggered which eliminates excessive jarring at the ends of the stroke and gives the ram an even, steady movement. The use of two driving gears permits the passing of long bars through an opening in the top of the column, when this is necessary for keyseating or in connection with other work. The head of the ram can be quickly loosened, swiveled and clamped to any angle by means of the clamping lever shown just back of it. The shifter dogs are placed on top of the ram, thereby permitting the latter to be of larger dimensions and greater strength.

The cam plate for shifting the belts, has eccentric slots so arranged that one belt is shifted before the other, thereby avoiding the unpleasant screeching of the belt which is frequently heard in triple-geared shapers. The outer support is, as the engraving shows, of very strong construction.

All the shaft bearings in the column of this machine are bushed with cast-iron bushings and they are provided with ring oilers. The shafts also have spiral oil grooves to insure the proper distribution of the lubricant over the entire bearing.

The vise has a swivel base which is graduated so that it may be set to the required angle. The upper jaw of this vise grips firmly around the lower jaw, so that it is prevented from rising when work is being tightened in the vise. Two additional clamping bolts are provided which extend through the upper jaw so that the latter can be fastened when considerable accuracy is necessary, the bolts overcoming any tendency on the part of the jaw to rise when the work is clamped.

The apron, as well as the table of this machine, is slotted, thereby providing liberal clamping surface. The table support

has a roller, as shown, which bears against a plain surface under the table. This roller can be quickly adjusted by means of the clamping lever shown. All the wearing surfaces are provided with flat gibs and the screws for adjusting the gib in the ram and "harp slide" are equipped with lock-nuts. The feed-screw and the harp-slide screw are provided with handwheels which will be found very convenient. This machine is geared in the ratio of about 42 to 1 and it is designed to take heavy cuts in high-speed steel. The column, ram and base are heavily ribbed and braced, and all the bearings are liberally proportioned.

LODGE & SHIPLEY SPECIAL DRILLING LATHE

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently completed an interesting special drilling attachment which is shown in Figs. 1 and 2 applied to one of the 30-inch by 30-foot motor-driven patent-head lathes built by this company. This attachment is intended for drilling 4-inch holes longitudinally through the centers of steel locomotive driving wheel axles, the purpose of the holes being to permit inspecting the interior of the forging for defects, such as seams due to piping, etc.

A front view of the lathe is shown in Fig. 1 in which some of the gear covers are removed to better show the gearing of the headstock and of the special drilling attachment. In the rear view of the lathe, these covers are shown in place, all gears ordinarily being completely covered so as to fully safeguard the workman. This special drilling attachment is mounted on the carriage as shown. It consists of a heavy bracket to which is attached a 4¾-horsepower variable-speed motor, that is connected to the main driving shaft through gearing and an intermediate shaft. The drill itself is carried in the main driving shaft which is in exact alignment with the lathe spindle.

One end of the axle to be drilled is gripped in a chuck (not shown) on the lathe spindle, while the other end is supported by a special steady-rest that is shown between the headstock and carriage in the illustration. That portion of the steady-rest which carries the end of the axle has a large annular bearing which revolves with the axle. The other side of the steady-rest serves as a guide for the drill which passes through a bushing that revolves with it. The particular bushing shown in place is for a 4-inch drill while those on the floor are for a 2-inch size. Between the steady-rest and carriage there is an intermediate drill rest and guide which is also equipped with a revolving bushing that supports the center of the drill. These bushings, while free to revolve, are kept from endwise movement by set-screws, the tips of which enter annular grooves cut around the center. When the hole is being drilled, the work revolves in one direction and the drill, of course, in the opposite direction. The rotation of the work, which is slow as compared with that of the drill, serves to keep the hole concentric.

To take care of the unusual end-thrust required to drive a 4-inch drill, the headstock of this lathe is provided with a special tie-piece across the top, that is fastened to the caps of each one of the four bearings. The front and rear gear covers of the headstock are bolted to each side of this tie-piece. The headstock gearing gives six mechanical changes of speed, which are supplemented by a 2 to 1 speed variation in the 10 horsepower main driving motor.

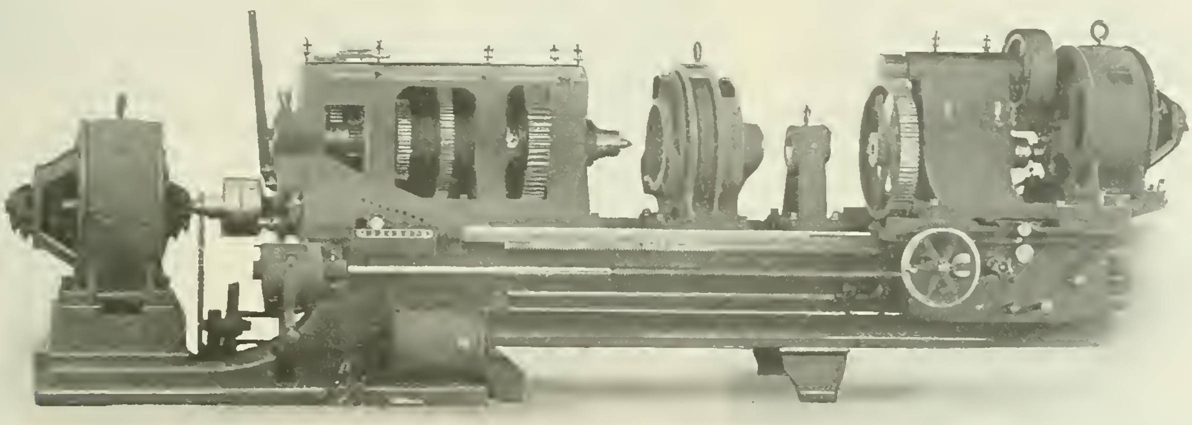


Fig. 1. Lodge & Shipley Lathe with Special Attachment for Drilling Locomotive Axles

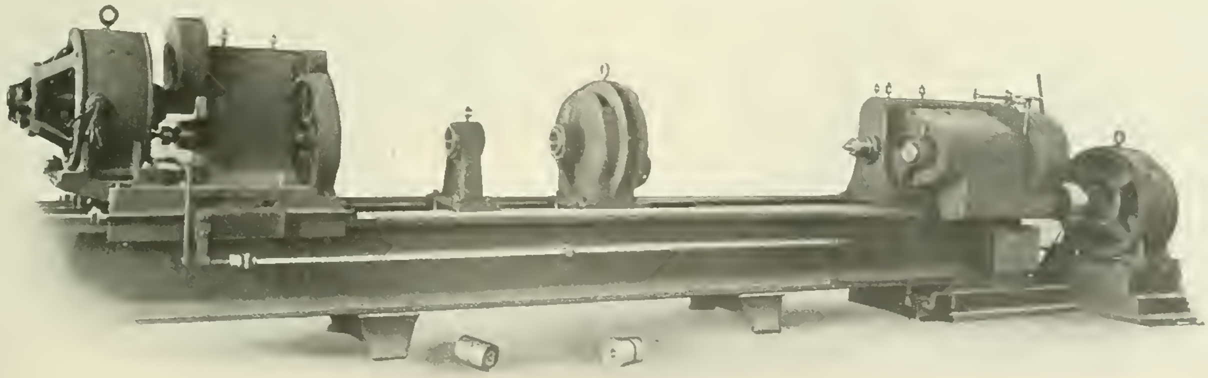


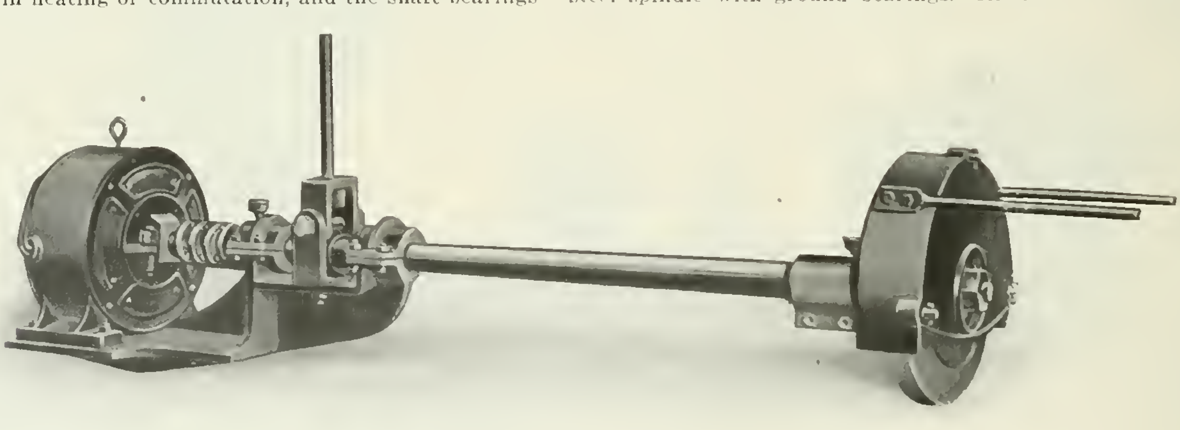
Fig. 2. Rear View of the Special Drilling Lathe

The arrangement of pump and piping is shown in Fig. 2. The pump is placed near the end of the headstock, and it is positively driven by a chain from the motor shaft. This forces the lubricant through the piping at the back of the bed, and up to the center of the main driving shaft of the drilling attachment. The lubricant then passes through the drill itself and is discharged at its tip. The pipe joint just below the carriage is fitted with a stuffing-box, so that the rear section of pipe telescopes the adjoining section. This makes a good joint and insures proper lubrication of the drill, regardless of the location of the carriage. The whole machine stands in a pan (not shown in the illustration) to retain the lubricant and chips.

HASSEL MOTOR-DRIVEN GRINDER

A motor-driven grinder which has proved very efficient for removing surplus metal from castings and for smoothing rough surfaces, has been placed on the market by the Pittsburg Steel Foundry Co., Pittsburg, Pa. This grinder, which is shown in the accompanying halftone, is rigid from end to end and it is balanced on a pivot from which it is suspended. The wheel is driven by a Westinghouse 5-horsepower direct-current motor, which rests on a bracket or frame of which the suspending pivot casting is a part. The entire grinder is so counterbalanced that the wheel tends to rise when released by the operator. Chain suspension is ordinarily used, which enables the grinding wheel to be swung horizontally through a wide arc. The motor shaft is connected to the wheel shaft by a rigid coupling. The wheel shaft is mounted in two bearings provided with grease-cup lubrication, and it is encased throughout its entire length by a heavy tube which supports the grinding wheel. It should be mentioned that grease has been found superior to any other lubricant for this grinder, because it works through the bearings enough to form ridges at the ends which practically seal the bearings against the entrance of dust.

The workman, in the operation of this grinder, grasps the two rods or handles which are shown bolted to the wheel casing, and moves the wheel across the part to be ground. As the working position is beside the wheel, sparks do not interfere with the movement of the operator or his observation of the work. The emery wheel of this grinder is 24 inches in diameter, it has a 4-inch face and is encased in a heavy cast-steel safety shield. In the foundries of the manufacturer of this tool, it has been subjected to severe service, the operation being continuous day and night and often with the full weight of two men on the handles. An emery wheel of the size previously mentioned, is worn out in about 48 hours on the average and this time has been as low as 24 hours. No trouble has ever been experienced with the motor, however, under these severe tests, either in heating or commutation, and the shaft bearings have required very little attention. The advantages claimed for this tool are: the absence of belts, freedom of vertical and horizontal movements, safety, and durability. When compared with belt-driven grinders, for which this type was substituted, the saving in belts alone is said to be sufficient to pay for the beltless grinder in about two years.

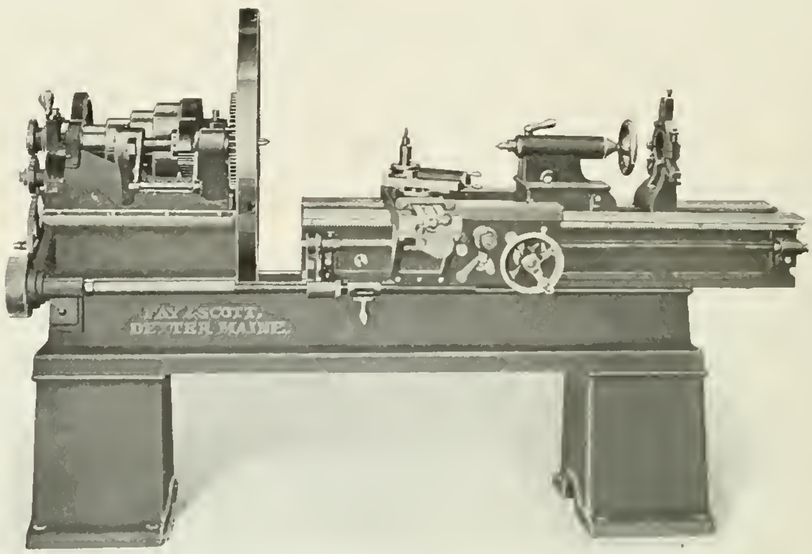


Hassel Motor-driven Grinder for Foundries, etc.

FAY & SCOTT EXTENSION GAP LATHE

The extension gap lathe shown in the engraving, is a new size recently added to the line of this type of lathes manufactured by Fay & Scott, Dexter, Me. In the construction of this machine, several important features not found in former designs have been incorporated, though the general construction is practically the same. One of these improvements is in the application of power for moving the upper bed, this adjustment having been made formerly by a hand feed screw. The power is applied by means of a small handle that may be seen projecting downward about midway of the lathe. This handle is attached to a half-nut that is lifted into mesh with the thread on the feed-rod, thus transmitting a power movement to the upper bed.

The bed is deep and rigidly designed, and the inside front track is flat to provide a bearing for the waist of the carriage. The upper and lower beds are carefully scraped and fitted together and they can be fastened rigidly by means of clamps. When the upper bed is extended for long lengths, jack-screws are furnished for supporting it. The rear end is cut away to allow the overhang or removal of the tailstock. The latter is of the improved cut-away type and it is adjustable for taper work. The clamping device for the tailstock spindle consists of a split bushing which eliminates danger of throwing the spindle out of alignment. The headstock has renewable spindle bearings of bronze and a hollow, hammered-steel spindle with ground bearings. All the headstock gears are covered with guards and the back gear lever has a positive locking device. The carriage is extended in the front for use in connection with the full swing of the lathe with the gap in use. This extension is rigidly supported by an angle bracket, as shown, which has a bearing against the apron, which, in turn, is supported against the upper bed by an adjustable gib. The apron has the double-plate construction and it is of the bevel gear driven type. The feeds are positively locked out when cutting threads.



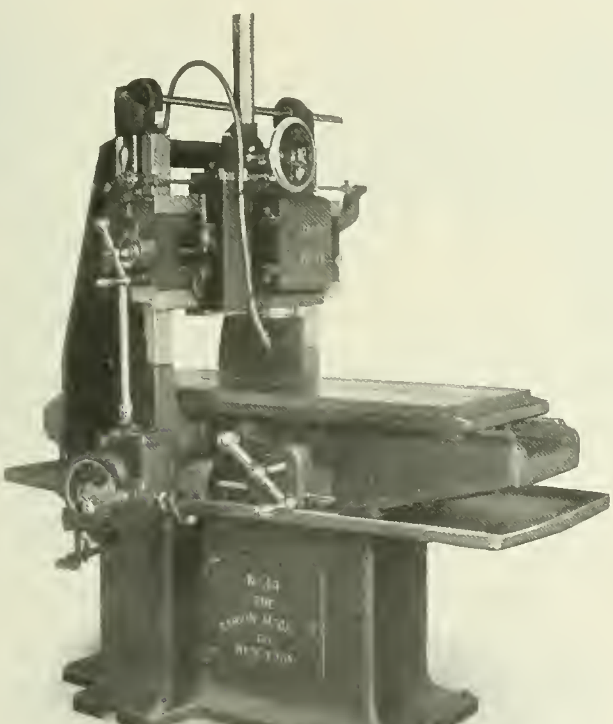
Fay & Scott 14 and 28 inch Extension Gap Lathe

This lathe swings over the shears, 14¼ inches; over the carriage, 8¼ inches, and in the gap, 29 inches. The 8-foot machine takes 63 inches between the centers with the bed closed, and 94 inches with it extended. The gap has a maximum opening of 32 inches. The thread-cutting capacity

ranges from 4 to 64 threads per inch. The equipment consists of a double friction countershaft, a plain or compound rest, a center rest, a full swing faceplate, a driving faceplate, wrenches, and a complete set of change gears. This lathe is particularly adapted for garage and general repair work.

GARVIN VERTICAL SPINDLE MILLING MACHINE

The No. 14 vertical spindle milling machine built by the Garvin Machine Co., Spring and Varick Sts., New York City, has recently been re-designed and important improvements have been made to increase the general efficiency of the machine. By reference to the accompanying halftone engraving, it will be seen that the standard rotary feed box used in this company's horizontal milling machines, has been adapted to the requirements of the vertical spindle machine. This feed box has twelve changes, ranging in geometrical progression, with the addition of a reverse movement for changing the direction of the feed. The feeding movement is transmitted to the head on the rail or to the work-table. Should the feed for one need to be different than the other, the desired feed can be quickly obtained by simply turning the crank shown attached to the side of the box. An illustrated description of this rotary type of feed box appeared in the department of New Machinery and Tools for March, 1910, in connection with an article descriptive of the Garvin geared feed milling machine. The feeds for the table and cross-slide are automatic in both directions. These feeds have an automatic trip which is so designed that the feed is thrown out a little before the



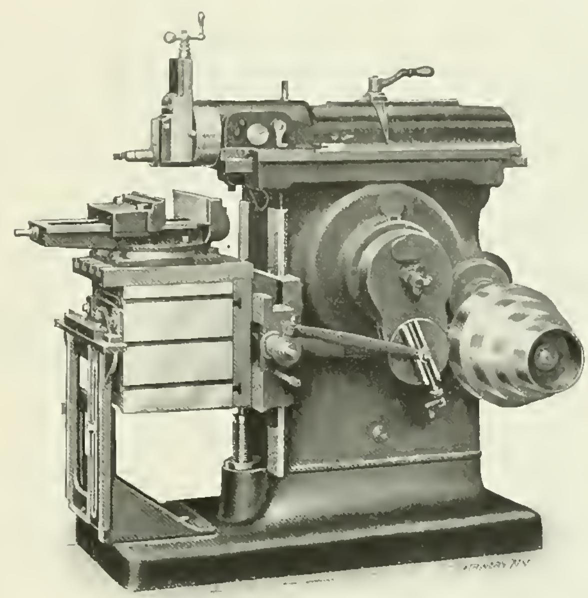
Vertical Spindle Milling Machine with Rotary Feed Box

positive stop is reached, so that the breaking down of the feed works by carelessness in setting the trips, is prevented. The speed changes for the spindle of this machine are through back-gearing which is located in the head as in previous designs. The different speeds are obtained by the operation of a single lever which through a rack and pinion movement shifts the gears that connect the driving shaft with the spindle. There are three positions for this lever, two of which give different back-gearing ratios, while the third is a neutral position. When the lever is in the neutral position, the universal joint drive can be disengaged from the back-gear shaft and attached directly to the spindle, thus giving a high-speed direct drive without gearing. The vertical slide of the head has a spring balance which is enclosed in a tube that may be seen extending above the slide. The depth of cut can be regulated by a micrometer gage stop which can be locked in position by a binder nut when necessary.

STOCKBRIDGE 16-INCH BACK-GEARED CRANK SHAPER

The Stockbridge Machine Co., Worcester, Mass., is now building the 16 inch back-geared shaper shown in the accompanying halftone. This machine, while adapted for tool-room work, is also sufficiently heavy and rigid to meet the requirements of a manufacturing tool.

Among the new features incorporated in the construction may be mentioned the method of attaching the cross-rail to the column. The gib on one side of the column ways is cast solid with the cross-rail, there being one adjustable gib lo-



Stockbridge 16-inch Back-geared Crank Shaper

cated on the working side of the shaper. With this construction, which is similar to that employed on milling machines, adjustments may be quickly made and the cross-rail locked to the column by simply tightening the gib binder screws on the working side of the machine.

The rocker arm used in this shaper is of a special design that has exceptional strength. The slot in the rocker arm has an unusual depth and width to provide ample surface for the crank block.

The ram has a semi-circular shape on the top with straight sides, which construction, in addition to the internal ribbing, gives the ram ample strength and stiffness. For taking up wear in the ram ways, tapered packings are provided which extend the entire length of the column and are adjusted from either end by means of screws. The head can be adjusted to any angle, and it is accurately graduated; it is locked in place by two bolts, one on each side. Either a hand or automatic down-feed can be provided for the head, and the slide has a graduated collar reading to thousandths of an inch, which can always be set to the zero position. The cross-feed is automatic in either direction and adjustments can be made while the machine is in motion.

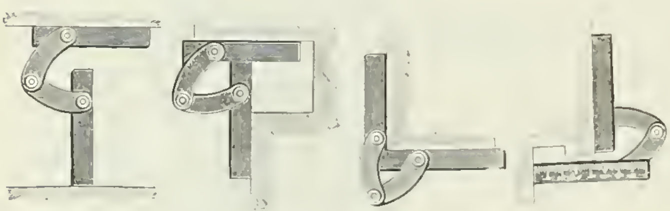
As the engraving shows, the base of this machine has an extension in front to which work may be clamped when necessary, there being slots provided for that purpose. The table is rigidly supported at its outer end by an angle-iron that is bolted to the base and has a sliding upright which adjusts itself to various heights of the knee automatically. By tightening two bolts, the slide and angle-plate are securely locked together. In addition to this support, the knee is hooked over the saddle so that the latter takes the forward thrust which would otherwise come on the bolts that hold the knee to the saddle. Vertical adjustments of the knee are obtained by means of a telescopic screw which has a ball thrust bearing.

The driving cone is supported by a self-oiling bearing that is built out from the side of the column. This bearing takes all the belt pull and thus relieves the driving shaft. The 4-step cone, in conjunction with the back-gears, gives eight changes of ram speed. All change gears are made of steel, and the driving shafts are carried through the column and are supported at both ends by self-oiling bushed boxes.

This shaper has a maximum stroke of 16¾ inches; a vertical travel for the table of 14¾ inches; and a horizontal travel of 23 inches. The head has a feed of 6½ inches. The minimum and maximum distances from the ram to the table are 2½ inches and 17 inches, respectively. The ram has a bearing in the column of 30 inches; a length of 36 inches, and a width in the column of 10¼ inches. The weight of the machine, complete, is 2850 pounds.

E. G. SMITH CO.'S UNIVERSAL ANGLE GAGE

The accompanying engraving illustrates a universal angle gage which has been brought out by the E. G. Smith Co., Columbia, Pa. This gage is simple in construction and will last indefinitely as there are no parts to become deranged. It consists of two straightedges that are connected by the curved



Views showing Various Applications of Universal Angle Gage

pieces shown. As the three adjustable connecting joints permit the straightedges to be placed at any angle with each other, this gage can be employed for a variety of purposes, some of which are indicated by the illustrations. For example, it may be used as a protractor, height gage, square and in a variety of other ways.

WALTHAM FILING MACHINE

The Waltham Machine Works, Waltham, Mass., has placed on the market a filing machine that is particularly adapted to die work and especially for the making of small sub-press dies for watches, clocks and similar work.

The work-table of this machine is 5 inches in diameter, and it can be tilted for filing the clearance angle and swiveled in a horizontal plane for a complete revolution while in the tilted

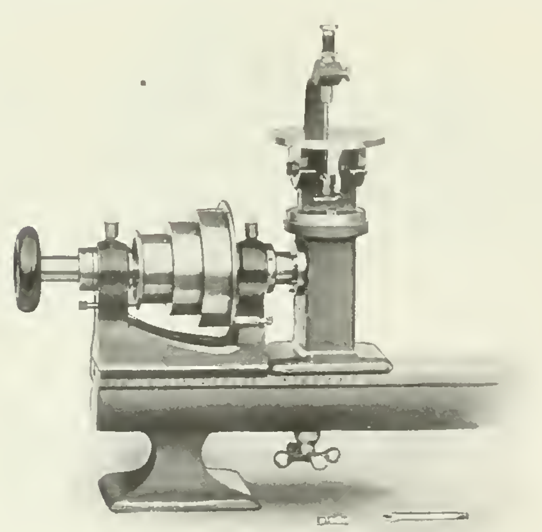


Fig. 1. Filing Machine as a Bench Lathe Attachment

position. This table is supported on each side, as shown in the illustration, and it is provided with two clamping screws so that it can be rigidly locked.

Two methods of holding the files are provided for in this machine: By one method, the lower end of the file is held in a vise while the upper end is gripped by a split chuck. As the vise has a vertical V-groove and the chuck four wide slots, either round or flat shanks can be securely held. With the second method, cross holes are drilled in the ends of the files which are looped over pins in the frame, similar to the manner in which a hack-saw blade is held in place. This method is desirable when very thin files or diamond-charged strips are being used, for by means of the nut at the top of the frame, considerable tension can be obtained. The upper spindle can be detached from the frame with the file, thus making it easy to remove a file from a die by simply releasing the lower end. Files having lengths ranging between 2 inches and 3½ inches can be held, and a set of assorted files is furnished with the machine. The stroke of the frame can be adjusted to any length up to 1½ inch.

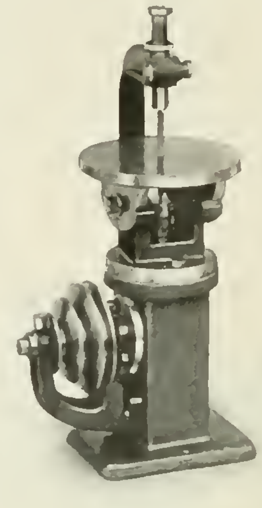


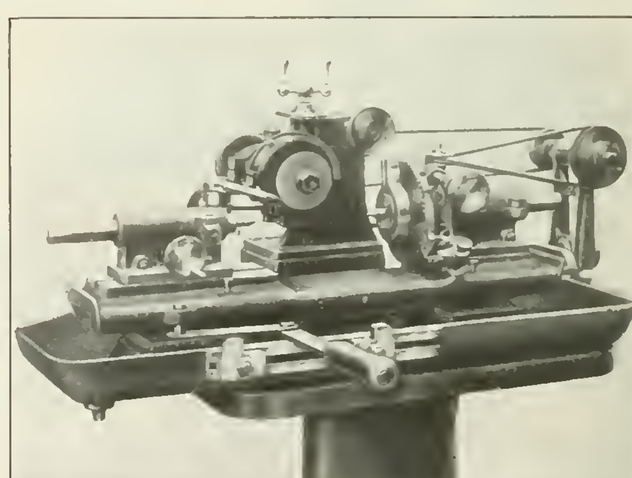
Fig. 2. Waltham Filing Machine with Independent Drive

This machine can be furnished either as an attachment to a bench lathe or as an independent machine. The first type when in use, is mounted on the bench lathe bed as shown in Fig. 1, and driven by a special chuck in the headstock spindle. A machine with an independent drive is shown in Fig. 2, the drive being in this case by means of a three-step cone pulley which is supported by an outboard bearing.

The height from the base to the table is 9¾ inches and the weight of the machine, 21 pounds. The workmanship is of the same grade as that employed on the watch machinery manufactured by this company.

MEISSELBACH-CATUCCI HOB GRINDING MACHINE

The Meisselbach-Catucci Mfg. Co., of 29 Congress St., Newark, N. J., is now manufacturing the hob grinding machine shown herewith. This machine grinds the teeth radially and



Meisselbach-Catucci Hob Grinding Machine

during the grinding operation there is an abundant water supply to prevent burning the edges of the cutter, both of which are important considerations. Means are provided for quickly setting the face of the emery wheel radial with the work, and the wheel face is kept true by means of a diamond tool that is held in a simple fixture. The teeth of the cutter are not depended upon for the spacing required in grinding them, as work is independently re-divided by a large and accurate index plate on the machine, so that all inequalities caused by hardening or uneven wearing are corrected. The arbor on which the work is held, revolves on two dead centers to insure accuracy. The cooling water is under control at all

times and the supply can be increased or diminished and directed to the proper place on the work. Guards are provided for confining the water, but these do not obstruct the view of the work which is in plain sight of the operator. While this machine was primarily designed for grinding straight fluted hobs intended for cutting gears of the smaller pitches, an attachment for grinding spirally-fluted hobs can be supplied. Gear cutters, forming cutters, circular forming tools for screw machines, taps and similar tools can also be ground. The machine will accommodate diameters up to 5¾ inches. A one-speed overhead countershaft and all the necessary wrenches are furnished.

GREAVES, KLUSMAN 15-INCH ENGINE LATHE

Greaves, Klusman & Co., of Cincinnati, O., have brought out a new lathe that embraces a number of novel features in its design. This machine has ample power for heavy reduction work and it is also adapted to comparatively light work by its convenience of operation.

The bed of this machine is of a new design, and has been heavily reinforced under the V's by an extra thickness of metal which extends down below the girts. The side walls above the girts are three times as thick as below so that twisting strains of the V's or bed are minimized. The headstock is webbed its entire length and is equipped with a high carbon steel spindle that is accurately ground and runs in phosphor-bronze bearings.

Figs. 2 and 3 show phantom and sectional views, respectively, of a new design of tailstock which is so constructed that it admits a spindle one-third longer than the usual length. This spindle telescopes through a thimble at the rear of the tailstock, as shown in Fig. 3, so that there is a full length bearing at the forward end of the travel. The spindle is clamped at both ends of the barrel by a single-handled clamping device. When this handle is turned in the direction for clamping, the pinions shown, which are mounted on the clamping screws, are revolved, by means of toothed sectors on the handle, sufficiently to cause the spindle to be firmly gripped between sleeves that are curved to fit it. The tailstock is clamped to the bed by means of a double clamp having three bolts, two of which are located in front and one in the rear as indicated.

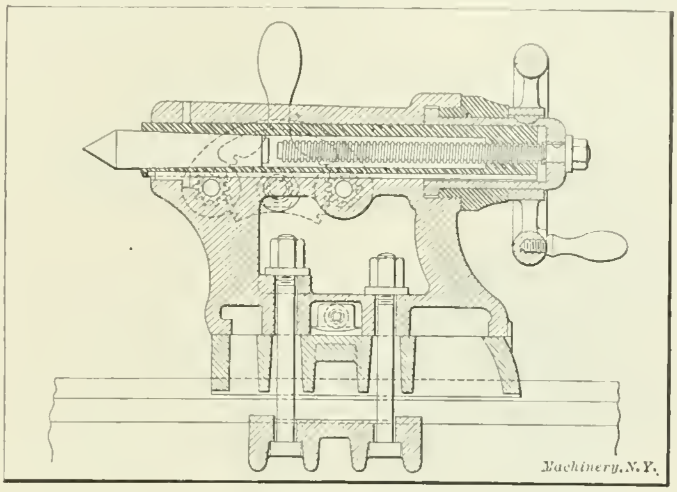


Fig. 3. Sectional View of Tailstock showing Method of Clamping and Spindle Construction

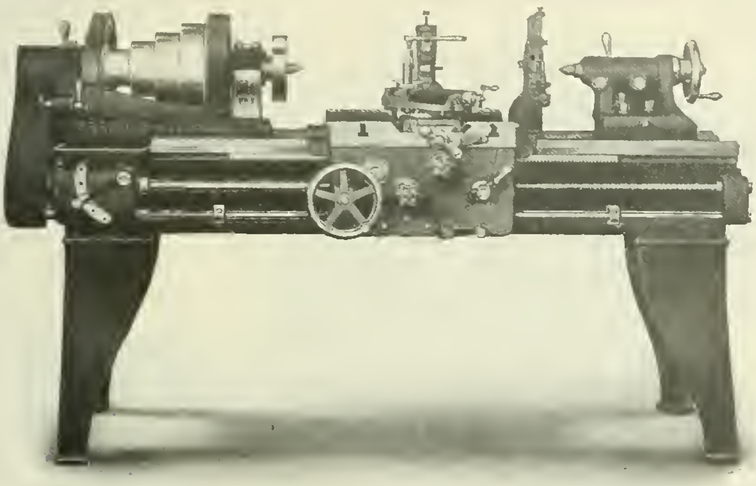


Fig. 1. Fifteen-inch Engine Lathe built by Greaves, Klusman & Co.

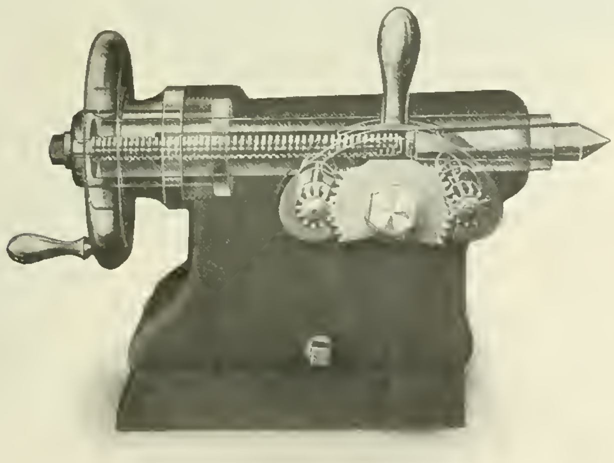


Fig. 2. Phantom View of Tailstock

The carriage is extra heavy and it has a full length bearing on each of the V's. In place of the usual inner front V on the bed, a wide flat bearing is provided which gives a substantial support directly under the tool-rest and shortens the bridge of the carriage. For cross-feed work, the carriage can be locked by means of an eccentric clamp operated by a handle at the front. The compound rest is substantially built, and both cross-feed and top-slide are provided with taper gibs. The tool-rest and cross-slide screw collars are graduated to read in thousandths of an inch. The apron of this lathe, an inner view of which is shown in Fig. 4, is of the double-plate box form with bearings at each end for the studs. All gears are of steel and of coarse pitch. The longitudinal and cross feeds are operated by frictions and they are reversed by a lever at the front of the apron. The lead-screw and feed-rod cannot be engaged at the same time, and the latter is supported at each end of the apron so that it is kept in alignment regardless of the position of the carriage.

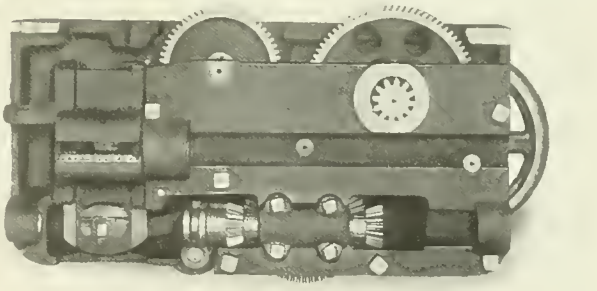


Fig. 4. Inner View of the Apron

The rack pinion can be disengaged when the lathe is to be used for screw-cutting, thus releasing all gearing and giving a free movement to the carriage. This lathe has a thread-cutting capacity ranging from 2 to 48, including 11½ pipe thread, and a chasing dial is provided which permits the thread to be "caught" at any point.

Five independent geared feeds, ranging from 10 to 160 are instantly available by simply shifting a feed lever located at the head end. These feed changes may be made while the lathe is running and the tool is taking a cut. The way the various changes are effected in shown in the sectional view Fig. 5. The power is transmitted from the spindle through

the shaft A to the shaft B, which is located inside the bed and on which gears of various sizes are mounted. Below this shaft there is a second shaft C, which is connected by gearing with the feed-rod and on which there is a pair of gears D_1 and E_1. These gears are keyed to shaft C but are free to slide on

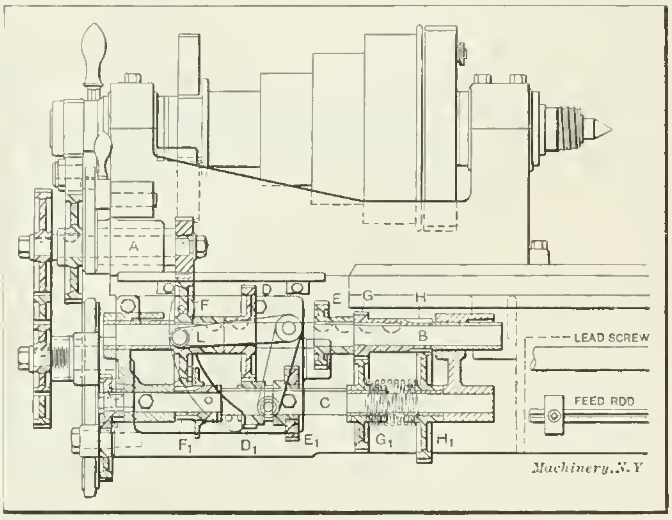


Fig. 5. Feed Changing Mechanism

it, and their position is controlled by lever L. When this lever is in the upper hole of its quadrant, a clutch on gear D_1 comes into engagement with the corresponding clutch on pinion F_1, which is in mesh with gear F and through which shaft C is driven. When lever L is moved to the second hole, as shown, the drive is through gears D and D_1, whereas a movement to the third hole brings into mesh gears E and E_1. A still further movement brings the clutches on E_1 and G_1 into engagement so that the drive is then through gears G and G_1. By moving the lever L to the last or lowest hole, G_1, which has clutches on both sides, is forced over against the tension of the spring shown, into engagement with gear H_1. When the gears are in this position, G_1 serves to connect E_1 with H_1, which is driven by the pinion H. In this way the five changes are obtained. All the feed gears are of steel, of coarse pitch, and run in an oil bath. The feed-rod is provided with an automatic stop in either direction.

This machine swings over the bed 16⅜ inches, and ovêr the carriage, 11¼ inches. The maximum distance between the centers with a 6-foot bed, is 36 inches. With a two-speed countershaft, there are sixteen changes of spindle speeds. As Fig. 1 shows, all the gearing is fully enclosed. The cover at the head end is hinged to permit changing the gears without difficulty. The regular equipment includes a compound rest, large and small faceplates, steady- and follow-rests, change gears, countershaft and wrenches. A plain rest can be substituted for the compound type if desired, and a taper attachment, turret on the carriage or shears, oil pan bed, pump and tubing, draw-in collet attachment, etc., can be supplied if required.

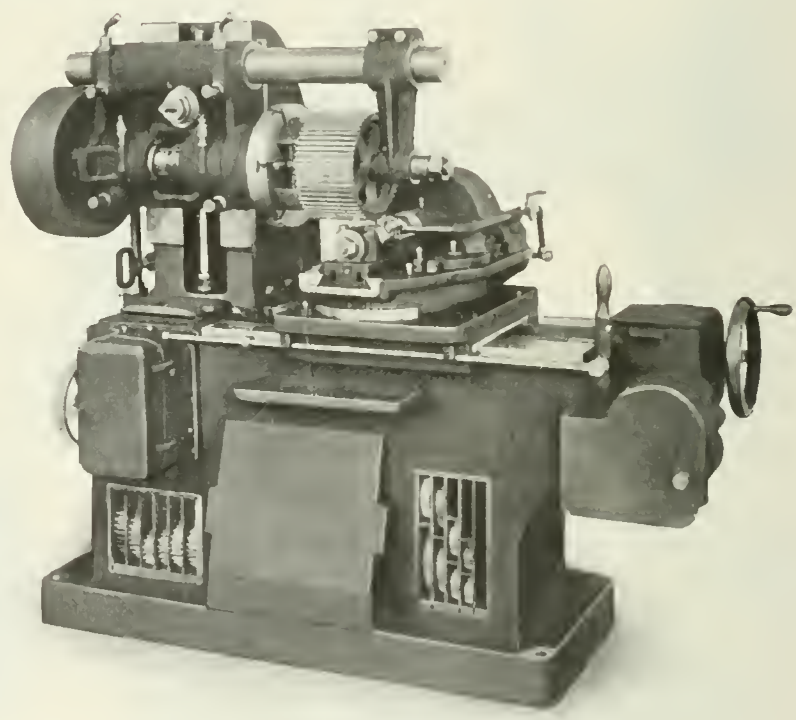
BARBER-COLMAN NO. 12 GEAR HOBBING MACHINE

The design of gear hobbing machine illustrated herewith is a recent development of the Barber-Colman Co., Rockford, Ill. This machine was designed strictly as a manufacturing tool for cutting accurate spur and spiral gears such as are required in the manufacture of modern machine tools, automobile transmissions, etc.

As the engraving shows, the work-spindle is horizontal and it is mounted in a slide that is vertically adjustable on the column for various diameters of gears. The cutter spindle, which is also placed in a horizontal position, is carried on a slide that is adjustable along horizontal ways on the bed. Attached to the work-spindle slide there is an overhanging arm, similar to the arm of a milling machine, on which is clamped a yoke for supporting the end of the work arbor. This yoke or support is provided with a bronze bearing in which runs a hardened sleeve clamped on the work arbor. The work-spindle is provided with long bearings which insure continued accuracy of alignment between the work arbor and the hob slide, and both the work and hob spindles run in conical bearings that provide practical means for compensating for wear.

The drive for this machine is of the direct single-speed belt type. The tight and loose pulleys are 14 inches in diameter, take a 3-inch belt, and run at 300 revolutions per minute so that it is possible to belt direct from the main line shaft or from a motor as desired. The speed changes are obtained by transposing gears at the front of the machine. The feed is positive, and any desired rate may be obtained by change gears. An automatic tripping mechanism is provided for disengaging the feed of the hob slide at any predetermined point in its travel.

As the slide on which the hob is mounted is in a horizontal position, it can be easily adjusted or swiveled to an angular position for cutting spiral gears. As the axis of the hob intersects the vertical axis of the swivel, the hob may be set for cutting spiral gears by first placing it in a central position with the work-spindle when at right angles to the latter or with the swivel set at zero, and afterwards swiveling it to the angle desired in the same manner that would be employed in setting for spirals on the milling machine. A lateral or



Barber-Colman No. 12 Gear Hobbing Machine

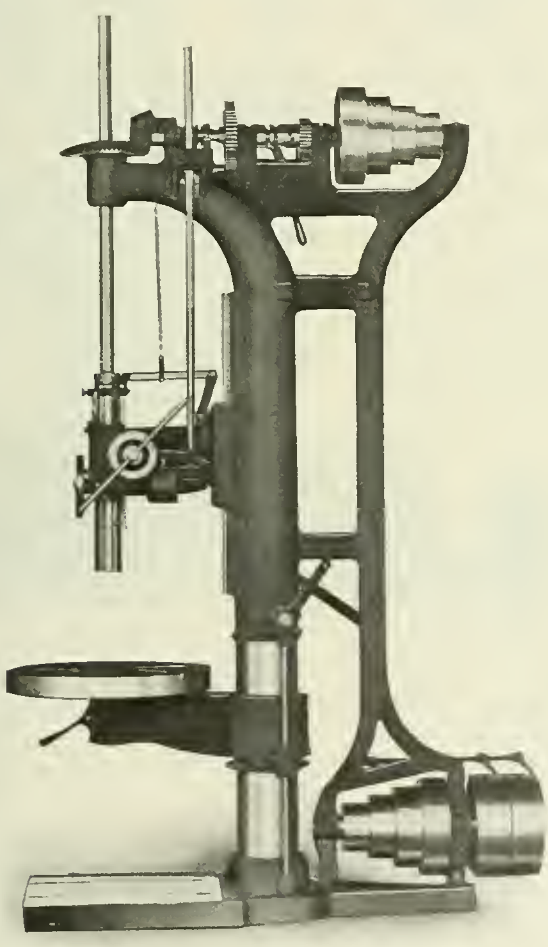
axial adjustment of the hob is obtained by a cross-slide on the swivel, which has sufficient movement to allow different teeth in the hob to be set central, so that each tooth can be brought into action and a maximum amount of work obtained from the hob before sharpening is necessary. The swivel base has an angular adjustment of 45 degrees on each side of the zero or right-angle position, and the graduations are provided with a vernier reading to 10 minutes. The machine is also equipped with a micrometer dial for accurately setting the hob to the correct depth.

All the bearings in this machine are bushed with bronze, and special attention has been given to lubrication. The lubricant for the hob is contained in a spacious tank cast integral with the bed, and an oil pump, regularly provided, is attached to the machine. All oil and chips are conveyed to a removable chip basin that is placed in the bed. The bed as well

as the upright for supporting the work-spindle, is of box section and rigidly constructed. The equipment consists of the necessary change gears for hobbing all gears ordinarily encountered, speed and feed change gears, wrenches, charts and feed tables. The net weight of the machine is approximately 3700 pounds.

GEARED FEED FOR SIBLEY DRILL PRESSES

The Sibley Machine Tool Co., South Bend, Ind., has designed a positive geared feeding mechanism which is to be applied to the entire line of Sibley drill presses above the 20- and 22½-inch sizes. The accompanying illustration shows a 28-inch sliding-head drill equipped with this new feed. The power is derived from the horizontal driving shaft at the top of the machine. This shaft is connected through spur gears and spiral gears to a vertical feed shaft. At the lower end of this vertical shaft, connection is made with the feed box proper which is located on the head of the drill press. The feeding movement is transmitted from the vertical shaft through bevel gears to a horizontal shaft in the feed box on which is mounted a cone of four gears that mesh with an equal number on the worm-shaft. The feed changes are effected by means of a small knob conveniently located in the center of the handwheel. This knob is connected with a sliding key which, by engagement with different gear combinations, gives four feed changes. This key can also be shifted to a neutral position.



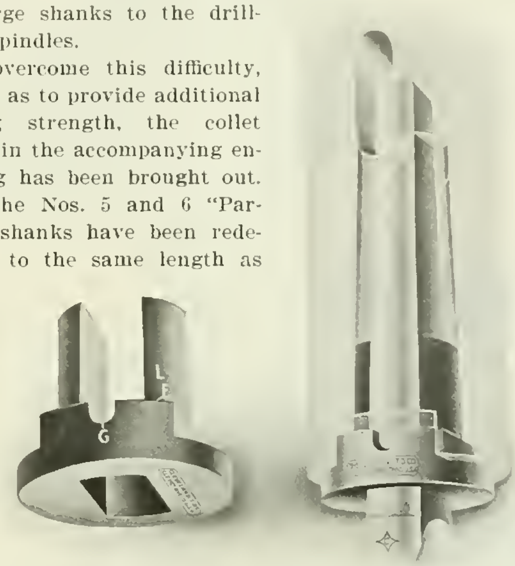
Sibley Drill Press with Positive Geared Feed

The gear case which encloses the feed mechanism is designed to be partly filled with oil so that thorough lubrication is insured. As all the shafts in the case are in a horizontal position, all the parts are well lubricated with the case one-third full of oil. By means of an automatic stop collar on the sleeve of the spindle, a latch which holds the feed worm in mesh with the bronze worm-gear is thrown out of engagement, thus causing the entire mechanism, which is fulcrumed on a large hinge pin, to swing down. This feed mechanism is geared down step by step, in such generous ratios from the initial drive, that an unusually powerful feed is obtained.

COLLET FOR DRIVING FLAT TWIST DRILLS

The Cleveland Twist Drill Co., Cleveland, O., has recently applied for patents on a new device for driving high-speed twist drills of the type that have flat taper shanks which are tapered both on the flat sides and round edges. Shanks of this kind are regularly furnished on the "Paragon" flat twist drills made by this company. The drive for these drills has been by sleeves or sockets having flat taper holes accurately fitting the shanks and externally tapered to fit standard taper sockets for the spindles. In the case of flat twist drills of large diameter having No. 6 shanks, this drive was found to have certain disadvantages, as it made necessary the use of cumbersome extension reducing sockets to adapt the large shanks to the drill-press spindles.

To overcome this difficulty, as well as to provide additional driving strength, the collet shown in the accompanying engraving has been brought out. Both the Nos. 5 and 6 "Paragon" shanks have been redesigned to the same length as regular taper shanks, the taper on the round edges being the regular Morse taper as formerly. When this modified shank is inserted in the spindle, its upper end is received and driven by the flat slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive, were it not for the fact that the shank would lack support at the lower end of the spindle. By the use of this new form of collet, a powerful additional drive is given to the shank at its lower end where the cross-sectional area is greatest.



"Paragon" Collet for Driving High-speed Flat Twist Drills

As shown in the illustration, this collet consists of two lugs *L* which project upward from a disk-like body through which is cut a rectangular hole to receive the drill shank. These lugs are ground on the outside to a standard taper and the inner surfaces are tapered to fit the flat taper shank. The view to the right shows the collet, drill shank and spindle in combination. As will be seen, the extension *E* which projects from the base of the collet, mortises into a slot cut across the end of the spindle so that the collet is rigidly held in place, and the entire combination is practically an interchangeable taper shank with an unusually long tang.

The width of projection *E* is such as to conform to the standard slots now being put in the spindles of heavy-duty drill presses by several well-known manufacturers. Collets made without this extension will fit any spindle or socket and will be furnished to those having machines with spindles not fitted with slots, when specified, but they will not, of course, have the same driving strength as the regular type. A groove *G* is provided to receive the point of a drift-key in case the collet should stick in the spindle.

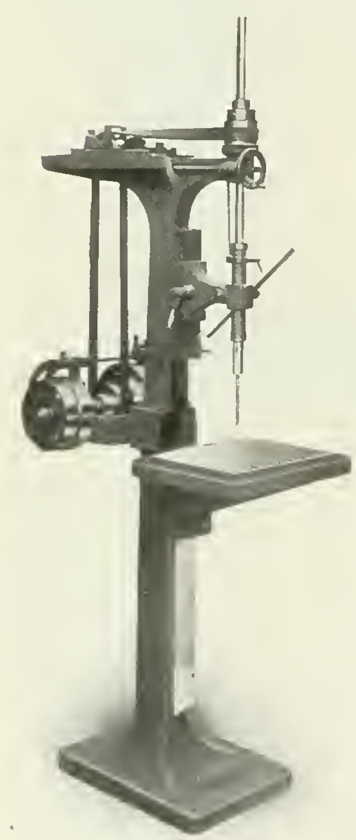
That this tongue and groove drive at the large end of the shank is much stronger than any drive on the tang, is evident from an inspection of the engraving.

AVEY NO. 1 SENSITIVE DRILL PRESS

The ball-bearing drill press illustrated herewith is a recent design that has been brought out by the Cincinnati Pulley Machinery Co., Cincinnati, O. The machine, which is known

as the "Avey No. 1," has ball bearings throughout, permitting it to run at the highest speed that high-speed twist drills will stand. The bearings are constructed on the four-point contact system, and all ball races and cones are of steel, hardened and ground.

Four changes of speed are obtained from a 4-step cone pulley, which drives a single pulley on the spindle. The adjustment of the belt, when changing the speeds, is taken care of by means of a carriage on the top of the column, on which are mounted two idlers. The movement of this idler carriage is effected by a screw-rod and handwheel which is located in front of the machine at a point convenient to the operator. The advantage of this screw connection with the carriage, in addition to the quick and convenient adjustment, is in the positive and precise belt tension it affords. In changing from one size twist drill to another, if a change in belt tension is required, it can be obtained by a slight turn of the handwheel.



High-speed Ball-bearing Drill Press

When making speed changes, the cone pulley is shifted longitudinally on its shaft in order to bring the step to be used into alignment with the spindle. This adjustment is easily made, and without the use of wrenches. It will be noted that the loose or idler pulley is smaller than the tight one, which relieves the tension on the belt and reduces wear on the countershaft bearings when the machine is not in use.

This drill press is designed to handle work within the limits of No. 1 taper shank drills, which range in size up to 37/64 inch. The spindle is of crucible steel and accurately ground. The spindle sleeve is graduated and the stop collar, which is mounted on it, may be set directly by these graduations for drilling holes of any predetermined depth. This stop collar has a fixed clamping screw so that no wrench or screw-driver is required. The rack pinion and shaft for the feed lever, is in one solid piece, which is a decided advantage over the construction in which a sleeve is held in place by a set-screw. The upper and lower columns, as well as the countershaft on this machine are tongued and grooved, which assures permanent alignment. The spindle is 7/8 inch in diameter, it has a traverse of 12½ inches, and is bored to receive a No. 1 Morse taper. If desired, an elevating device can be furnished for the table. This device, which can be applied at any time, is practically the same as those used on milling machines, there being a telescopic screw operated through bevel gears.

This machine is built with any number of spindles up to and including 4. The distance between the spindle centers of a multiple-spindle machine is 9 inches. The tables range in size from 15 by 18 inches for the single-spindle machine, to 15 by 43 inches for the four-spindle type.

ALLEN SAFETY SET-SCREWS

The danger attached to the use of the set-screw having a projecting head is well known, as this type has been directly responsible for an appalling loss of life. An excellent substitute for it, which has the required strength and gripping power without the dangerous element, has been placed on the market by the Allen Mfg. Co., Inc., 135 Sheldon St., Hartford, Conn.

In Fig. 1 a sectional view of this safety type of set-screw is shown and also the kind of wrench that is used. These screws are made from high-test steel bars and are said to be able to withstand more strain than the projecting-head type of screws of the same diameter. In the process of manufacture these screws are turned from the solid, drilled, and then swaged over a mandrel to form the hexagon hole for the wrench. This hole is neatly and accurately finished so that the wrench, which is simply a bar of hexagonal steel bent at right angles, will have a good hold. The points of these screws are backed up by a thick wall of metal so that when hardened and drawn, they will stand up under any pressure that can be applied with the wrench. If desired, the leverage of the wrench can be increased by the use of a piece of pipe or a monkey wrench. Any pressure within the capacity of the wrench can be applied, as the screw cannot break if it fits the hole. If a lock is required a second set-screw is screwed in on top of the first, thus effectually locking it in place. A screw that is slightly shorter than the depth of the hole should ordinarily be used, and when these screws are employed on marine work or in a damp place, the hollow head should be filled with beeswax or a mixture of beeswax and tallow, to prevent rust.

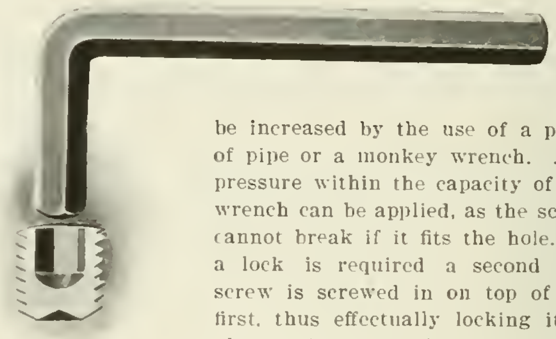


Fig. 1. Allen Safety Set-screw and Wrench

In Fig. 2 a cast-iron test piece is shown that was broken by the pressure exerted with one of these set-screws. This piece is 1¼ inch square and has a ¾-inch tapped hole extending through it. When the test was made, set-screws were inserted in each end of the piece with a plain cylindrical steel block between them. One screw was then tightened until the test piece was broken as shown. To effect such a break, a pressure of approximately 8 tons was required, but this excessive pressure on the screw failed to distort the end or cause it to "mushroom" in the hole. This company will eventually bring out a full line of machine screws with hollow hexagon heads.

Fig. 2. Test Piece Broken by Pressure Applied with Safety Set-screw

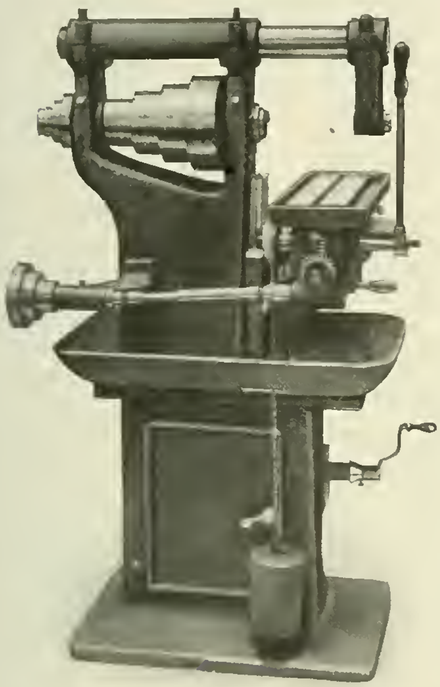
BICKFORD AND WASHBURN NO. 1 MILLING MACHINE

The milling machine illustrated herewith has been designed by its builders, Bickford & Washburn, Inc., Greenfield, Mass., to meet the demand for a plain miller of medium size and price. This machine has several important features which should appeal to manufacturers who want to increase the efficiency of their equipment.

The table has a power feed and a hand lever is also furnished to provide a rapid hand feed for light work. The feeding movement is transmitted to the table through a worm-wheel, kept in constant mesh with a rack which is a quarter section of a screw. This construction gives a smoothness of cut not obtained with the ordinary rack-fed machine, and the tendency to chatter is prevented by the curved teeth of this screw rack. The worm-gear meshing with the rack, is driven by a short worm which is mounted on a shaft that is rotated through worm-gearing and a feed shaft of the regular type.

Another feature of this machine is the provision for imparting a quick return movement to the carriage when the feed stops. This is often desirable, especially when the machine is being used for such work as fluting taps or reamers. This quick return of the table is effected by means of a short drum mounted on the cross shaft which carries the worm-gear meshing with the table rack. As this drum revolves, it winds up a wire cable to which is attached a weight. When the feed is released, this weight immediately falls and returns the machine table by unwinding the cable. The exact place at which the table will stop is varied by means of a special clamp by which the length of the cable is easily adjusted.

A crank handle is used interchangeably on the elevating screw, cross-feed and table feed, and the screw for the latter is provided with a device for keeping the crank from falling off. Both the elevating and cross-feed screws have graduated collars which may be set in any position. The entire feed mechanism is protected by a guard not shown in the illustration. The table has a T-slot through its center for 5/8-inch bolts and a large oil channel extends around it. The edge of this channel is planed off flush with the platen.



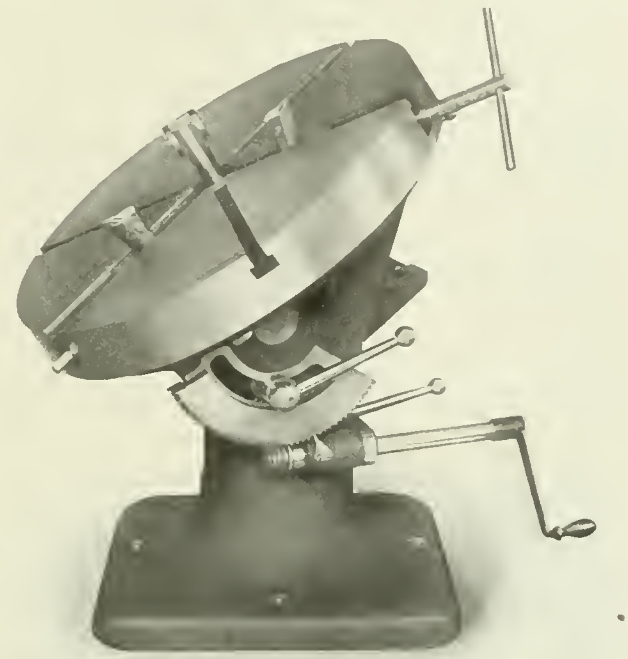
Bickford & Washburn No. 1 Milling Machine with either Hand or Power Feed

This machine weighs 900 pounds. The working surface of the table is 8 by 23½ inches and it drops 7½ inches from the center of the spindle. The table has a horizontal movement of 15 inches, a vertical adjustment of 7 inches, and a cross-feed of 3 inches. The spindle, which is bored for a No. 10 Brown and Sharpe taper, runs in bronze bearings that are adjustable for wear. For supplying lubricant, either an oil drip-cup or pump will be furnished. When the latter is supplied, the tank is placed in the base.

This machine is to be built in two sizes designated as Nos. 1 and 2. The No. 2 machine will be nearly identical with the No. 1 size shown in the illustration, the principal difference being an increase of about 600 pounds in weight and the addition of back-gears.

GANG UNIVERSAL DRILL PRESS TABLE

The auxiliary drill press table shown in the accompanying illustration is built by the William E. Gang Co., Cincinnati, O. This table, which is equipped with a chuck attachment, is fully universal in its adjustments and therefore adapted to a wide variety of work. The upper part on which are located all the operating levers, can be swiveled in a complete circle about the base. In addition to this movement, the chuck can also be revolved upon its center irrespective of the angle to which it is tilted. This tilting movement is effected by a crank which operates a worm meshing with a toothed segment of large diameter. This segment is graduated from zero to ninety degrees so that the operator can set the table accurately to any desired angle. The three-jawed independent chuck shown is 26 inches in diameter and is adapted to hold work of a round or irregular shape. This chuck was originally designed for drilling copper tuyeres for blast furnaces, or work of a similar nature. For chucking castings that are tapered either on the inside or outside, the jaws are equipped with adjustable faces that will accommodate themselves to any taper within wide limits. These faces are provided with springs that keep them tilted back toward the center of the chuck so that work having a tapered bore can be easily placed on the jaws, thus making it necessary to loosen only one jaw when removing or placing work in the chuck. The chuck jaws are reversible and if desired they can be removed, thus converting the chuck into a round table. When the chuck is used in this way, the three T-slots shown can be used for clamping. This table can be furnished with a plain top, either round or square in shape, instead of a chuck. The plain round top has the same diameter as the chuck—26 inches—and the square table measures 24 inches across.



Drill Press Table with Universal Adjustments

ANDERSON GEAR ROLLING MACHINE

A process for forming gear teeth by the molding-generating method or by rolling the blank in contact with an accurately cut toothed roller, has been developed by H. N. Anderson, chief engineer of the Speedwell Motor Car Co., Dayton, O. The machine which has been designed for forming gear teeth by this method, is shown in Figs. 1 and 2. The blanks to be rolled, which are made slightly larger than the pitch diameter of the finished gear, are first heated to a forging heat, after which they are placed in the machine and clamped firmly between two arbors which are timed by a gear of the same size as the one to be rolled. The carriage holding these arbors is then swiveled to bring the heated blank into contact, first

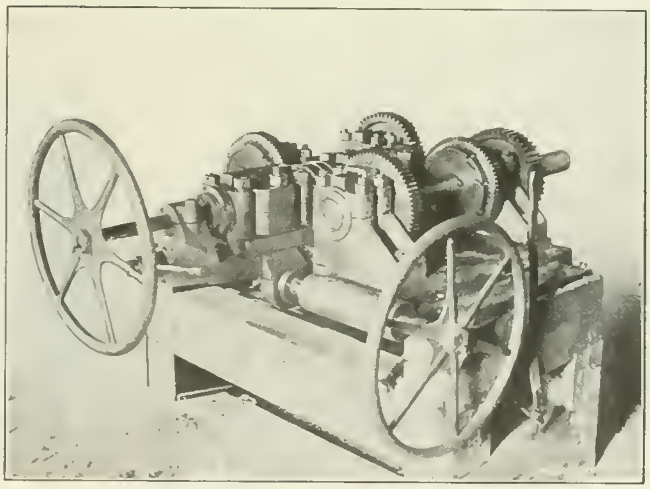


Fig 1. Machine for Forming the Teeth of Gears by a Rolling Process

with a breaking-down roller in which are V-shaped teeth that cause the metal to flow out into a larger diameter than the finished gear. The carriage is then moved to bring the blank into engagement with the finishing roller which develops the shape of the teeth; at the same time, any surplus metal flowing out at the ends of the teeth is removed by a trimming tool.

The construction and operation of this machine will be understood by reference to Fig. 3, which shows a plan view. The roughing and breaking-down rollers R and R_1 are mounted on shafts S and S_1 that are connected by gears E, F and G of the same size, so that both rollers rotate at the same speed. The shaft S_1 is the driver, and it is connected to the work arbor by gears C and D. The blank B is clamped between enlarged ends on the arbors, which bear against the web of the blank and fit into recesses of large diameter formed in each side of the gear, thus giving it a firm support. The clamping action is effected by the handwheel H. The carriage on which the work arbors are mounted, is free to swivel on a pivot which is located in line with the rear faces of gears C and D.

When a gear is to be formed, the heated blank, after being clamped in place, is forced into contact with the breaking-down roller R by means of the handwheel H_1. During this preliminary rolling operation, the carriage is swiveled, as shown

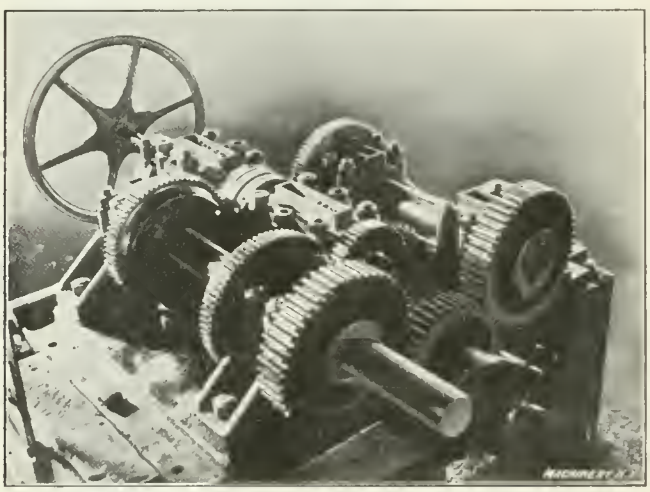


Fig. 2. Another View of the Gear Rolling Machine

in the illustration, so that the axes of roller R and the blank are not parallel. For this reason roller R is made slightly conical so that the teeth will be parallel with the periphery of the blank. When the teeth have been rough rolled sufficiently, as indicated by the positive stop K, the carriage is swiveled to the right, thus bringing the blank into contact with the finishing roller R_1, which continues the forming operation until further movement is prevented by the stop N. After the teeth have been finished in this way, the work arbors are adjusted longitudinally in first one direction and then the other to bring the sides of the rotating blank into contact with the trimming tools T, which remove the "flash" or superfluous metal at the ends of the teeth. The ends of the work arbors between which the blank is clamped, are provided with a stripping arrangement which enables the finished gears to be removed without distortion.

It will be seen from the foregoing that gears C and D, through which the work arbor is positively rotated, are shifted out of engagement somewhat when the blank is being rolled, by the swiveling action of the carriage. By locating the pivot on which the carriage turns, in line with the rear faces of these gears, as stated, they have a normal contact when the blank is swung around into engagement with the finishing roller R_1. The number of teeth formed in the blank is, of course, governed by the size of gear D, which has to be changed for different sizes. When such a change is made, the pivot for carriage J, as well as the plate M on which the roughing roller is mounted, will also have to be adjusted.

In order to minimize slight imperfections which might exist in the toothed rollers, the gears C and D are so proportioned, in this particular case, that the blank makes 73 revo-

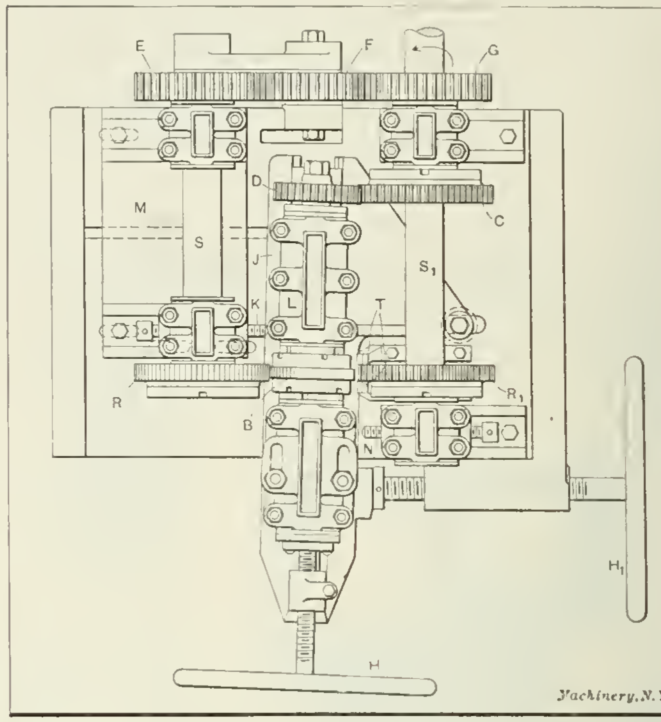


Fig. 3. Plan View of the Gear Rolling Machine

lutions before a given tooth on the roller enters a given space in the blank a second time. The product is also improved by reversing the direction of rotation after the rolling process has been practically completed.

In Fig. 4 samples of gears rolled in this machine are shown. The one to the left still has the flash at the ends of the teeth, while the other has been trimmed.

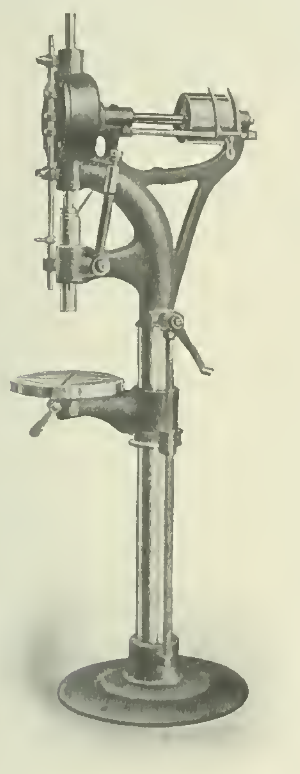
The advantages claimed for this process are as follows: cheapness, as the actual rolling operation does not exceed 45 seconds per gear; strength and superior wearing qualities, owing to the pressure exerted on the faces of the teeth in rolling which makes the metal dense and gives the faces a hard outer shell. By removing the blanks from the heating furnace at a uniform temperature, the shrinkage can be gaged, and it is claimed that the accuracy of the finished rolled gears is equal to that of those which have been cut and casehardened. The tendency of the rolled gear to warp in casehardening is also less than with the cut gear, as the structure of the metal at the periphery is changed while hot, so that there are no internal strains to be righted in the casehardening operation, which is likely to be the case with a cut gear, which is operated on with the metal in a cold state.

Fig. 4. Rolled Gears before and after the Flash is trimmed from the Ends of the Teeth

These gears are intended to be used in connection with automobile work for differentials and transmissions on the cheaper classes of cars, without being finished or timed after the rolling operation. For more accurate work, they could also doubtless be finished advantageously by grinding, after having first been rolled slightly over the finished size.

HIGH-SPEED GEARED 16-INCH DRILLING AND TAPPING MACHINE

The accompanying engraving shows a new design of drilling and tapping machine, which is being placed on the market by the Frontier Iron Works, Grant and Letchworth Sts., Buffalo, N. Y. One of the interesting features of this machine is the geared driving mechanism for the spindle. This mechanism is contained in the circular case shown attached to the head. On the pulley or driving shaft a disk 8½ inches in diameter is mounted in which are inserted three rows of hardened steel pin teeth of involute form. The inner of these rows has thirteen teeth, the center row, twenty-four teeth, and the outer row, thirty-four teeth. On the spindle two pinions are mounted, which are held in position by yokes connected to a tube shown on the outside of the case in the illustration. When the upper of these pinions is in mesh with the teeth, on the disk, the spindle revolves in the direction for drilling, whereas the engagement of the lower pinion gives it a reverse movement for backing out taps. As there are three rows of teeth, in the driving disk, three changes of speed are available and the changes are instantly obtained by adjusting the vertical tube to the correct position.

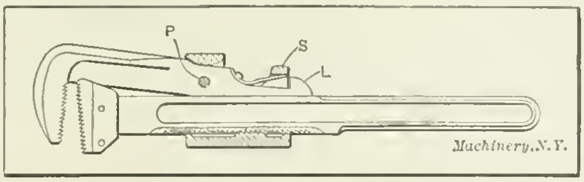


Frontier 16-inch Drilling and Tapping Machine

This machine will drill holes of any diameter up to and including ¾-inch, and it has a maximum tapping capacity of ⅝ inch. When the machine is being used for drilling, the lower pinion is shifted to a neutral position between two rows of teeth on the driving disk. All speed changes can be made while the machine is in motion. The table is slotted so that jigs, etc., can be bolted to it. The maximum distance between the spindle and table is 36 inches. The traverse of the spindle is 4½ inches, its diameter in the sleeve is 1⅛ inch, and it is bored to conform to a No. 2 Morse taper. The column is 4 inches in diameter, and the over-all height of the machine, 78 inches. This machine is rigidly designed throughout and is adapted for manufacturing and repair shops.

WRIGHT QUICK-ADJUSTING PIPE WRENCH

In the department of New Machinery and Tools for April, 1910, we described a quick-adjusting pipe wrench which was brought out by J. F. Wright, Canton, O. This wrench has since been considerably improved, the design having been changed as shown by the accompanying line engraving. The commendable features of this wrench are its simplicity, ease of adjustment and strength. It can be gripped to or released from the work quickly and it is easily adjusted to different sizes with one hand, the adjustment being made by simply depressing the sleeve *S* with the thumb; this disengages a pawl in the sleeve from a rack on the under side of the handle. The movable jaw has a rocker action independent of the yoke and the latter also has a similar action that is independent of the movable jaw. The lug *L* on the end of the movable jaw relieves the pivot *P*, which is simply intended for holding the parts together when the wrench is not in use, from all strains



Wright Quick-adjusting Pipe Wrench

and also equalizes the strains over the entire length of the yoke. By inserting a match in place of the pivot *P*, it has been demonstrated that there is no strain on this pivot when the wrench is in action.

PLANT INSIDE MICROMETER CALIPER

The Emerson Apparatus Co., 251 Causeway St., Boston, Mass., is now manufacturing the inside micrometer caliper shown in Fig. 1. This micrometer is a primary instrument as it is graduated to give direct readings in thousandths of an inch, without the use of an outside micrometer caliper. By estimation even finer measurements can be obtained. This caliper consists of a set of two tools each of which has two screws for different ranges of measurement. The smaller

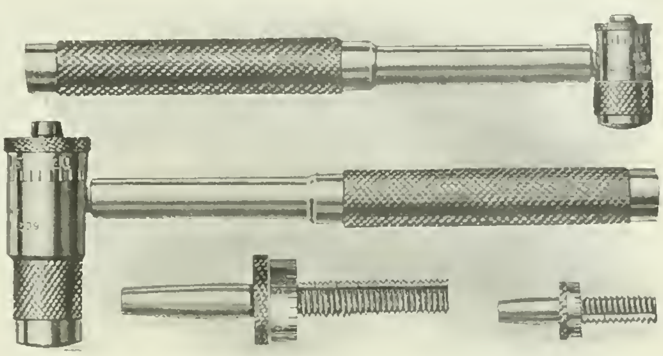


Fig. 1. Plant Inside Micrometer Caliper

of these tools with its two screws has a capacity for measurements ranging from ½ to 1 inch, inclusive, whereas the larger size, with its two screws, will take measurements ranging from 1 to 2 inches.

The construction of this caliper is shown in the sectional view Fig. 2. The barrel or body *A* of the instrument holds the measuring screw *B*, which telescopes into the barrel. This measuring screw is advanced from the barrel by means of a graduated nut *H*, and it is prevented from rotating when being adjusted, by a locking pin *E*. The pin is held in the end of the handle and it is pointed to fit a V-slot in the meas-

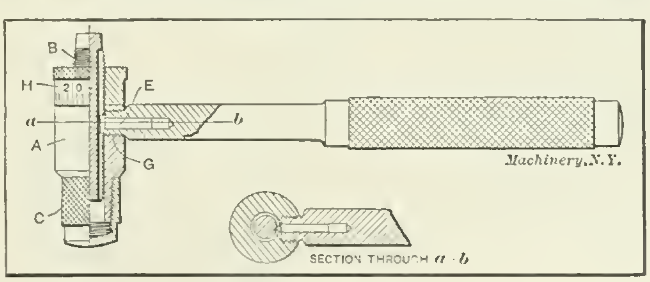


Fig. 2. Sectional View of the Plant Caliper

uring screw with which it meshes. By a slight rotation of the handle which is threaded into the barrel, this pin is brought to bear on the measuring screw and in this way the latter is locked after an adjustment has been made. The periphery of the adjusting nut *H* is graduated and each graduation, in passing the index mark on the barrel, indicates a movement of 0.001 inch of the measuring screw. Every revolution of the nut advances the screw 0.025 inch and after every fourth revolution, a tenth of an inch graduation appears

on the slot in the measuring screw just above the upper edge of the nut. To the lower end of the barrel, a knurled cap C is fitted that may be used for making slight adjustments to compensate for wear. All parts of this micrometer, with the exception of the measuring screws, are hardened. It is adapted to either tool-room or general shop work for taking accurate measurements in connection with boring, slotting, grooving and internal work in general.

FAY & SCOTT 16-INCH GEARED HEAD LATHE

A new design of single-belt drive, friction geared-head lathe, having instantaneous spindle speed variation is shown in Fig. 1. This machine is the product of Fay & Scott, Dexter, Me. The drive is through a single constant-speed pulley located at the back of the headstock. This pulley is designed to be belted direct to the lineshaft, and power is transmitted to the spindle through gearing, thus relieving it of all belt pull. The headstock, a plan and elevation of which are shown in

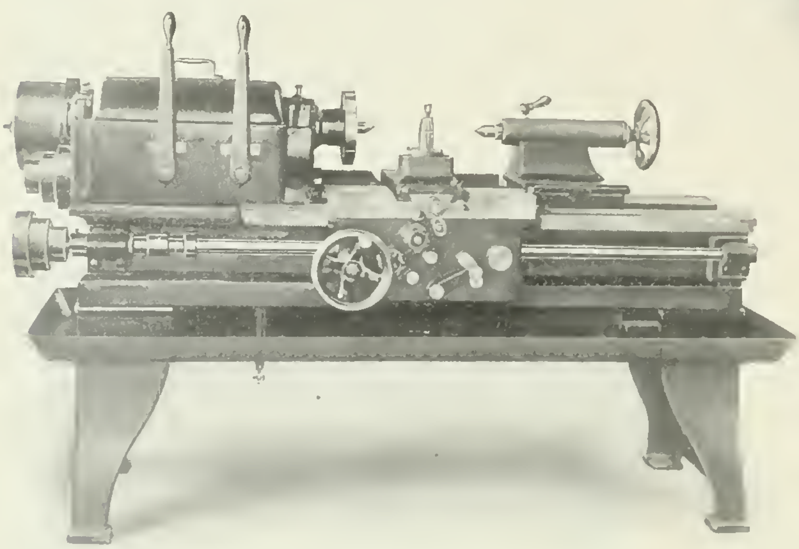


Fig. 1. Fay & Scott 16-inch Geared Head Lathe

Figs. 2 and 3, has four mechanical speed changes that are effected by means of friction clutches. These frictions are of the expanding type, fitted with cork inserts and operate as follows:

The sleeve A, carrying gears B, C and D, is driven at a constant speed, turning on shaft E. Four gears, F, G, H and

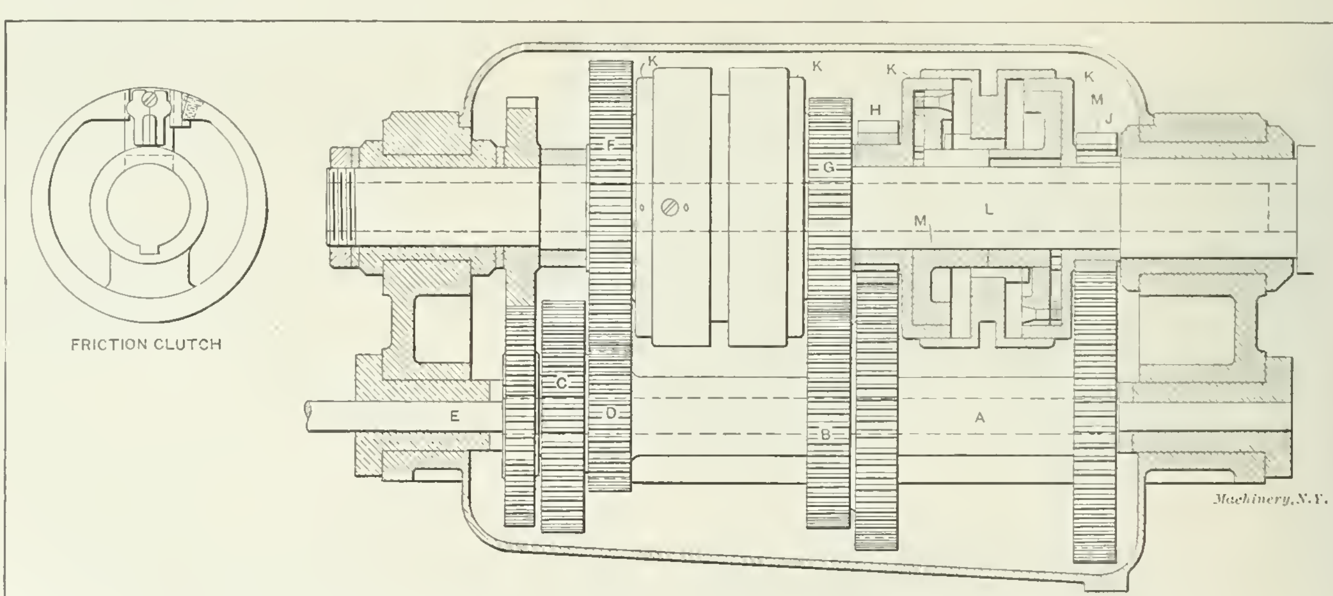


Fig. 3. Sectional View of Fay & Scott Geared Headstock, and Cross-section of Clutch

J, are mounted on four friction bands, K, which turn loosely on the spindle L, and may be clutched to the spindle by four frictions, M. These gears are always in mesh with the gears on sleeve A, and drive the spindle at four speeds. Gear N meshes with C and is driven by the pulley O through reducing gears which are located on shafts P and Q, as shown in the plan view, Fig. 2.

The speed changes are controlled by means of the two vertical levers that are shown mounted at the front of the headstock. These speed changes may be made while the machine is in motion and without any shock to the gears, the engagement of two conflicting ratios of gearing at the same time

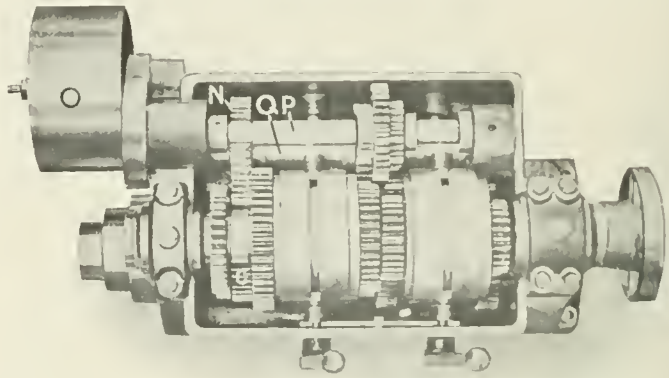


Fig. 2. Plan of Fay & Scott Geared Head

being made impossible. The entire mechanism runs in a bath of oil and is practically noiseless in operation. The working parts are readily accessible, and the friction clutches have a single adjustment that may be made with a screw-driver.

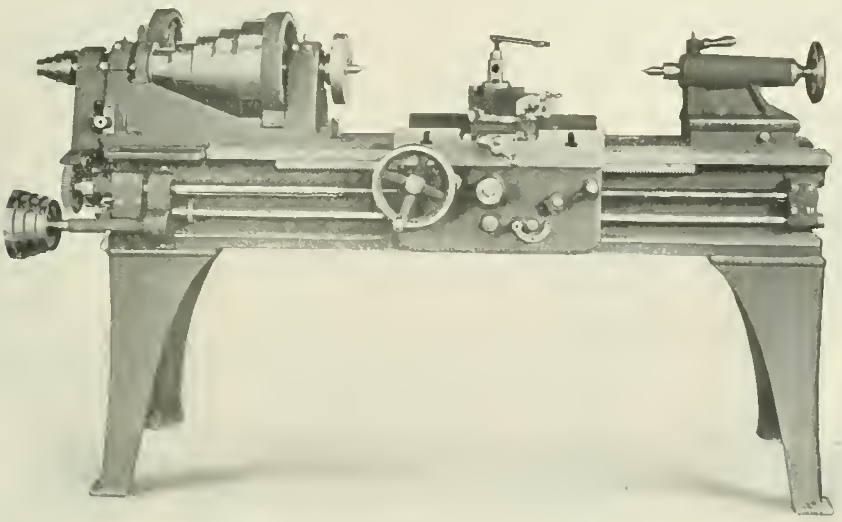
The particular machine shown is fitted up for plain turning with the usual rest, and with the screw-cutting feature omitted. It can, however, be furnished with facilities for screw-cutting and with a compound rest.

Modern features have been incorporated in the design, snuch as hollow hammered-steel spindle with ground bearings; bronze boxes; cut-away type of tailstock; wide waist carriage; flat inside front bearing, and a double-plate apron of the bevel gear type. This apron has reverse feeds and there is a positive lock-nut for the feeds when the machine is arranged for thread cutting. If desired, a taper attachment can be supplied and a turret can also be fitted to the carriage or V's.

As this machine was designed for the special purpose of turning cams of different sizes, four spindle speeds only were necessary. By the use of a two-friction countershaft, however, the speeds can be doubled, or by using a countershaft of the variable-speed type any desired number of speeds can be obtained.

ROCKFORD 15-INCH LATHE

The 15-inch engine lathe shown herewith is a product of the Rockford Tool Co., Rockford, Ill. This lathe has been designed to meet the requirements of tool-room work and manufacturing. It is strictly high-grade throughout and is heavily constructed and well ribbed, so as to stand up under heavy cuts. The spindle is made of high-grade spindle steel and it runs in phosphor-bronze bearings. The front bearing is 2⅝



Rockford Tool Co.'s 15-inch Lathe

inches in diameter by 4 inches long, and the rear bearing has a diameter of 1 15/16 inch and a length of 3 inches. A hole 1⅜ inch in diameter extends through the spindle. The particular lathe illustrated is equipped with a 5-step cone and a single back-gear with a ratio of 10 to 1. This lathe is also built with double back-gears and with a 3-step cone, when it is to be used on work requiring considerable power. The headstock is of a heavy pattern that is well braced, and the faceplate supplied with the machine is heavy and well ribbed to prevent any springing action when work is clamped to it. The bed is also heavily constructed and well ribbed and the webs in the sides are located directly under the shears to prevent any springing or chattering when taking heavy cuts. The shears have a large bearing surface and the carriage is gibbed in the front and back. The apron is well ribbed and is so constructed that the split nut and feed cannot be thrown in at the same time. The feed-screws for the cross-slide and the compound rest are both graduated. The opening in the tool-post is ¾ inch by 1½ inch. The tailstock is very rigid and the tail spindle is 1 15/16 inch in diameter and has a travel of 6 inches. The centers have a No. 3 Morse taper. Either a belt feed or a positive geared feed may be employed, there being a geared connection between the lead-screw and feed-rod which is readily thrown into or out of engagement. The thread-cutting capacity of this machine ranges from 3 to 20 per inch, including 11½ threads, and every other number from 20 to 40 per inch. The necessary gear changes for screw cutting can be quickly made without the use of wrenches, there being a special construction which enables this to be done.

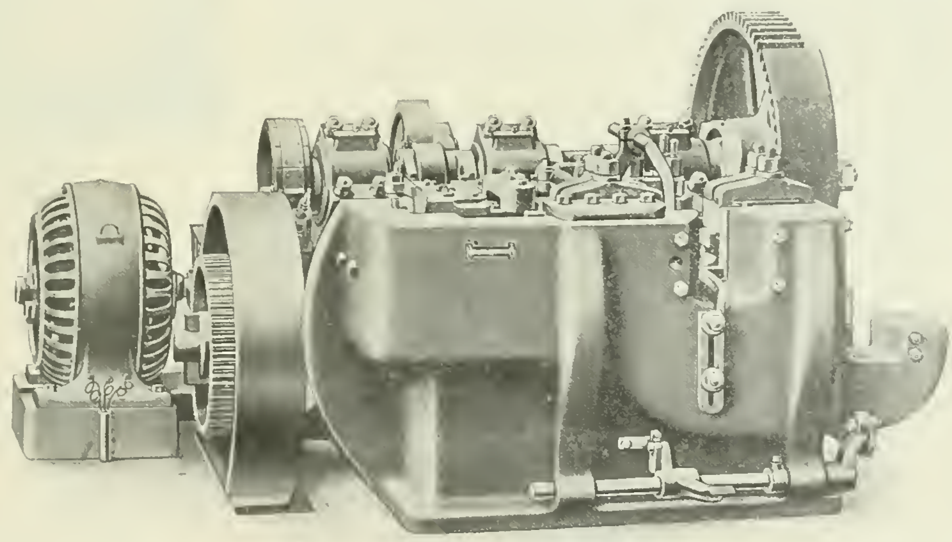
NATIONAL FORGING MACHINE WITH FRICTION SLIP FLYWHEEL

Among the many new and improved designs shown at the recent exhibition of bolt, nut and forging machinery, held by the National Machinery Co., Tiffin, Ohio, August 19 to 23, none attracted more attention or proved of greater interest than the "National" line of improved forging machines. The new features in particular were the "friction slip" flywheel design and the direct motor drive construction.

The "friction slip" flywheel, while simple in detail, meets a positive requirement in forging machine construction. It is a protection or relief to the machine against the enormous strains thrust upon it by the flywheel momentum when the machine "stalls," or, in other words, is prevented from completing the revolution due to an excess of stock or cold metal fed into the dies. The flywheel is held between friction flanges which are keyed to the shaft. When excessive material or cold stock is fed into the machine and prevents the heading tool from completing a full stroke, the flywheel slips between these friction flanges. This slipping action dissipates the momentum of the wheel, eliminates the excessive strains attendant to a rigid flywheel and protects not only the machine but the motor as well.

In the "National" direct motor drive design the motor is secured to a bracket bolted to the machine bed. The motor pinion meshes with a gear bolted to the "friction" flywheel. The design insures long life and protection to the motor and freedom from petty repairs, and has proved under the most severe tests to be a most practical method of directly connecting a motor and forging machine.

The double cam mechanism operating the grip is an interesting feature, also. This double cam mechanism allows the opening and closing of the dies to be "timed" so as to give unusually large upset or "gathering" capacity and this makes possible a wide range of work and more intricate forgings in fewer operations.



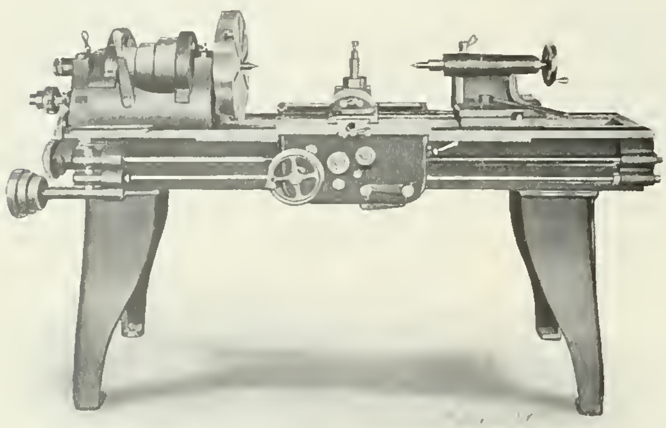
National Forging Machine with Friction Flywheel and Improved Gripping Mechanism

These machines are built in sizes of 1½-, 2-, 2½-, 3-, 3½-, and 4-inch capacity. The illustration is of a 2-inch machine and shows the motor application and "friction slip" flywheel plainly at the left.

MONARCH 16-INCH ENGINE LATHE

The Monarch Machine Co., of Sidney, O., has recently added to its line of machine tools the 16-inch engine lathe shown herewith. This lathe is equipped with double back-gears that are operated by a conveniently located lever. The headstock has a three-step cone and it is strongly ribbed. Either a positive geared feed or a belt feed can be employed and the range is sufficient to cover all practical requirements. The spindle is made of high carbon hammered crucible steel and it is ac-

curately fitted in bronze bearings. The tailstock is of the offset pattern which permits swinging the compound rest parallel with the bed. The bed has extra weight and depth and is webbed in 19-inch sections which insures rigidity. The carriage and apron are of modern construction throughout. The compound rest has a bearing surface of ample width and is provided with gibs for taking up wear. The steel rack used is in one section, and the pinion meshing with it can be disengaged for screw cutting. The ratios of the back-gears on this machine are 9 to 1 and 5 to 1. It has an actual swing

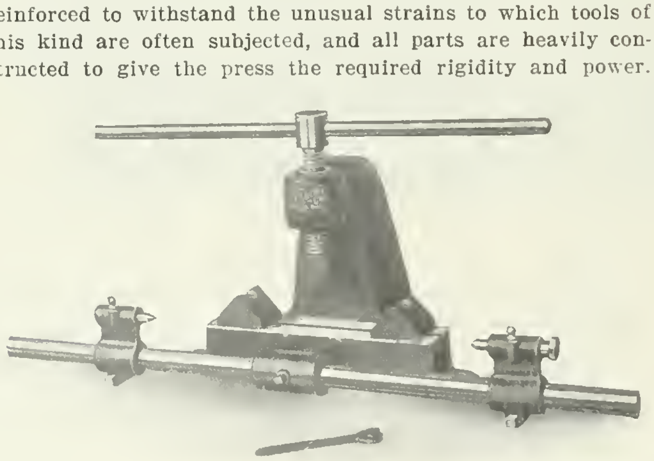


Sixteen-inch Engine Lathe built by Monarch Machine Co.

over the bed of 16 inches and over the plain and compound rests of 10 inches. The maximum distance between the centers with a 6-foot bed is 34 inches. The parts included in the regular equipment are a friction countershaft, a full set of gears, large faceplate, dog-plate, steady-rest, follow-rest and the necessary wrenches. All lathes are drilled to receive a taper attachment which can be furnished with the machine, if required.

GEIER NO. 1 STRAIGHTENING PRESS

The bench straightening press shown herewith is now being manufactured by the P. A. Geier Co., 5112 St. Clair Ave., Cleveland, O. This press, which is a No. 1 size, is designed for straightening shafts, arbors, forgings, spindles, and similar work. It has a capacity for straightening cold stock of 2 inches in diameter. The body is of box-type pattern, heavily reinforced to withstand the unusual strains to which tools of this kind are often subjected, and all parts are heavily constructed to give the press the required rigidity and power.



Geier Bench Straightening Press

Adjustable centers are attached directly to the press, as shown, so that centered work, which is being straightened, may be tested. The bracket supporting the centering shaft serves also as a hand-rest for holding the chalk when testing. The V-blocks, on which the work is supported, are easily adjusted along a groove in the bed. The thrust-block on the screw is of machinery steel, casehardened, and the adjustable centers are of tool steel and hardened. The body of the No. 1 press is 13 inches high; the length of the centering shaft, 40 inches, and the net weight, 135 pounds.

ACME TURRET LATHE TURNING TOOLS

The Acme Machine Tool Co., Cincinnati, O., has brought out a new line of turning tools for the Acme turret lathes. These tools are made to fit the 1½-inch and 2½-inch machines and the respective tools have a capacity equal to the spindle opening of the lathes for which they are intended. The back-rests are made of either the roller or plain type as desired. One of these tools of the roller-rest type is shown in Fig. 1, and also in Fig. 2 attached to a turret. As the engravings show, these rollers are mounted on dovetailed slides that can readily be adjusted for different diameters by the knurled screws shown. When the rollers are set, means are provided for locking them in position. The tool-block is fulcrumed on a large pin so that it can be swiveled to different positions. This block is clamped in place by the lever

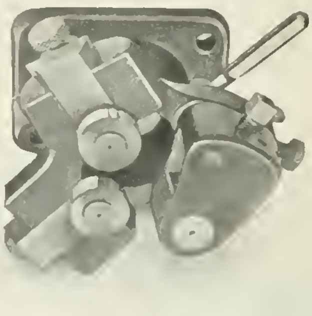


Fig. 1. Acme Turning Tool with Roller Rests

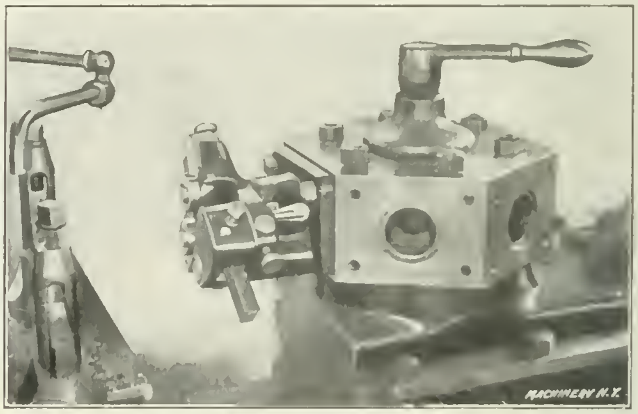


Fig. 2. Turning Tool Attached to the Turret

shown, which is attached to a screw tapped into the tool-block. This screw passes through a radial slot in the base casting. When the block is set in the proper position and clamped, it is securely held by a knurled backing screw, which, in turn, is prevented from turning by a locking screw.

HENDEY QUICK-THREADING ATTACHMENT

An interesting and valuable attachment, known as a quick-threading attachment, has recently been designed by The Hendey Machine Co., Torrington, Conn., and applied to the company's Hendey-Norton lathes. The attachment, as the name indicates, is intended for rapid thread cutting. Its use

Hendey Quick-threading Attachment

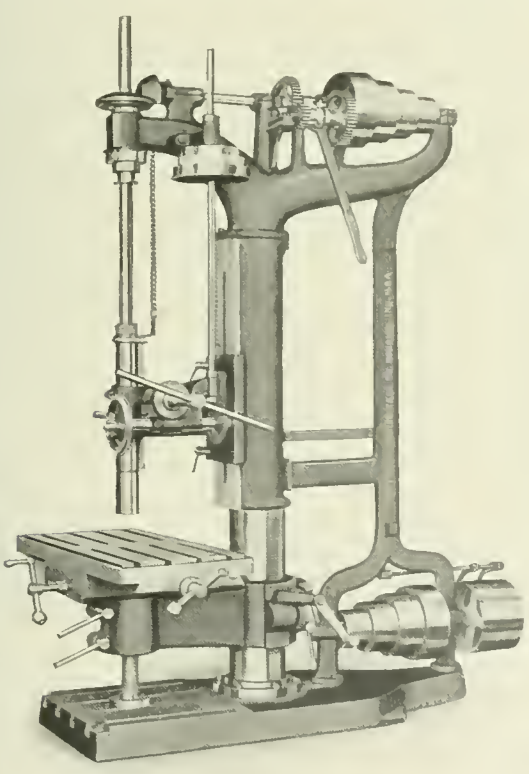
is especially advantageous on work where threads averaging from one to three inches in length are to be cut, but this is not the limit of the application of the attachment, the maximum capacity of which is a threaded length of 6 inches. The attachment, as shown in the accompanying illustration, con-

sists of a feed and a reversing sleeve, both assembled in a main bracket, a rocker shaft with rocker, and an operating lever with supporting bracket. In addition, two sets of trip dogs are provided, the pins of which engage with pins in the main bracket and act as automatic stops. A suitable chip guard is provided for the sleeves.

The principal advantage of this device is the saving in time over ordinary methods, which is due to the high speed at which the carriage is returned from the end of the cut to the starting point. This high speed is obtained by means of the quick-return sleeve which has a multiple thread of very coarse pitch. Both the quick-return sleeve and the feed sleeve are in constant rotation when the attachment is in use, the feed sleeve being driven from the reversing sleeve by spur gearing, the latter sleeve, in turn, being driven by the lead-screw. No time is lost when one of the sleeves is thrown in and the other thrown out of gear. This advantage will be all the more appreciated when contrasted with the ordinary method of reversing everything from the countershaft down. When the attachment is not used it is easily disconnected and can be moved out of place to the foot end of the bed. The attachment can be furnished for any of the Hendey-Norton 14-, 16- and 18-inch lathes, either for English or metric pitches.

SUPERIOR 32-INCH UPRIGHT DRILL

The Superior Machine Tool Co., of Kokomo, Ind., has added to its line of drilling machinery the 32-inch machine shown in the accompanying illustration. This drill press is equipped with a compound table which has both cross and longitudinal adjustment. The feed-screws, by which these adjustments are effected, have graduated dials reading to the thousandth



Superior 32-inch Upright Drill

part of an inch. The table has a working surface of 18 by 36 inches and its dimensions over-all are 20 by 40 inches. The arm is of heavy design having an exceptionally large bore for the table, which is rigidly supported by an adjustable supporting screw that rests on the base. This machine has been especially designed for handling automobile parts and for the use of railroad shops.

* * *

Radium has slightly decreased in price and it is now stated that it costs about $2,100,000 per ounce. This is less than it was a year ago, when it was estimated at about from $2,500,000 to $3,000,000 per ounce.

NEW MACHINERY AND TOOLS NOTES

Combination Forge and Furnace: C. U. Scott, Davenport, Ia. Combination forge and furnace with heating space of 4 by 9 inches. The design is such that the work does not come in direct contact with the blast, thereby greatly reducing the formation of scale.

Brazing Outfit: Gilbert & Barker Mfg. Co., Springfield, Mass. Fuel oil brazing torch and stand for holding work. A mixture of fuel oil and air is used in the burner, in which combustion is completed, so that a flame free from smoke is directed upon the work.

Bench Torch: C. U. Scott, Davenport, Ia. Torch for bench use which can be operated either with city or gasoline gas and air at 1½ pound pressure. A stand 10 inches high is provided for holding the burner, and the latter can be adjusted to the most convenient height.

Steel Pulleys: Oneida Steel Pulley Co., Oneida, N. Y. Steel pulleys ranging in size from 6 to 126 inches in diameter and with face widths varying from 2 to 40 inches. By means of a system of interchangeable cast-iron bushings these pulleys may readily be fitted to any one of several sizes of shafting.

Adjustable Reamer: Lapointe Machine Tool Co., Hudson, Mass. Large adjustable reamer 10 inches in diameter, intended for reaming cylinders. The body is made of machinery steel and the inserted blades are of high-speed steel. A 4½-inch hole extends through the body in which a ¾-inch keyway is cut for fastening the reamer to an arbor. The weight of this reamer complete is 92 pounds.

Hydraulic Wheel Press: Logemann Bros. Co., Milwaukee, Wis. Hydraulic wheel press which is operated by a triple two-stage pressure pump that is adjusted to respond automatically to the requirements of the service either at high or low pressure. This automatic control of the pressure meets the changing degrees of resistance and prevents sudden and severe strains which might result in breakage.

Steam or Air Hammer: Buffalo Foundry & Machine Co., Buffalo, N. Y. Improved design of steam or air hammer built in four sizes. The weights of the falling parts are, respectively, 250, 450, 700 and 1500 pounds, and the cylinder diameters for the different sizes are 6, 8, 10 and 12 inches. The valve gears of the two larger sizes have been redesigned, the oscillating valve formerly used having been replaced by a balanced piston valve.

Rotary Slitting Shear: Niagara Machine & Tool Works, Buffalo, N. Y. Rotary shear in which the widths of the strips to be cut are regulated by a gage which may be rapidly adjusted. Anti-friction rollers on the face of the gage, reduce the friction between the gage and stock, which, in turn, reduces the friction on the cutters and increases their wearing qualities. A holding-down attachment is provided which bears upon the stock as it passes through the machine.

Profile Truing Device: S. A. Woods Machine Co., Boston, Mass. Truing device for wood-working planers that sharpens and correctly forms the knives while running at full speed. This device corrects the inaccuracy of grinding and setting and insures an equal cut for the knives. When this attachment is in use, the holder carrying the truing stone is caused to automatically rise and fall in its movement across the machine, by a profile or pattern plate so that all cutters are accurately trued and made to "track" perfectly.

Annealing Furnace: Hawley Down Draft Furnace Co., 736 West Monroe St., Chicago, Ill. New type of annealing furnace known as the Hawley automatic. A special feature of this furnace is the automatic operation, it being driven by an electric motor controlled by a clock, so that all work to be annealed is kept in the furnace for a definite time according to the character of the work. The furnace is fed from an overhead hopper and can thus be kept in continuous operation without much attention.

Universal Grinder: Modern Tool Co., Erie, Pa. No. 3 universal grinder of rigid design. The body is nearly as long as the ways so that the latter have practically no overhang and are therefore evenly supported throughout their entire length. A smooth steady movement is given the reciprocating table by simplified worm-gearing and large bearing surfaces. The reversing mechanism is mounted on a bracket which is bolted to the outside of the machine so that it can be easily removed if necessary.

Milling Machine Drive: Garvin Machine Co., Spring and Varick Sts., New York City. Milling machine drive so designed that the motor can be applied to a stock machine, thus avoiding expense and delay. The motor is mounted preferably on a bracket at the rear, and drives by belt to a high-speed 2-step cone, which is connected to the countershaft on top of the column. By means of back-gears, sixteen changes of speed are available. The countershaft is mounted in eccentric bearings which may be rotated by a segment worm-gear to vary the belt tension.

Jolt Ramming Machine: Arcade Mfg. Co., Freeport, Ill. Large jolt ramming machine especially designed for handling

heavy loads and large flasks. This machine is built in three sizes, the smallest of which has a table 6 by 10 feet with a ramming load capacity of 40,000 to 45,000 pounds. The largest has a table 6½ by 12 feet with a ramming load capacity of 55,000 pounds. Tables of greater length can be furnished if required. The table is actuated by three pneumatic cylinders, the pistons of which operate in unison. The stroke is ¾-inch and the air pressure is 80 pounds.

Measuring Machine: Pratt & Whitney Co., Hartford, Conn. Large precision measuring machine with capacity up to 144 inches. To eliminate error in the microscopic readings, the standard bar has been elevated to a position nearly level with the surface of the bed. The delicacy of contact between the measuring faces is obtained by the use of auxiliary jaws holding a small cylindrical drop-plug by the pressure of a light helical spring. The tension of this spring is so adjusted that the instant the clamping surfaces are brought into perfect contact, the plug, which is held in a horizontal position by friction, will swing toward a vertical position and excess pressure will cause it to drop out.

Sheet Metal Straightener and Cutter: F. B. Shuster Co., New Haven, Conn. Sheet metal straightening and cutting machine for strip metal up to 14 inches in width and 0.065 inch thick. The cutting-off mechanism is electrically controlled and may be operated either automatically by a stop gage or with an electric button located at the front of the machine. The metal passes through the feed and straightening rolls and between the cutting-off knives to the gaging table. As it comes in contact with the gage, an electric connection is made which engages the cutting-off mechanism and at the same time stops the movement of the rolls. The severed stock is delivered to a rack or suitable receptacle.

Four-slide Milling Machine: Garvin Machine Co., Spring and Varick Sts., New York City. Special four-slide milling machine especially adapted for such work as the cutting of oil grooves in automobile axles, keyseating, fluting, notching, squaring ends, etc. The machine has four slides or work-tables which may be operated independently so that there are practically four machines. With this construction, three slides may be at work continuously while the fourth is being loaded. There is one cutter spindle for each pair of slides and this is also independently driven so that one slide can be entirely disengaged when required. The slides may be fed by hand or power and twelve changes of feed are provided.

Carborundum File: The Carborundum Co., Niagara Falls, N. Y. Carborundum file adapted to the work of a steel file and also for filing parts which a steel file could not cut. This file is made of a solid block of carborundum 13 inches long, 1½ inch wide and 1½ inch thick. One end is rounded and the other is fitted with a durable wooden handle. It is claimed that this file will work much more quickly on castings or soft metals than one of steel, and in addition it may be used for touching up casehardened parts and also for removing the scale from hard metals. Owing to the extreme hardness of carborundum, this file has excellent wearing qualities and it cuts fast and clean and does not glaze or wear smooth. The size and shape, as well as the grade of abrasive used, are such as to adapt the file for all-around work.

Machine Recorder: National Machine Recorder Co., Marquette Building, Chicago, Ill. In the department of New Machinery and Tools for October, 1908, we described an instrument for recording automatically the length of time machine tools are idle or in operation. This machine has recently been improved by the addition of an adding attachment, a time-setting device, and a set of production counters. The adding attachment accurately and automatically computes the net running or idle time of each machine. Each producing unit in the shop has an adder which shows distinctly in large figures the net time that the machine has been producing or, if desired, the idle time together with the total at the end of the day. The time-setting device, when set to a fixed time for an operation, records on a chart and adding wheels such time as is consumed in excess of the given time. A set of production counters, placed directly above the time adding attachment, records each piece produced by each machine as it is finished, so that there is an accurate record of the output, time consumed, and time wasted.

Circular Milling Machine: Barber-Colman Co., Rockford, Ill. Eighteen-inch circular milling machine of the vertical type intended for finishing small parts such as links, levers, connecting-rods, universal joints, clutch-yokes, etc. The machine is equipped with a circular table which may be revolved continuously and to which the work is clamped radially in suitable fixtures. After each piece is milled, it is removed and replaced with an unfinished part so that the milling operation is continuous. The machine is not designed for circular work, though such work can be handled conveniently, but for the single purpose of machining those pieces that can be milled with face, side or straddle mills. The construction of the machine is high-grade throughout. All running bearings are bronze bushed and are generously proportioned. The spindle is of crucible steel and it has a No. 11 taper hole in which the shanks of arbors or end mills can be held. The nose is also slotted for positive driving and the end threaded for the larger sizes of face mills. The drive is of the direct gear type, and six changes of speed are provided. The table is rotated through worm-gearing and it also has six feed changes. This machine occupies a floor space of 44 by 66 inches, and it has a net weight of 3300 pounds.

Gear Tooth Chamfering Machine: Ingle Machine Co., Rochester, N. Y. Machine for chamfering the ends of teeth on all styles of gears, including those of the internal type. The operation is performed automatically on any gear within the machine's capacity regardless of pitch or number of teeth. The chamfering is effected by a rotary motion of the gear being cut, combined with a reciprocating movement of the slide in which the cutter spindle is mounted. The machine is driven by two belts from a countershaft, one driving the cutter spindle and the other the feeding mechanism. The feed is varied for different metals and pitches by a cone pulley which provides three changes. Provision is made for swiveling the cutter head to the right or left, depending on which side of the gear is to be chamfered, and the head is also adjustable. All gears are located in the cutting position by a guide or stop and no adjustment of the work is necessary after the machine is once set up. This machine will take gears ranging from 1½ to 12 inches in diameter and with diametral pitches of from 12 to 4. The equipment furnished includes an oil pump, all necessary fittings, two double cutters, an arbor, complete countershaft and the required wrenches.

Vertical Surface Grinder: Blanchard Machine Co., Cambridge, Mass. Vertical surface grinder equipped with a rotary work-table or magnetic chuck, which forms an integral part of the machine. This chuck is mounted on a sliding table which may be quickly adjusted clear of the wheel to place and remove work. The work-table runs on a ball bearing of large diameter; it is securely gibbed down by a ball thrust bearing at the center. The massive construction of the head and spindle has made it practical to mount the driving pulley or drum directly on the spindle which is driven by a 5-inch double belt from an overhead countershaft. The spindle is mounted on a sliding bar that is secured to vertical ways on the column. This head has a rapid power traverse which is operated by a conveniently located lever. Over travel in either direction is prevented by a simple device which positively returns the operating lever to a neutral position when the limit of travel is reached. The splined shaft which drives the table through bevel and spur gears, is, in turn, driven by a constant-speed pulley through a gear-box giving eight speed changes. The levers for the speed variations and also for starting and stopping the table are conveniently located. The cooling water is supplied by a submerged centrifugal pump which forces it through pipe and hose connection, and suitable channels, to the inner face of the wheel, whence it is driven across the ground surface in a rapidly-moving sheet, thus effectually cooling the work. All important bearings in this grinder, as well as all continuously running gears (except the pump gears) have oil bath lubrication. The grinding wheel used in this machine is 16 inches in diameter and the rotary magnetic chuck has a diameter of 24 inches. The maximum height under a new wheel is 12 inches. The net weight of the machine is 6800 pounds.

Planer: Knecht Planer Co., Cincinnati, O. Electrically-driven planer in which the table reversal is effected by means of gearing, the driving belt and pulley running continuously in one direction. The drive is such that the power is independent of that used for the return movement of the table, so that different cutting speeds with a constant return can be obtained. The drive is by belt from an electric motor on the housing to the main driving pulley. The reversing belt, which is shifted in the regular way, is located on the left side of the machine. The reversing pulley, like the main driving pulley for the cutting stroke, runs in one direction only. This reversing pulley is held by a ratchet and pawl mechanism during the cutting stroke, and it is released at the end of the cut just before the reversing belt is shifted to the pulley. As the latter starts as soon as released, it is in motion at the time the belt is shifted which relieves the motor of heavy loads. The feed mechanism is positive and independent of the driving mechanism. The feed is actuated by a clutch which is tripped at each end of the stroke. The feed boxes through which the feed movements are transmitted, are mounted on each end of the cross-rail so that the feed can be controlled from both sides. The feeds range from 1/64 to 3/4 inch, increasing by 64ths and any desired amount can be instantly obtained by shifting a conveniently placed lever. A handle at the top of the feed-box provides means for engaging or disengaging the feed without disturbing the setting either as to amount or direction. By means of a handle at the center of each feed-box, a fast traverse may be transmitted to the slide that is connected for feeding. This feature saves considerable time particularly when setting or testing work. If desired, this planer

can be equipped for belt drive in which case the countershaft is mounted on the cross-tie between the housings, in place of the motor. Four tool-heads are provided and those on the side are counterweighted.

* * *

WRECK OF WELLMAN'S DIRIGIBLE BALLOON "AMERICA"

Walter Wellman, the newspaper man who achieved international notoriety a few years ago by making an attempt to reach the North Pole in a dirigible balloon, essayed to cross the Atlantic in the same type of flying machine in October. The start was made from Atlantic City, October 13, in the *America*, a dirigible balloon 228 feet long carrying Wellman and a crew of five—besides the cat. The balloon was provisioned for a long trip and carried an ample supply of gasoline for the engines. The project was backed by three newspapers in London, New York and Chicago, to whom wireless messages were to be transmitted by a Marconi apparatus on board. A novel feature of the equipment was the "equilibrator," a long snake-like appendage to the car consisting of gasoline containers attached to a wire cable. The function of the equilibrator was to maintain the balloon at a constant height and to assist in steering. The tail end floated in the sea, and as the balloon rose above a predetermined height more of the equilibrator weight would be carried and as it descended, less of its weight would be supported. Thus it was expected that a constant mean height would be automatically maintained without the expenditure of gas and ballast. The equilibrator was a development of the leather "snake" stuffed with food which was to be dragged over the ice on the proposed North Pole expedition, but which was never given an adequate trial because of the wreck of the balloon before it was well under way. The daring, not to say foolhardy, navigators, were caught in a great storm and blown out of their course in a southwesterly direction, but fortunately were rescued about 400 miles off Cape Hatteras by the steamer *Trent*, bound for New York, on October 18. The equilibrator was condemned as being unsatisfactory. The action of the heavy waves transmitted severe shocks to the car and threatened the destruction of the whole fabric. Thus endeth the last of a long series of experiments with the dirigible balloon, a device that must necessarily be the sport of the winds, no matter how powerful the engines or how skillful the navigator. By good fortune Wellman might have succeeded in crossing the Atlantic, but the exploit would have proved little, and would have been of little practical value.

* * *

THOMAS DAVENPORT, INVENTOR OF ELECTRIC MOTOR

A tablet was unveiled in memory of Thomas Davenport in Forestdale, town of Brandon, Vermont, September 28. The inscription on the tablet reads:

"In memory of Thomas Davenport, 1802-1851. Inventor of the electric motor. Near this spot stood the building where he developed his invention. This tablet is placed here by the allied electrical associations in America in recognition of the great service rendered mankind by the invention, to the development of which he devoted his life. Erected September 28, 1910."

Davenport's father died when the boy was ten years old, and he was apprenticed to a blacksmith in Forestdale. In one corner of the old blacksmith shop he arranged a crude experimental laboratory where he conceived the idea of transmission of intelligence by wire before Morse invented the telegraph. He produced here the first electric motor before there was a mile of steam railway in Vermont, and built and operated a model electric railway. Later he moved to New York to perfect his inventions. While in New York he drove a printing press with an electric motor and published an electric journal known as the *Electric Magnet* and later as the *Magnet*. Both these publications expired after a few issues. Broken in health and financially ruined, he returned to Vermont where he died July 6, 1851. Davenport's inventive career was one of discouragement and misfortune. His inventive genius was of a high order, but unfortunately he was ahead of his time and the world was not ready to accept and develop his ideas and reward him financially as it has later inventors who conceived practically the same inventions.

THE USE OF BALL OR ROLLER BEARINGS IN MACHINE TOOL CONSTRUCTION*

The author of the paper abstracted in the following stated at the outset that he hesitated considerably about accepting the call to address the machine tool builders on the subject of ball or roller bearings, not because he had not a great deal to say about this subject, but because he knew full well how difficult it was to get below the machine tool builder's hide the idea that there could be anything in ball bearings for him. Then however, he remembered that the machine tool builders had all prospered, and hence were familiar with the ball bearings in their automobiles.

In the following no discussion of the merits of ball bearings in general or of various types and designs will be given, but rather a brief reference to a number of cases where ball bearings are used on various machine tools, the examples being taken from both American and European practice.

One of the oldest uses for ball bearings in machine tools is on the vertical spindles of drill presses. Ball bearings used in this manner have proved successful when proper bearings, properly mounted, have been used. The Colburn Machine Tool Co. showed at the recent convention of master mechanics and master car builders at Atlantic City a heavy drill press driving a 1½-inch drill through 31 inches of cast iron per minute, and a 3½-inch drill through 11¼ inches per minute. It is evident that here a heavy thrust is produced. This thrust is taken by a Hess-Bright ball bearing of the self-adjusting seat type. On radial drill columns the weight is sometimes taken on a thrust bearing at the top. It is preferable to take the weight at the top on a ball bearing placed there, rather than on a ball bearing placed at the lower end of the column. The reason for this is that the relatively small bearing at the top costs only a small fraction of what a ball bearing big enough to surround the column at the bottom would cost. In order to relieve the friction due to the pressure that the sleeve exerts at the base of the column in a radial direction, this pressure is taken on one or more small radial bearings, arranged in a special manner. These small bearings cost much less than a single large one, and are quite as efficient. In the swinging arm type of radial drills, bearings are employed at the top and bottom to take the radial thrust and a compensating seat thrust bearing is placed at the bottom to take the vertical load.

Certain German milling machines take the thrust of the table-elevating screw on a ball bearing. The Becker Milling Machine Co. shows in its catalogue some types of belted vertical milling machines with speed boxes equipped with Hess-Bright ball bearings. Other prominent American builders of this line of machines take the feed screw thrust on ball bearings. One German type of heavy worm-driven 144-inch planer is provided with two thrust bearings for taking the worm thrust both on the forward and reverse strokes. It has been found that the correct employment of suitable ball bearings on a planer eliminates all liability to back-lash, and increases the ease of running the planer as well as its power efficiency.

The weight of the vertical spindle of a surface grinder built by the Blanchard Machine Co. is taken at the top on a ball thrust bearing, and the radial load at this point is taken on a radial ball bearing, while the grinding thrust is taken immediately above the face grinding wheel on a ball thrust bearing. The entire countershaft of a grinding machine, built by Unger of Stuttgart, Germany, is mounted on ball bearings. The author stated that in the Hess-Bright Co.'s own shops they had also remounted on ball bearings a number of their grinding machine countershafts as well as the wheel spindles. It was found that while the belts were frequently thrown off in suddenly starting the machine, when the machine was provided with the original plain bearings, the substitution of ball bearings entirely eliminated this difficulty. In addition, the annoyances due to wear and the necessity for frequent lubrication have been done away with. The Pratt & Whitney Co. uses ball bearings on a very heavy grinding machine, the entire load of 10- and 7-inch belts being taken on ball bearings. The Rushmore Dynamo Works has mounted a con-

*Abstract of paper by Henry Hess read before the National Machine Tool Builders' Association Convention in New York, October 26, 1910.

siderable number of its grinding and buffing heads on ball bearings after having first thoroughly tried them for durability and other qualities.

In the examples mentioned so far, ball bearings have been employed under fairly uniform conditions as to load, and at speeds ranging from moderate ones on drill presses, milling machines, etc., to high speeds on grinding machines. Ball bearings, however, are used with very decided success under conditions where they are subjected to considerable shock, as for example, in heavy punch presses in which the driving shaft is mounted on a ball bearing. This is done on fairly heavy presses, having driving gears weighing 2000 pounds. Carefully made comparative tests on this press showed that the ball bearings decreased the power used on the idle stroke by 54 per cent. The power used with a plain bearing during the working stroke was 16.8 horsepower, which was reduced to 13 horsepower with the ball bearing. The power saving for the complete cycle was about 40 per cent. A punch press provided with these bearings has been in use for a number of years and the ball bearings do not yet show the slightest indication of wear.

Ball bearings can be used to advantage on cold disk saws. In a special case the plain bearing required renewal about once every three weeks, and that renewal necessitated a returning of the shaft itself, and hence put the machine out of commission for some time. The disk ran at a speed of 4100 revolutions per minute and required 20 horsepower. It would, when thrown in, almost stall the motor, and it frequently blew out the fuse. A stream of cold water was kept constantly running through the water jackets of the babbitted bearings. The same machine provided with Hess-Bright ball bearings and driven by a 7½ horsepower motor has ample power, and readily takes up the load without shock. The machine has now been running for over a year and no deterioration in the bearings has been noticed.

The use of ball bearings on wood-working machinery is of no less importance. One of the largest European manufacturers of this class of machinery, Fleck & Sohne, of Berlin, Germany, use ball bearings to a very great extent in their machinery. This firm considers the matter of ball bearings of such vital importance that its catalogue reads very much like that of a ball bearing manufacturer. Carefully conducted tests have shown that the power saving amounts to 60 per cent when the machines run idle, and while in action the actual horsepower saved is still greater, owing to the greater load on the bearings. This company also states that besides the saving of power, the wear is very much reduced, all danger of heated bearings is eliminated, and the consumption of lubricant is greatly reduced. Among American woodworking machine builders, the Defiance Machine Co. mounts an 18-inch spoke lathe on ball bearings. With the original babbitted bearings, two horsepower was required to run the cutter-head idle and 7 horsepower for turning an 18-inch spoke. When mounted on ball bearings these values were reduced to 0.8 horsepower and 5.8 horsepower, respectively.

A somewhat peculiar condition of affairs relating to the introduction of ball bearings, is that many of those who employ them ask in the first place for an exclusive right to use them on their machines as against their competitors, and then, as that is not possible, that no mention be made of the use of ball bearings for their certain class of machines, in order that their competitors may be kept in the dark as long as possible. This condition, of course, is irksome to the manufacturer of ball bearings, since it prevents the using of the most effective of all arguments in convincing a prospective customer.

Ball bearings can also be used to considerable advantage on the countershafts for machine tools. In the German Niles Tool Works the entire line of countershafts is thus mounted. In German practice ball bearings are used on cranes, both in the trolley and for the hook. In one case a swing crane column is mounted on ball bearings carrying up to 10 tons horizontally and 14½ tons vertically. Radial ball bearings are regularly made in sizes with carrying capacities up to 14,000 pounds, and thrust ball bearings for loads up to 28,000 pounds at 10 revolutions per minute. Special ball bearings can be made to suit any demand, even up to a load of 400,000 pounds.

CONCRETE VS. WOOD FLOORING

The subject of "Concrete vs. Wood Flooring for Machine Shops" was of great interest to us because we had just prepared plans for a new shop which would more than double the capacity of our works, these plans calling for reinforced concrete construction with saw-tooth roof, etc., and the question of the best floor had, of course, been one that called for considerable study.

Letters were sent out in which two questions were asked: 1. Are you using concrete floors at present, and are they satisfactory to you and the workmen? 2. If you were to build a new shop, what would your experience lead you to use for the floors, and how would they be constructed?

In answer to these inquiries forty letters were received, of which eight were distinctly in favor of concrete floors for machine shop use. There were twenty-six decidedly in favor of wood, and six were non-committal, being favorable to either under certain conditions and for certain work.

These reports came with only one or two exceptions from those operating machine shops, although sixteen of them were not machine tool builders. All of the eight who preferred concrete have had experience with both wood floors and concrete floors. Seventeen of the twenty-six preferring wood floors have actually had experience with both; the other nine based their preference for wood upon investigations made by them when looking up this matter for their own benefit. The general point of view of the writers of these letters can best be given, perhaps, by two or three extracts from the letters received, the first being from Southern Vermont.

"Regarding concrete floors for shops, we built a three-story cement and steel building in 1904, and in 1907 we put up a saw-tooth single story building. In both of these buildings we have used concrete floors without wood. We noticed the men who were accustomed to standing on a wood floor became more 'foot-tired,' at least at first, in the cement building, and possibly those whose work gave them an opportunity to move about were also slightly affected in the same way, but as for this we are not sure. . . . In these buildings with concrete floors we provide a thin platform of wood for men who do not move about; we do not find it necessary to provide it for others. The planer and the bench hands whose work calls for standing in one position most of the time need the wood insulation.

"At first we thought it was the difference in the hardness of the material, and in fact, this may be one of the reasons why it is more tiresome, but the Aberthaw Construction Co. put out a circular on this subject, in which it was suggested or stated that the reason cement floor was objectionable was that it carried off the heat from the men's feet faster than the wood, which is not as much of a conductor of heat, and that, with the same temperature, this greater heat conductor produces the undesirable effects, and in that paper we think it used the comparison of the difference in feeling in the hand of an iron and wood surface of the same temperature. Among other objections was that the cement was supposed to increase rheumatic troubles. We have had no such complaints, and have felt that the advantages more than off-set the disadvantages.

"It makes a cleaner, more wholesome shop—one in which it is possible to clean the floors from all of the objectionable matter that accumulates in the cracks of wood floors, and it also makes possible the introduction of cuspidors cast directly in the floor, into which we run a flushing stream at regular intervals.

"If plants could be heated through simply warming the floor, as we believe has been suggested, then the only serious objection to the cement floor would be removed. It is possible that the hollow tile may serve for this purpose. I refer to the hollow tile made by the National Fire Proofing Co. A layer of this tile with openings registering the entire width of the building, and connected with conduit pipes on the lines already suggested, would give a very even distribution of heat and would not make an expensive floor, although the total thickness would have to be probably 2 inches under and 2 inches over of cement, with hollow tile of 4 inches or 6 inches, according to the load.

"This would bring the temperature of the floor up closer to that of the workmen's feet, and would make the floor the warmest part of the building, and do away with pipes of all kinds. It might not be necessary to have any immediate openings into the room, excepting for a slight circulation. There is no reason why steam pipes could not be put in the same openings.

"There remains the element that always enters into the use

* Abstract of paper by James N. Heald, read before the National Association of Machine Tool Builders' Convention, at New York, October 26, 1910.

of concrete which must be seriously considered by anyone building a more than one-story building. A few shovels of earth without the proper amount of cement, or a few shovels full of inferior earth material instead of sharp sand, may happen to be placed where it will cause serious disaster, but we have had no experience of this kind, excepting that we have had to worry about it, particularly at first."

Among the letters favoring wood floors, the following from Cleveland, Ohio, will be of interest:

"We have one building in our group made all out of concrete. This building is three stories high and all the floors are concrete. We have been greatly disappointed in the concrete floors. In the first place any water spilled on one of the floors filters down through to the next. These floors are not suitable for trucking, as they chip out and wear in grooves. Our men do not like them and complain of the effect that standing on the concrete floors has upon their legs. This may be imaginary, but it is to be considered.

"We have recently made an experiment on these floors by covering them with about two inches of first-class paving asphaltum put on by the company that does the asphaltum paving in this city. So far, we think this is an improvement, and another year may extend this coating over all the floors in this building.

"In our judgment the best floor for a factory is narrow matched maple. It wears smoothly and is easily repaired."

The second is from a manufacturer of automobile parts in Detroit, Mich.:

"We are using concrete floors in our factory building, which is devoted to light machine shop manufacturing operations. From our experience so far, we are quite firmly of the opinion that this is a decided mistake, and that wood floors would be much better and more economical in the long run for this kind of work. While there have been a few cases of complaint from workmen, this has not been at all serious. So our objection to concrete is more on the score of its being unsuitable as a wearing and working surface in general as applied to machine shop operations. As a matter of wear, we find it giving way much more rapidly than we had anticipated, while due to this and at the same time aggravated by the presence of metal chips and oil, it is rather difficult to keep clean. Another serious objection to concrete is the invariable damage suffered by tools and finished pieces of work dropped upon it.

"One-inch to one-and-one-half inch by three-inch maple is generally considered to be the best flooring material, and is what we should use in future."

The third and last is from a manufacturer in Stamford, Conn.:

"We have in two instances in our factory examples of concrete floors on which active manufacturing is being conducted, and in both cases, during the winter months, we have trouble in keeping the men comfortable in these rooms. The reason undoubtedly is due to the fact that the concrete floors abstract the heat of the body from the feet, chilling the blood and consequently producing a feeling of discomfort which is attributed by the employes to want of proper heat in the room.

"The main portion of our factory is composed of wooden floor of three thicknesses, namely a supporting floor of sufficient strength underneath, an intermediate floor and a top wearing floor of maple. We find that this construction of flooring gives us excellent satisfaction from the standpoint of the employes and likewise has the advantage of being readily repaired by replacing the upper surface without disturbing the main features of the construction of the building.

"In two of the buildings we have used the reinforced concrete form of construction as far as the floors and columns are concerned, and in this instance we have put screeds in the concrete, nailing down an intermediate floor and top wearing floor of hard maple as above. This method has given excellent satisfaction, and the writer has had the chance of studying, from his own personal feelings, the effects of such a floor, on account of our main offices being laid in one of these reinforced concrete buildings.

"On the ground floor we have used a method of tar concrete for a depth of four inches in which are buried screeds, and an intermediate floor and top maple floor as in the above examples cited. This method for the ground floor work is highly satisfactory, as it keeps out the dampness and preserves the floor. The writer had the experience within the past six months of taking up a portion of a floor of this character, which had been down thirty years. The under flooring and screeds were just as clean and well preserved as if they had just come from the lumber yard.

"In cases where we have found sensitive persons complaining as to the conditions arising from the use of concrete floors, we have made a lattice of wood for the employe to stand upon with a marked improvement in his physical comfort."

During the last three or four years the use of concrete for factory buildings has greatly increased, and when properly reinforced, has proved entirely satisfactory, and owing to the reductions in the cost of cement and increases in the cost of other materials, the use of reinforced concrete has become quite general, and therefore floors of such structures are worthy of special notice. Reinforced concrete floors are made in numerous styles by different engineers, but the fundamental idea is that of using bars or other forms of steel as the tension members, imbedded in concrete bodies. The floor proper is simply a slab like a cement sidewalk with reinforcement near the lower surface and supported by beams of concrete, also reinforced, which are formed as a part of the slab.

The Effect of Granolithic Floors on Operatives

It is claimed by some of the advocates of concrete floors, that the real cause of the workman's complaint is undoubtedly the coldness and not the hardness of concrete floors. Everyone knows that the coolest seat on a hot day is a stone doorstep, and like the stone step, the concrete floor feels colder than the wood floor. When a concrete floor is in contact with the ground, it actively withdraws heat from its inner surface because it is a good heat conductor. At all seasons the concrete floor feels colder than the wood floor and the effect of this on the operator who stands for hours in one place is to gradually chill his legs and thus retard the circulation in them. In some shops the operators not only bring in boards and the like to stand on, but have gone so far as to wear heavy overshoes during working hours.

The actual heating of the concrete floor-slab itself by means of contained steam pipes or hot air ducts arranged in the substance of the flooring has proved remarkably successful in the plant of the Morse Chain Co., Ithaca, N. Y.

In this plant, which was described in the *American Machinist*, February 10, 1910, the workrooms are heated by radiation from the concrete floors, with no direct admission of hot air except in extremely severe weather. The experience of the Morse Chain Co. seems to demonstrate that workmen have mistakenly attributed the effects of the cement floor to its "hardness," when in fact it was the "coldness" which was to blame.

Taking up now the requirements of satisfactory floors of concrete, we come first to the wearing qualities:

1. Liability of granolithic to wear into hollows, or ruts, under heavy trucking.
2. Dust, due to abrasion of the floor surface, which is sometimes merely disagreeable, but which in other cases works damage to machinery and product.
3. The difficulty of making effective repairs in granolithic finish.
4. Trouble in attaching machines to granolithic floors.

Trucking, as shown by the letters received, develops considerable trouble, especially where the concrete blocks are marked off into squares, as is usually done. It would be much better, so far as this point is concerned, if the marking off of the squares (which is done partly for looks and partly that any cracks which develop may run through these markings and in that way not show in the level surface) was omitted in such floors.

One suggestion has been made by an advocate of cement floors, which is that flat iron bars slightly separated and not on edge be imbedded in the floor in the direction in which the trucking is done, and in that way take the wear of the trucks and save the concrete. These are better than solid flat plates which become polished and therefore very slippery after a time.

Various paints are offered to prevent dust, but they are of very little value; the floors can be kept painted, but the expense seems prohibitive. No film, as thin as the average coat of paint, will permanently resist the usual wear of the shop. It is claimed that a boiled linseed oil thinned with gasoline or naphtha until it runs into the pores of a porous surface, oftentimes prevents trouble and is cheaper than some of the floor paints. This preparation is incidentally a good waterproofing for porous surfaces, as well as a preventative of dust.

In the matter of repairs, the granolithic surface is obviously at a disadvantage compared with wood, because of the difficulty of firmly bonding new material to the old.

The difficulty of attaching machines to the concrete floor is probably over-rated by those who have had no experience in this line. Many of the later types of machine tools are so heavy, so well-designed and so nearly self-contained that they require very little, if any, attaching or bolting to the floor, and, therefore, the drilling for plugs into which screws can be driven, or the use of expansion bolts, should be a comparatively simple matter.

The breakage of parts in process, by dropping, is something that must be considered individually. If manufactured articles are delicate and finished all over, there is risk of serious injury to them in dropping on a concrete floor, which would not be the case with a wood floor. Therefore, if the article being made is fragile the wood floor is quite desirable.

With regard to cleanliness, there is not much question but what the concrete floor can be kept cleaner than the wood floor, which has so many cracks, usually full of dirt. What dirt accumulates on the concrete floor is right on the surface and can much more readily be taken up.

With reference to waterproof granolithic floors, experts say that they must be troweled hard in order to make the surface durable, and that this troweling also makes it practically waterproof. There will be no leakage of water that may get into the surface, except at joints, and possibly in places that have been worn by use. The extent of damage would be simply whatever was done by the leaking water in the room below. The conclusions are, that the highest success in the construction of a granolithic floor surface can be obtained only by following very carefully correct principles of construction and certain methods of manipulation, in order that the surface may be able to give the service expected of it.

There are certain situations where in spite of its higher cost, the wood top floor is probably better than any granolithic surface for the owner to put in, simply because his case may require certain qualities which the wood top can provide, and which no masonry surface can give, and which he must have, even at a higher first cost.

The virtues of a wood floor are inherent in naturally formed material whose fitness is apparent at a glance. Saw up the tree, season the sawed and planed strips, let the carpenter make them into a floor, and you have a wearing surface of certain high recognized value. With the granolithic surface in contract, it is necessary to select cement and other materials for certain qualities which are not evident in the appearance of these materials; correct proportions must be determined; materials must be put on the right kind of surface and at the right time, and must be manipulated in the right manner. The green surface must be protected for a certain number of days while it is setting. The mere statements of the procedure necessary with the granolithic finish is enough to show that the average granolithic floor will be more or less unsatisfactory, because the average concrete workman is inclined to hurry, and is often poorly informed as to the procedure necessary for getting a good surface, and for that reason to a large extent, the success or failure of a granolithic surface comes down to the question of workmanship.

The cost of different types of flooring varies considerably in different localities according to the relative prices of the materials at that point. In a general way it might be said that the finished granolithic floor would cost around 25 to 30 cents per square foot, and a concrete floor with wood top covering, as suggested above, would figure 12 to 14 cents additional.

* * *

The White Star triple-screw steamer *Olympic* was launched at the Harland & Wolff shipyards, Belfast, Ireland, October 20. The new vessel is 882 feet long, 92 feet wide and displaces 66,000 tons; it is 92 feet longer than the *Lusitania* and the *Mauretania* of the Cunard line, and displaces 21,000 tons more, but will be a slower boat than the Cunarders, its speed being 22 knots. The rudder weighs 100 tons, and will be operated by electric motors. The rivets used in the hull weigh 1200 tons and number 3,000,000. The *Olympic* and its sister ship the *Titanic*, now building, will accommodate 2500 passengers and carry crews of 860.

ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

The ninth annual convention of the National Machine Tool Builders' Association was held in New York October 25 and 26 at the Hotel Astor. The association has grown from the small group of twenty-eight manufacturers of lathes, drilling machines, planers and milling machines who met at the Hollenden, Cleveland, in October, 1902, to perfect an organization, to a body embracing a large part of the machine tool industry in the United States, the membership now numbering one hundred and forty-five concerns building all classes of machine tools.

The present administration has done extraordinary work in increasing the membership, and President F. A. Geier and Secretary C. E. Hildreth are entitled to much credit for their work in cooperation with others, in strengthening the association. The following new members have been admitted since the Rochester meeting in May:

Acme Machine Tool Co.	Cincinnati, Ohio.
Bardons & Oliver	Cleveland, Ohio.
Blanchard Machine Co.	Cambridge, Mass.
Cincinnati Pulley Machinery Co.	Cincinnati, Ohio.
Blount, J. G., Co.	Everett, Mass.
Cleveland Automatic Machine Co.	Cleveland, Ohio.
Cleveland Planer Works	Cleveland, Ohio.
Fay Machine Tool Co.	Philadelphia, Pa.
Frontier Iron Works	Buffalo, N. Y.
Gardner Machine Co.	Beloit, Wis.
Gleason Works	Rochester, N. Y.
Grant & Wood Mfg. Co.	St. Louis, Mo.
Knight, W. B., Machinery Co.	St. Louis, Mo.
Lapointe Machine Tool Co.	Hudson, Mass.
Lea Equipment Co.	New York.
Lees-Bradner Co.	Cleveland, Ohio.
Milwaukee Machine Tool Co.	Milwaukee, Wis.
Morse Twist Drill & Machine Co.	New Bedford, Mass.
National Machine Co.	Hartford, Conn.
Newton Machine Tool Works, Inc.	Philadelphia, Pa.
Putnam Machine Co.	Fitchburg, Mass.
Ransom Mfg. Co.	Oshkosh, Wis.
Robbins Machine Co.	Worcester, Mass.
Sloan & Chace Mfg. Co.	Newark, N. J.
Wood Turret Machine Co.	Brazil, Ind.
Willard Machine & Tool Co.	Cincinnati, Ohio.
Wilmarth & Morman Co.	Grand Rapids, Mich.

The meeting opened with the usual routine business, following which were the reports of the following committees:

Patent Committee, C. L. Taylor, chairman; Committee on Revision of Constitution, A. H. Tuechter, chairman; Apprenticeship Committee, E. P. Bullard, Jr., chairman; Cancellation of Orders, also Dealers' Commissions Committee, C. Wood Walter, chairman.

Ways and means of checking the evil of cancellation of orders at the pleasure of the buyer were threshed over with a vigor that showed what a vital subject it is to the members of the organization, and to the trade in general. While it was conceded that there is no practicable way of enforcing the acceptance of all orders contracted for, it was believed by some of those who have given the matter much thought that the practice of cancellation without good and sufficient reason could be made so disreputable that it would cease to be the disturbing element threatening the prosperity of the trade. It is a well-known trick winked at because a "trade custom" for the purchasing agents of large corporations to order machine tools of all kinds recklessly, for delivery several months in the future on the chance that they will be badly needed to take care of anticipated business. If that business does not materialize, the orders are cancelled without compunction, and the machine tool builder must shoulder the load. A resolution was passed to the effect that no cancellation of orders would be accepted, provided shipment is made within the time specified. The National Supply and Machinery Dealers' Association, through its committee, has signified that it will cooperate in checking the practice. A step forward has been taken in creating a moral sentiment against an abuse that is not tolerated in any other manufacturing industry.

The dealers have signified their desire for increased commissions on rates to compensate for the increased cost of selling. The report of the committee appointed to investigate was

to the effect that the commission to which a dealer was entitled was a variable matter, depending largely on the prestige of the concerns represented and their selling policies. No general scale of commissions could be agreed on by the members of the association, as the commissions must necessarily be adjusted to suit individual conditions.

In his report on apprenticeship conditions, Mr. Bullard spoke of the great importance of the uniform apprenticeship agreement adopted some years ago by the association. This statement brought out discussion of the fact that the "master and servant" laws of the states do not agree, and it is virtually impossible to draw a contract binding an apprentice and employer that will be legal in all the states.

The revision of the constitution, a draft of which was read by Mr. Tuechter, will be voted on by letter ballot after the members have had an opportunity of criticising it by letter.

Two interesting papers on the subject of who should pay the expenses of a representative sent from the works to assist an agent, were presented by Messrs. F. L. Eberhardt and C. H. Norton. Mr. Eberhardt stated that it had been found advisable, in most cases, to send a man from the works to set up the machine, and have the selling price cover his expenses. On the contrary, Mr. C. H. Norton was of the opinion that a man, employed by the manufacturer especially for this work, who thoroughly understood the construction of the machine, should accompany it, set it up and demonstrate how to operate it. His expenses were to be covered entirely by the manufacturer, unless other arrangements had been made with the agent. Both came to the conclusion, however, that to obtain satisfactory results to all concerned, it was absolutely necessary for the manufacturer, agent and his salesman to work in cooperation.

Mr. Henry Hess of the Hess-Bright Mfg. Co. read the interesting paper "The Use of Ball or Roller Bearings in Machine Tool Construction." An abstract appears elsewhere in this number.

Mr. Thomas H. Moore, advertising manager, John Wanamaker, New York, spoke on the subject "Advertising—Large Space in a Few Papers vs. Small Space in a Number of Papers." Mr. Moore conceded that he knew so little of the practical conditions of the machine trade that he was unable to advise which is the best policy for the machine tool builders. In a large retail business, all kinds of advertising are legitimate, as it is the aim of the retailer to reach all classes of buyers. In the retail business 2 to 3 per cent of the total sales is a conservative appropriation for advertising expenses.

The growing importance of concrete in machine shop construction made the paper "Concrete vs. Wood Flooring," by Mr. James N. Heald of the Heald Machine Co., of great interest to the members of the association. An abstract of the paper will be found in this number.

Messrs. C. K. Lassiter, mechanical superintendent of the American Locomotive Works, and John Riddell, of the General Electric Co., read papers on: "The Design and Construction of Machine Tools from the User's Standpoint." An abstract of Mr. Riddell's paper is presented in this number.

The meeting was one of the most successful in point of attendance and interest displayed. Every session was attended by a large majority of those registered, and the good work of the officers and contributors of papers was highly appreciated.

The following officers were elected for the coming year, President Geier and Secretary Hildreth being re-elected: President, F. A. Geier, of the Cincinnati Milling Machine Co.; First Vice-President, Charles H. Alvord, of the Hendey Machine Co.; Second Vice-President, S. H. Reck, of the Rockford Drilling Machine Co.; Treasurer, A. E. Newton, of the Prentice Bros. Co.; Secretary, Charles E. Hildreth, of the Whitcomb-Blaisdell Machine Tool Co.

The next semi-annual or Spring meeting will be held in Atlantic City, N. J.

The report would be incomplete without mention of the very enjoyable theatre party of machine tool builders, friends and ladies entertained Thursday evening by the *American Machinist* at the New Amsterdam, where the popular musical comedy "Madame Sherry" is playing.

DESIGN AND CONSTRUCTION OF MACHINE TOOLS FROM THE USER'S STANDPOINT*

The author of the paper abstracted in the following dealt with the subject with particular reference to the practice followed in the Schenectady Works of the General Electric Co. He has been considering seriously the advisability of having, instead of standard engine lathes, simple turning machines, to produce pieces, such as small shafts, which are required in quantities; but since there is a certain variation as to dimensions in this class of work, the machines should not be so special that they could not be used for a general run of similar work. It has been the practice to purchase standard engine lathes fully equipped for screw cutting, and with cross-feed, rod-feed, compound rest, large and small faceplates, and frequently, with an extra block for large outside turning. It was thought advisable to have the machines as universal as possible. Experience has taught, however, that an engine lathe once placed in, say, the shafting department, would often wear itself out before having to do any faceplate, chucking, or screw-cutting work. Hence, lathes for shafting should be equipped with a powerful rod-feed, and with a suitable friction device which would slip if the turning tool should meet with any obstruction. They should also be so designed that the screw-cutting attachment and cross-feed could be readily applied, if required later.

Numerous attempts have been made to solve the problem of small shaft turning, but many machines designed for this purpose have been rather complicated, which precludes the use of inexperienced men to run them. A lathe to be used exclusively for shaft turning, say from about 2 to 4 inches in diameter, would not require the range of speeds of a standard engine lathe. All the range of speed required would be from about 20 to 250 revolutions per minute for turning, and two or three higher speeds for filing and polishing. These speeds should possibly be between 450 and 600 revolutions per minute. It is desirable to have such machines fitted for electric motors. The motors should have a speed variation of about two to one, which, with two or three gear changes, would give all the speeds necessary.

The automatic screw machine, in a general way, is made so that six, seven, or eight operations can be performed. A very large quantity of the work, however, requires but two or three operations, such as milling, threading, and cutting off. Many screw machines are so complicated that they perform the operations whether the tools are actually working or not. It would seem that machines could be very much simplified by making some do three or four operations only, and not encumbering them with too many useless parts.

The same is true of some larger automatic turret lathes. Some of these machines are designed for boring and facing, but nevertheless the turret has five or six positions, all of which require certain movements even when there are but one or two simple operations to be performed.

Machines such as shapers and slotters appear to be as simple in construction and design as they should be made, and they have all the necessary feeds and speed variation.

It is gratifying to see that some machine tool builders are making variable speed planers. This would seem quite necessary at present, on account of the variety of material which planers are called upon to machine. We have a range of material from chrome-, nickel- and vanadium-steels, to the various steel castings, and from cast iron to aluminum. It is, therefore, necessary that planers can operate at a satisfactory speed on any kind of material. This can be accomplished by variable speed motors, or through gear change boxes.

In regard to milling machines generally, there is a pretty large range to select from, and there are several satisfactory types and makes. Drill presses have been well taken care of also. Sensitive drills can be purchased with any number of spindles, and with one or two changes of speed. A full line of upright machines can be purchased with or without tapping attachment; the tapping attachment has become a necessity

* Abstract of paper by John Riddell read before the National Association of Machine Tool Builders' Convention, at New York, October 26, 1910.

in a great many cases. Complaints are heard about the breaking of taps by its use, but with tap holders which can be adjusted to slip before breaking, this fault can be overcome. A great deal might be done toward adapting multiple spindle heads to single spindle presses. It is doubtful if, as at present constructed, it is good judgment to put in too many expensive multiple spindle drills, for the reason that it takes too long to adjust them for a small number of pieces.

Radial drills generally should be so stiffened as to allow of only the smallest amount of spring to the arm. Many drills are ruined by the springing of the arms, because under the pressure of drilling, the arm goes up, and when the pressure is relieved from the point, the drills are forced through, and, in many cases, catch on the lips and break.

Grinding machines, generally, are probably as near perfection as can be expected, and there seems to be very little to be desired from the user's standpoint. There is one very important point, however, about all grinders, and that is the protection from injury to the operator by the breaking of wheels, and from dust. There should be exhaust hoods of ample capacity provided with each dry grinder, as well as some safety device to prevent the wheel from flying in case it should break.

Horizontal boring mills are well up to the times, but in many cases, as for gasoline engine cylinders and work of similar character, special machines should be provided, as this work is very particular, and in many cases presents special difficulties. Vertical boring mills are built for various purposes, from car wheel borers up to machines taking 25 feet or more. It does not pay to unnecessarily complicate such machines; rigidity and accuracy are the essential points, and these features should not give way to unnecessary complications. All gears and counterweights should be thoroughly protected against injury to the operators.

From an experience extending over some twenty-eight years in the electric motor business, the author said that he was a thorough believer in the individual electric motor drive. Criticism has been made on the ground that on universal machines which might be called upon to do from a fraction of a horsepower of actual work, to six or seven horsepower, the investment is unnecessarily high as compared to group driving. To a certain extent this is true, but if more care were exercised in designing along the lines just indicated, this criticism would disappear. As to advantages, a motor-driven machine can be taken from any part of a large plant and placed in another part, and can be running in a very short time in any location where there is no other source of power. It will only absorb the amount of power actually required to do any particular job, and the line shafting with its hangers, pulleys, etc., is eliminated.

Considerable difficulty has been experienced at the Schenectady Works trying to conform to the new State laws, which are very stringent as to the protective devices on machine tools in general, and on wood-working machines in particular. It is an exceedingly difficult matter to so protect buzz-planers and circular saws as to guard against carelessness and the apparent indifference of the workmen, and there is a need for proper means for protecting such machines. Accidents are frequently due to carelessness on the part of the operators, often because they will not take time to shut down their machines when making adjustments, for the reason that a spindle running at 3000 or 4000 revolutions per minute would require an appreciable length of time to come to rest, and also to start again. This would suggest some suitable brake which would quickly and effectively stop such machines.

If an operator has a great many pieces of a similar kind to either saw, plane or shape, he may possibly take pains to apply such guards as are usually provided, but if a man wants to work on one single piece he will not take time to adjust the safety appliance; hence the necessity of suitable guards which would always be available no matter what the conditions might be. As it is, the market is flooded with unsatisfactory devices, which are mere traps and, generally, do more harm than good.

Punch presses in general are very well designed, but they, like wood working machinery, are dangerous. In the Schenectady Works there are several hundred of these machines, and many safety appliances for protecting the workmen have been applied, but it appears that these devices are either taken off or neglected in some manner, so that sooner or later an operator is hurt. This suggests effective automatic feed mechanisms, and something to take the piece from the dies after the operation is completed. Another defect in this class of machinery is that when clutches and other parts come loose, due to wear, the press is very apt to repeat the stroke. This frequently happens when a man's hand is between the dies. Such accidents should be made impossible.

There is a great deal of gear noise in the machine shops of the present day; this is not wholly due to the fact that there are more gears used in the construction of machine tools, but is more especially due to the higher speeds at which the machines are run. Shafts are turned at a cutting speed of from 75 to 125 feet per minute instead of at 20 feet which was formerly a fair speed. Hence, the machines of to-day are producing from three to six times more work than they did a few years ago, and it should follow that there would be more noise. These gear noises are very unfortunate but with improved gear cutting machinery and the use of various materials which have recently been introduced, this trouble will gradually disappear.

The Schenectady Works have introduced gears made of a high grade of muslin. One of these has been used for two years on a boiler maker's punch and shear which previously gave considerable trouble, both on account of noise, and from the breaking of the gears, due to excessive back lash and fly-wheel action. The success with the muslin pinion was so pronounced that the use of these gears was gradually extended until they are now used on two 10-foot planers operated by electric motors and compressed air clutches, as intermediate pinions for the reverse motion. Various other substitutes experimented with, including bronze, would go to pieces in two or three weeks; steel would last longer, but made an intolerable noise; and rawhide would seem to shrink and burn out quickly. The muslin pinions have at present been running four months and they have not yet begun to show any signs of distress.

In order to test muslin pinions to destruction two railway motors opposed to each other were rigged up. One of them had a cloth pinion on the armature shaft running into a steel gear on the countershaft. On the other end of the countershaft was another cloth pinion engaging with another large steel gear. The other side of this steel gear engaged a cast gun-iron pinion of the same dimensions as the cloth gear. This was connected with its shaft and gear to a rawhide pinion on the opposite motor. That particular motor was resisted by rheostats to load the motor which had the muslin pinion. In starting this test there were no results from a normal load. An excessive overload was applied, however, and the shock was so severe that it broke about one-half of the teeth from the gun-iron pinion, leaving the two muslin pinions in as good a condition as before. Another gun-iron pinion was put on, which also broke. A third was then put on and the load reduced, and the life test has now been running some two or three weeks, and will be continued until some of the gears actually wear out, as they cannot be broken. Hence we have reason to believe that with the use of this new material, the noises in machine shops will gradually disappear.

There is one other thing that must be borne in mind in the production of machine tools, and that is the gradual disappearance of the old time all-around mechanic. It has frequently been pointed out, when some special machine tool has been brought out to reduce the cost of certain operations, that such a machine could be operated by a farmer boy, or one without any practical knowledge of machine tools. This has very seldom proved to be the case as such a one cannot make the necessary adjustments on such machines. Therefore, simplicity is a prime factor in machine tool designing; and to sum up briefly, the essential requirements, besides simplicity, are rigidity and accuracy, with ample protection for the workmen.

MACHINERY'S EIGHTH ANNUAL OUTING

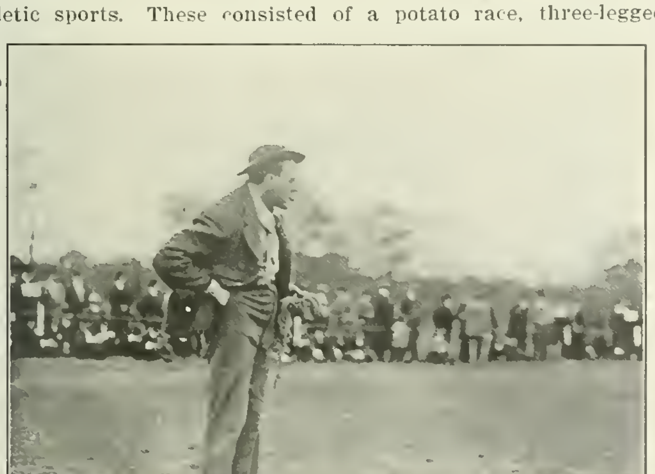
The National Machine Tool Builders' Association Convention was followed by MACHINERY'S eighth annual outing, October 27, at Sea Cliff, Long Island, where over five hundred and fifty men—and Miss Kate Gleason—prominently connected with the industry were entertained for the day. The steel

Hot Potato Race

steamer *Majestic*, baving a much larger capacity than the *Sagamore* used several years heretofore for these outings, was chartered for the day to transport the party through the winding East River to the destination on Long Island Sound.

A Leg and a Half apiece

The day was perfect for the event and a most enjoyable time was spent "refreshing the inner man" and watching the athletic sports. These consisted of a potato race, three-legged



The "Rube"

race, relay race, football (soccer) and push ball. Following are the names of contestants and winners:

Potato Race

C. H. Pierson, 1st; B. F. Damon, 2d; S. H. Simon, 3d; J. T. Ryerson; A. F. Corbin; A. I. Jacobs; W. B. Johnson; G. L. Markland, Jr.; H. W. Mons; W. H. Miller; C. F. Tucker; E. Rivett, judge.

Three-legged Race

N. E. Zusi and H. A. Pratt, 1st; O. P. Meckel and A. A. Mills, 2d; E. Stillman and A. G. Lea, 3d; G. J. Thompson and A. E. Hoermann; O. R. Adams and J. T. Ryerson; E. W. McKeen and Geo. Rowbottom; E. J. Frost and Geo. B. Woodruff; C. J. Wetsel, judge.

Relay Race

Massachusetts, 1st.—A. R. Stedfast, captain; O. R. Adams; J. O. Smith; C. J. Wetsel.

New Hampshire and Vermont, 2d.—O. M. Flather, captain; W. L. Bryant; R. E. Flanders; H. E. Flather.

New York, 3d.—H. A. Pratt, captain; A. G. Lea; E. Stillman; A. I. Totten.

Illinois.—J. T. Ryerson, captain; E. T. Hendee; H. W. Mons; S. H. Reck.

Ohio.—H. M. Lucas, captain; H. V. Hilker; H. M. Hitchcock; J. G. Oliver.

Football (soccer)

East—Forwards: A. E. Carpenter, P. M. Brotherhood, W. C. Buell, Jr., W. L. Neilson, H. H. Pease. Halfbacks: H. L.

Push Ball—Up against it

Sevin; A. R. Stedfast, S. A. Howell. Fullbacks: W. F. Loomis, C. W. Higgins. Goaler: D. M. Wright, captain.

West—Forwards: C. R. Burt, E. L. Essley, O. B. Iles, W. H. Reid, H. A. Seaverson. Halfbacks: C. Wood Walter, E. T. Hendee, A. J. Larmon. Fullbacks: A. T. Barnes, H. W.

Star Players

Trout. Goaler: C. A. Johnson. W. Ingersoll, captain.

East, 9 points; West, 6 points.

Push Ball

East—A. E. Newton, captain; L. M. Batting; E. Blake, Jr.; G. Briggs, Jr.; R. L. Crane; H. E. Erwin; H. E. Flather; S. E. Horton; R. B. Jacobs; J. N. Lapointe; W. P. Poole.

West—E. F. Muther, captain; H. T. Bradner; J. E. Brandt; C. T. Bush; D. J. Campbell; A. C. Cook; H. M. Hitchcock; E. J. Kearney; A. J. Larmon; O. P. Meckel; W. R. Mitchell.

W. A. Viall, referee; C. S. Stallman, assistant referee; G. E. Merryweather, scorekeeper; J. H. Drury, timekeeper; H. C. Woglom and W. H. Miller, linemen.

The East won by 8 yards.

The stein for the most popular machine tool builder was voted to Miss Kate Gleason, of the Gleason Works, Rochester, N. Y.

PERSONALS

E. R. Evinger, formerly of the National Automatic Tool Co., Richmond, Ind., has been made superintendent of the Miami Valley Machine Tool Co., Dayton, Ohio.

K. Kishi, manager of the Osaka office of Andrews & George, Yokohama, Japan, spent October with the various American machinery and machine tool manufacturers for whom his firm is the Japanese sales agent.

Charles H. Jenness, for the past thirteen years with the Deane Steam Pump Co., Holyoke, Mass., has severed his connection with the company to accept the position of instructor of mechanical drawing in the Chicopee, Mass., high-school, made vacant by the resignation of Mr. George H. Babbitt, who resigned on account of ill-health.

William A. Tucker, superintendent and treasurer of the H. A. Rogers Co., New York, celebrated the thirtieth year of his connection with that company October 18. Mr. Tucker, who is known as one of the most experienced credit men in the machinery supply trade, is the oldest officer and employe of the company in years of service.

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OBITUARIES

Franklin T. Zimmermann, vice-president and manager of the Zimmermann Mfg. Co., died at his home in Auburn, Ind., September 29, aged fifty-nine years.

George Poole, president of the Poole Engineering & Machine Co., Woodberry, Baltimore, Md., died at the home of his niece, Mrs. Robert R. Smith, in New Hartford, Conn., September 24, aged fifty-six years. Mr. Poole was identified with the concern of which he was president at his death for nearly forty years, having entered the shop with his father when seventeen years old. He learned the business thoroughly and was made superintendent and general manager while still a young man, the firm then being Poole & Hunt. When Mr. Hunt retired Mr. Poole was made vice-president and general manager of Robert Poole & Son, incorporated, and at the death of his father he became president and treasurer when the name of the company was changed to that now used. Many of the workmen still employed were with the company during the whole period of Mr. Poole's connection, and a few are descendants of men who worked for the father and helped establish the business. Mr. Poole leaves a widow, two daughters and a son, Robert Poole.

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COMING EVENTS

November 17-18.—Annual meeting of the Society of Naval Architects and Marine Engineers, 29 W. 39th St., New York. W. J. Baxter, secretary.

November 17-19.—Fourth annual convention of the National Society for the Promotion of Industrial Education, Boston, Mass. A feature of this convention will be a lecture on "Continuation Schools," by Dr. George Kerschensteiner, superintendent of schools, Munich, Germany. Edward H. Reisner, secretary, 20 West 44th St., New York.

December 5-6.—Annual meeting of the American Society of Refrigerating Engineers, New York. W. H. Ross, secretary, 154 Nassau St., New York.

December 6-9.—Annual meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York. Calvin W. Rice, secretary.

December 12-15.—Convention of the National Gas and Gasoline Engine Trades Association, Racine, Wis. Albert Stritmatter, secretary, Cincinnati, Ohio.

SOCIETIES AND COLLEGES

DREXEL INSTITUTE, Philadelphia, Pa. Leaflet announcing evening courses in electrical, civil and mechanical engineering, and chemistry.

UNIVERSITY OF TENNESSEE, Knoxville, Tenn. Catalogue of the institution, containing photographic views, and description of the equipment, laboratories and courses.

NEW BOOKS AND PAMPHLETS

ANNUAL REPORT OF THE STATE GEOLOGIST OF NEW JERSEY FOR THE YEAR 1909. By Henry B. Kummel. 123 pages, 6 x 9 inches. One large folding map. Published by the State Geologist, Trenton, N. J.

ANNUAL REPORT OF THE CHIEF OF BUREAU OF MANUFACTURES TO THE SECRETARY OF COMMERCE AND LABOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1910. 23 pages 6 x 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

EXPLOSIBILITY OF COAL DUST. By George S. Rice, J. C. W. Frazer, Axel Larsen, Frank Haas and Carl Scholz. 186 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, United States Geological Survey, Washington, D. C., as Bulletin No. 425.

OHIO STATE UNIVERSITY COMMEMORATIVE BULLETIN. By C. E. Sherman. 63 pages, 6 x 9 inches. Published by the University, Columbus, Ohio.

The bulletin gives the history of the institution and the educators connected therewith, maps, illustrations, description of engineering work, list of alumni and ex-students, and other information.

HISTORY OF THE TELEPHONE. By Herbert N. Casson. 315 pages, 5 x 8 inches. Published by A. C. McClurg & Co., Chicago, Ill. Price $1.50.

This interesting book is written in the entertaining style characterizing the author's works, "The Romance of Steel," "Cyrus Hall McCormick, His Life and Work," "The Romance of the Reaper," etc. He is one of the few writers who are able to write interestingly and accurately of all phases of discovery and inventions and manufacture. The book is one that should form a very acceptable addition to the literature of the scientist, engineer and mechanic.

APPLIED THERMODYNAMICS. By H. W. Spangler. 160 pages, 6 x 9 inches. Published by John Jos. McVey, Philadelphia, Pa.

This work by Prof. Spangler which contains the substance of his lectures to the students in the mechanical, electrical and chemical engineering classes of the University of Pennsylvania, treats of the flow of steam, steam engine tests, refrigeration (air machines—volatile liquids), absorption machines, internal combustion engines, and evaporators. The work was prepared for students and others having some preliminary knowledge of the subject, the author's "Notes on Thermodynamics" being an excellent introduction.

WIRELESS TELEPHONES. By J. Erskine-Murray. 68 pages, 5 x 7 inches. 17 illustrations. Published by Norman W. Henley & Son, New York. Price $1.00.

The work is a popular description of wireless telephones and the principle of operation. It first describes the phenomenon of hearing and the conversion of sound into electric waves. The difference between wire and wireless transmission is simply explained and a diagram illustrates the radiation of electric waves from the conductor. Chapters V and VI are devoted to the production of alternating currents of high frequency, and how the electric waves are radiated and received. The receiving instruments and conductors are described in the following two chapters. The valuable feature of the book is the glossary of technical words used in wireless telegraphy and telephony.

THE INDICATOR HANDBOOK. By C. N. Pickworth. 142 pages, 5 x 7½ inches. 93 illustrations. Published by D. Van Nostrand Co., New York. Price $1.50.

This work which has passed into the fourth edition, has been completely reset in new type and new matter has been added. A chapter is devoted to indicator instruments designed for gas and oil engines, while optical indicators, pressure indicators, etc., also receive attention. The chapter headings are: Construction of the Indicator—Steam Engine Indicators; Indicators for Gas and Oil Engines, etc.; Errors of the Indicator; the Arrangement of the Indicator; Errors of Indicator Connections; Indicator Reducing Gear; Errors of the Indicator Reducing Gear; the Use and Care of the Indicator. The simplicity of treatment commends the book to stationary engineers, mechanics and others who may be required to prepare for indication and determining the results of tests.

NOTES ON MECHANICAL DRAWING. By Horace R. Fry. 61 pages, 6 x 9 inches. Published by the University of Pennsylvania, Philadelphia, Pa. Price $1.00.

The number of books on mechanical drawing is legion and it is difficult for an author to present a treatise suitable to the needs of the average student that will differ in any fundamental respect from the many other books published before. We must say, however, that this work differs in certain practical respects from other works, to its own advantage. The book covers four courses in drawing for the freshman, sophomore, junior and senior years. The subject matter is: instruments; size of sheets, trimming; lettering; titles; scales; full, dotted, center, dimension, shade and construction lines; inking; dimensions; abbreviations; sections; cross-hatching; line shading; projections; bill of materials; assembly drawings; blueprints; sketching; gearing, screw threads; tapped holes; conventional threads; screw thread proportions and tables; tapers; weights of castings of forgings; pipe; etc. Tables of data of machine parts are provided as copy to give practice in lettering and tabular arrangement. These at the same time are valuable in themselves to the budding mechanical engineer or machine designer.

MACHINE DRAWING. By Gardner C. Anthony. 104 pages, 6 x 7¼ inches. Published by D. C. Heath & Co., Boston, Mass. Price $1.50.

This well-known textbook on mechanical drawing has passed through several editions, and is in many respects deservedly one of the most popular works published for students. It is modern in its treatment and thoroughly practical from the mechanical engineer's standpoint, including, as it does, many examples of machine details which serve as excellent practice examples for the students and at the same time gives them knowledge of proper proportions of well-known machines and tools. The contents by the chapter headings are as follows: Screw Threads, Bolts and Screws, General Rules for Making Drawings, Sectional Views, Dimensioning, Technical Sketching, Examples for Practice, Tables. The examples for practice include: Bolt Drawing for Boiler Feed Pump, Assembly Drawing for Boiler Check Valve, Detail Drawing for a 2-inch Globe Valve, Assembly Drawing of a Connecting-rod, Assembly Drawing of a Crank Pin Stub End of a Connecting-rod, Detail and Assembly Drawing of a Cross-head, Assembly Drawing of a Slide Valve Engine Cylinder, Pillow Block Bearing, Screw Polishing Machine and Lathe Headstock and Detail Drawings of Lathe Tailstock, etc.

WORKINGMEN'S INSURANCE IN EUROPE. By Lee K. Frankel and Miles M. Dawson, with the cooperation of Louis I. Dublin. 477 pages, 6 x 9 inches. Published by the Charities Publication Committee, 105 E. 22nd St., New York. Price $2.50; by mail $2.70.

The book deals historically with the introduction of workingmen's insurance and compensation in Europe. It is divided into four parts, *viz.*, Insurance against Accidents, Insurance against Sickness and Death, Insurance against Invalidity and Old Age, and Unemployment Insurance. A brief history is given of the development of employer's liability, and of changes in attitude of the public and the courts with regard to applying to cases of industrial accidents the old common law principles of assumption of risk and the fellow-servant rule. Various types of accident, death and burial associations are described, which antedated laws passed in Europe for insurance against loss or poverty due to these contingencies. The third part is devoted to insurance against invalidity and old age and its status in various countries is briefly mentioned. Insurance against unemployment is the subject of the fourth part, brief mention being made of the success or failure of this type of insurance in Germany, Norway, Sweden, Holland, Belgium, France, Switzerland, Italy, and other countries in which investigations were made.

HANDBOOK FOR HEATING AND VENTILATING ENGINEERS. By James D. Hoffman, assisted by Benjamin F. Raber. 322 pages, 4½ x 6¾ inches. Published by James D. Hoffman, Purdue University, Lafayette, Ind. Price $3.50.

This comprehensive handbook on heating and ventilating work should be generally appreciated by architects, contractors, engineers and those who are required to design and install heating and ventilating work in offices, factories, mills and other buildings. It is of convenient pocket size, thus making it available for reference to the contractor or erector on the job. The work has been compiled for the most part from lectures given at Purdue University during the past eight years. Most of the material was previously issued in pamphlet form and used as a textbook with satisfactory results. Contents of chapters are as follows: Heat, Air, Heat Losses, Furnace Heating,

Hot Water and Steam Heating, Mechanical Warm Air Heating, Mechanical Vacuum Heating, District Heating, Temperature Control, Electrical Heating, Specifications. A feature of the work that should be highly appreciated by engineers who collect all available data on heating and ventilation is the references to technical books and technical periodicals at the conclusions of the chapters. The authors realize the impossibility of compiling a complete digest in handbook form of available literature on the subject and have, therefore, referred readers to other sources of information. The book should be generally appreciated by those interested.

World Corporation. By King C. Gillette. 240 pages, 6 x 9 inches. Illustrated. Published by the World Corporation, 6 Beacon St., Boston, Mass. Price $1.00.

This prospectus of the scheme of Mr. Gillette, the safety razor man, for unifying the world's industries no doubt contains a few grains of truth, but so buried in a mass of glittering generalities and obvious impracticalities as to make the common reader doubt the sanity of any part of the plan. Mr. Gillette seems to have a clear vision of the forces at work undermining representative government and dividing the population into two great classes—the rich and the poor—but in his endeavor to get away from destructive individualism he would create a structure so massive but weak that it must fall by its own weight. He would, for instance, concentrate the majority of the population of the United States into one gigantic city of 80,000,000, having its center in Buffalo, N. Y. The colossal egotism of the promoter is shown by the fact that he has planned and illustrated an enormous beehive tenement sheltering 10,000 which he proposes to make the standard type of housing for his "world corporation" city. We wonder if Mr. Gillette would take kindly to the idea of living in a house planned by an eighteenth century architect. So long as people think, invent, improve and progress it will be impossible for one generation to build for succeeding generations. It is an utter impossibility in a progressive age and when, if ever, it does become possible, it would mean that the period of crystallization, decay and death had been reached. The plan of "world corporation" apparently is a socialistic dream that out-Herods the rankest Herod of them all.

Composition and Heat Treatment of Steel. By E. F. Lake. 252 pages, 6 x 9 inches. 143 illustrations. Published by McGraw-Hill Book Co., New York. Price $2.50.

In this work the author, who is a well-known metallurgical expert, has simply described the process of making steel from the pig iron to the structural product and the tool steel bar. It has been prepared with a view of filling the want for a general book which treats of the principles and processes, and no attempt has been made to go into technical details. The author has endeavored to cover all materials that are used, either commercial or experimental, in making steel, but has not attempted to go into the metallurgical and chemical aspects of the different compositions. The chapter headings are as follows: Making of Pig Iron, Bessemer Process for Converting Iron into Steel, Open Hearth Process for Making Steel, Crucible Process of Steel Making, Electric Furnaces for Steel Making, Ingredients and Materials used in Steel, Working Steel into Shape, Furnaces and Fuels used for Heat Treatment, Annealing Steel, Hardening Steel, Tempering Steel, Carbonizing. The work is one that should be highly appreciated by the class who use and fabricate steel in the machine shop, but are more or less ignorant of the processes of manufacture. The chapters on furnaces and fuels used for heat treatment, annealing, hardening, tempering and carbonizing steel contain matter of practical application for the machinist, toolmaker and smith, and with the information contained in the previous chapters they will be provided with a work of much practical value.

Hendricks' Commercial Register of the United States. 1344 pages, 7½ x 10 inches. Published by S. E. Hendricks Co., 74 Lafayette St., New York. Price $10.00.

The nineteenth annual revised edition of this valuable trade directory just issued, is much improved and enlarged. The eighteenth edition required eighty-seven pages to index its contents, while the nineteenth edition required just one hundred pages or thirteen additional pages. As there are upwards of four hundred classifications on each page, the thirteen additional pages represent the manufacturers of over five thousand articles, none of which have appeared in any previous edition. The total number of classifications is 35,481, each representing some machine, tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. The eighteenth edition numbers 1220 pages, while the nineteenth edition numbers 1344 or 124 additional pages. Counting one hundred and fourteen pages of matter omitted from the new edition that appeared in the eighteenth edition makes a total of two hundred and thirty-eight pages of new matter, the whole representing upwards of 350,000 names and addresses. An important feature of the register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes, all manufacturers of a particular trade being classified under a general heading for mailing purposes, and sub-divided under as many classifications as the variety of their products calls for. Among other valuable features are the inclusion of trade names of all articles classified, as far as they could be secured. These trade names appear in parentheses between the names and addresses under the classifications where they appear.

Mechanical Engineer's Pocket Book. By William Kent. 1461 pages, 4¼ x 6¾ inches. Published by John Wiley & Sons, New York. Price $5.00, net.

This well-known reference book of rules, tables, data and formulas for the use of engineers, mechanics and students was first published in 1895, and soon became recognized as an authoritative compendium of mechanical engineering data. Its popularity is indicated by the fact that it has passed into the eighth edition and 71,000 have been printed. The eighth edition has been rewritten and reset throughout, the old electrotypes being so worn that new plates were imperatively required. Advantage of the fact was taken to use new and distinctive type for tables with heavier face than that of previous editions. The eighth edition is considerably enlarged, containing 340 pages more than the seventh, despite all efforts to condense the material into the smallest possible space. A greatly improved feature is the new index, which fills 45 pages, and contains 4500 titles, being nearly four times the size of the index in the first edition. Among the numerous alterations and additions are the following: The slide rule; logarithmic ruled paper; manufacturers' tables brought up-to-date; new Bethlehem structural steel shapes; new alloys for various purposes; chapters on cast-iron and malleable iron; matter on the new tool steels and other alloy steels; methods of preventing corrosion; small size spring table; new formulas for triple and quadruple riveted joints; tables of moisture and air at different pressures and temperatures; the fans, blowers, compressed air; heating and ventilation chapters rewritten; new steam tables based on tables of Marks and Davis; new matter on steam, boilers, chimneys, steam engines, locomotives, steam turbines, gas and oil engines, shafting, pulley, belting, gearing, hoisting and conveying, wire and rope transmission, friction and lubrication and the foundry. Machine shop data is given considerable space including matter on high-speed tool steels, Taylor's researches on cutting tools, emery wheels, force and shrinkage fits, etc. Kent's Pocket Book is popularly regarded as the mechanical engineer's Bible and the new edition should be even more favorably regarded than its predecessors. The only adverse criticism to be offered is in regard to the arrangement of the matter. We think the author could have advantageously followed the plan of arrangement found in *Des Ingenieurs Taschenbuch*, published by the Hutte Association, which appeals to us as being generally logical. Numerous cases of misplaced chapters can be found in Kent's, making reference tedious. All works of this sort should be arranged in such order that the constant user can readily find chapters on almost any subject without being obliged to turn to the index. The index is indispensable as it necessarily must be consulted for minor matters, but for the general subjects we believe that the arrangement of the book itself should be such as to enable even the occasional user to know just about where to look for a chapter on any subject. Otherwise the work has our hearty commendation.

CATALOGUES AND CIRCULARS

Peerless Electric Co., Warren, Pa. Folder advertising the Peerless motor.

Cutler-Hammer Clutch Co., Milwaukee, Wis. Circular of the Cutler-Hammer lifting magnet.

American Blower Co., Detroit, Mich. Bulletin No. 284 descriptive of Sirocco fans and blowers.

National Tube Co., Pittsburg, Pa. Set of illustrated blotters advertising Shelby seamless tubes.

Pike Mfg. Co., Pike, N. H. Circular of the "Pyko" grinders for wood-working, machine, blacksmith, wheel-wright and other shops.

Adams-Bagnall Electric Co., Cleveland, Ohio. Leaflet illustrating the regenerative arc lamp for lighting factories, foundries, mills, etc.

Saginaw Mfg. Co., Saginaw, Mich. Catalogue of the Gilbert wood split pulleys, printed in colors, illustrating the types and construction.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 391 descriptive of the direct-current, steel frame, type F "Triumph" motors.

Allis-Chalmers Co., Milwaukee, Wis. Circular descriptive of the Allis-Chalmers friction clutch pulleys and friction clutch cut-off couplings.

Fort Wayne Electric Works, Fort Wayne, Ind. Instruction book No. 3043 on type K single-phase integrating induction watt hour meters.

Pennsylvania Railroad, Philadelphia, Pa. Pamphlet illustrating and describing the Pennsylvania Railroad standard steel underframe live-stock car.

Rochester Electric Motor Co., Rochester, N. Y. Catalogue of the Rochester direct-current, constant-speed, variable-speed, and adjustable-speed motors.

Crescent Tool Co., Jamestown, N. Y. Circular of the Crescent adjustable wrenches, Crescent combination pliers, linemen's pliers, "Simplex" combination pliers, etc.

General Electric Co., Schenectady, N. Y. Bulletin No. 4771 superseding Bulletin No. 4440 B on hand-operated starting compensators for alternating-current motors.

General Electric Co., Schenectady, N. Y. Bulletin No. 4774, superseding Bulletin No. 4564, on centrifugal air compressors for industrial air blast and exhauster service.

North Western Expanded Metal Co., Chicago, Ill. Pamphlet containing data for the use of designers using expanded metal for reinforcing concrete structures of all kinds.

Adams Co., 845 White St., Dubuque, Ia. Circulars Nos. 701 and 811 illustrating and describing the No. 1 Farwell quick change miller and the No. 3 Farwell automatic gear hobber, respectively.

Mechanical Appliance Co., Milwaukee, Wis. Circular of the Watson buffers and grinders in bench or pedestal form, with either direct or polyphase alternating current, direct-connected motors.

Castolin Co., 1609 Wright Bldg., St. Louis, Mo. Folder advertising "Castolin," a new process for brazing cast iron without the use of special appliances. Brazed castings are unaffected by water, acids or heat.

Barber-Colman Co., Rockford, Ill. Circular descriptive of the No. 12 gear hobbing machine for cutting spur and spiral gears. It is a single-purpose manufacturing machine built expressly for heavy-duty work.

International Typographical Union, 120-130 Sherman St., Chicago, Ill. Pamphlet of testimonials from students who have taken the I. T. U. course of instruction in printing, and have been greatly benefited thereby.

Bayonne Steel Castings Co., Bayonne, N. J. Bird's-eye view illustration of Bayonne and surrounding territory showing advantageous location of Bayonne for prompt delivery of castings to a large manufacturing district.

Standard Mfg. Co., Bridgeport, Conn. Circular illustrative of 4-inch, 6-inch and 8-inch automatic gear cutters, especially adapted for cutting spur gears, bevel gears, sprockets, small milling cutters, ratchets, knurls, etc.

Buffalo Steam Pump Co., Buffalo, N. Y. Catalogue No. 229 descriptive of the Buffalo single, duplex and triplex power pumps for general water supply, boiler feed, mine pumping, paper mills, municipal water works, etc.

E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. Circular illustrating tools exhibited at the Brussels Exposition, comprising presses, tin can making tools, swaging machines, etc. The company received the Grand Prize for its exhibit.

Bemis & Call Hardware and Tool Co., Springfield, Mass. Catalogue and price list of wrenches No. 20, comprising drive punches, Briggs and Merrick nut wrenches, combination pipe and nut wrenches, adjustable S nut wrenches, etc.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Leaflet illustrating the Metcalf emery-wheel dresser, which consists of two heavy knobs on the end of a short shaft on which is mounted an abrasive wheel of special grade and grit.

Crocker-Wheeler Co., Ampere, N. J. Bulletins Nos. 120, 122, 123 and 125 on belt-type, direct-current, generators, Form I, and belt-type direct-current generators, Form D, adjustable speed motors, and "Remek" type transformers for light and power.

Raymond Mfg. Co., Ltd., Corry, Pa. Catalogue of wire springs and wire specialties, comprising extension springs, compression springs, springs of rectangular section, conical springs, agricultural implement springs, gas engine and automobile springs, bicycle saddle springs, etc.

Western Electric Co., 463 West St., New York. Bulletin No. 9635 describing the Hawthorn commercial and folding type "mazdaliers," the new lighting fixture which has been developed since the advent of the mazda (tungsten) lamp in the field of commercial lighting.

American Laminated Belting Co., 113 Hudson St., New York. Booklet entitled "The Difference between Albeco Laminated and Multi-lap Leather Belting," giving comparisons of the operating principles, power transmitting qualities and ultimate economy of both types of belting.

Becker Milling Machine Co., Hyde Park, Mass. Pamphlet No. 56 descriptive of the new-model belted vertical-spindle Becker milling machine. Details of construction are shown, making the pamphlet of unusual interest to all interested in the design, construction and use of machine tools.

Dickerson Automatic Governor Co., American Fork, Utah. Pamphlet descriptive of the Dickerson water wheel governor by Prof. E. H. Backstrand. This pamphlet will be found interesting to those concerned with the difficult problem of automatically governing the speeds of water wheels.

Mechanical Appliance Co., Milwaukee, Wis. Bulletin No. R 1 illustrating and describing the Ajax electric riveting machines which punch the hole, drive and head the rivet with one pressure of the pedal, delivering blows at the rate of 6000 per minute. See Machinery, August, 1910, for descriptive note.

Webster & Perks Tool Co., Springfield, Ohio. Catalogue of bolt-pointing, threading and special tapping machines, comprising single-spindle, two-spindle, four-spindle and six-spindle solid die automatic threading machines, single-spindle bolt pointing machine, duplex solid die automatic threading machine and accessories.

Kempsmith Mfg. Co., Milwaukee, Wis. Bulletins Nos. 1, 2, 3 and 4 illustrating the growth of the new plant, construction of which was begun July 5. These interesting records of construction begin with the view of an open field, and close with views of the machine shop taken October 1, when the work was nearing completion.

Joseph T. Ryerson & Son, Chicago, Ill. Catalogue of emery wheel machinery, containing hints on selection of grade, mounting the wheels, and data for selection of grades, table of shapes and descriptions of bench, stand and cabinet base machines, water tool grinders, surface grinder, automatic planer knife grinder, buffing lathes and countershafts.

B. F. Sturtevant Co., Hyde Park, Mass. Bulletin No. 182 on horizontal center crank engines, Class HC 1. The bulletin is gotten up in the attractive style characteristic of the Sturtevant bulletins in general, and shows views of the engine, constructive details and a direct-connected engine and Sturtevant high-pressure blower; also a direct-connected generating set, etc.

National-Acme Mfg. Co., Cleveland, Ohio. Folder illustrating the "Acme" automatic multiple-spindle screw machine for the manufacture of bolts, screws, nuts and all duplicate parts from metal bars, and containing list of railroad shops using "Acme" machines for producing locomotive parts. The illustration on the cover is a railroad train with a new design of locomotive, sure to interest superintendents of motive power.

Pennsylvania Railroad Co., Philadelphia, Pa. Pamphlet by D. Ward King describing the King split log drag, a simple device for working country roads after heavy rains, putting them into condition to carry traffic without destructive rutting. The King drag has been used successfully in the West for years, and is really a marvelous device, considering its simplicity and the wonderful road improvement following its use.

Pennsylvania State College, Harrisburg, Pa. Bulletin No. 1 of Volume 1, outlining the purpose and work of the engineering experiment station and containing articles: "Results of Experiments on the Effects of the Form of Alternating Current Waves on the Life and Efficiency of Incandescent Lamps," by Prof. Charles Lambert Kinsloe, and "Practical Suggestions for the Construction of Concrete Floors," by Prof. Elton D. Walker.

Pennsylvania Railroad School of Telegraphy, Ridenour Bldg., Bedford, Pa. Pamphlet of the Pennsylvania Railroad School of Telegraphy where students are taught practical railroad work. An automatic sending machine with a transmitter that can be set at any speed has been installed. The regular railroad telegraph wires are run through the school and train orders are received and transmitted in the same way as in regular practice.

Hendey Machine Co., Torrington, Conn. Catalogue of quick-threading attachment, describing a new threading attachment brought out by the company, by means of which a high-speed return of the carriage is possible without reversing the lathe. The catalogue is illustrated with halftones and line engravings, and a complete description of the construction and operation of the attachment is given. Directions for mounting the attachment in place on Hendey-Norton lathes are also included.

Oscar E. Peraigo, 6 Beacon St., Boston, Mass. Circular of Modern Systems Correspondence Schools, describing a new departure in correspondence school work, and advertising the introductory courses of instruction that have been lately established. These additional courses are intended for men who do not desire to spend the time and money required for complete courses, but who wish to acquire certain fundamental knowledge in various engineering subjects and modern manufacturing methods and systems.

Norton Co. and Norton Grinding Co., Worcester, Mass. Anniversary number of *Grits and Grinds*, a monthly bulletin published by the two companies. This anniversary edition for employes and friends is issued in commemoration of the twenty-fifth anniversary of the Norton Co. and the tenth anniversary of the Norton Grinding Co. It contains lists of the employes of both works and photographs of the officials, heads of departments and foremen, views of the offices and plants, and pictures of the officers of the Pike Mfg. Co., Pike, N. H., selling agents. This souvenir number is one of the handsomest typographical productions we have seen. It is of much present interest, and will acquire greater and greater historical value as the years pass.

TRADE NOTES

Jones & Lamson Machine Co., Springfield, Vt., has begun the construction of a new shop, the concrete foundation for which is 100 x 520 feet.

Falls Rivet & Machine Co., Kent, Ohio, maker of rivets, bolts, nuts and washers, has been purchased by Edwin Seedhouse and associates and will be conducted as heretofore.

Falls Clutch & Machinery Co., Cuyahoga Falls, Ohio, formerly the power transmission and general machinery business of the Falls Rivet & Machine Co., has been purchased by Theophilus King and associates, and will be conducted as heretofore.

Pittsburg Testing Laboratory, 325 Water St., Pittsburg, Pa., has moved its New York office from 1 Liberty St. to No. 50 Church St., Hudson Terminal Building. The New York office is in charge of Mr. William Zimmerman, the company's second vice-president.

Buffalo Steam Pump Co., Buffalo, N. Y., has re-opened its St. Louis office, 911 Third National Bank Building. The office is in charge of H. H. Downes, who was transferred from the Buffalo office. Mr. Downes has had a wide experience in the lines handled.

Screw Cutting Company of America, 17th St. and Sedgley Ave., Philadelphia, Pa., manufacturer of power, lead and feed screws, is under new management. Mr. J. W. Bramwell has been elected general manager in place of Mr. E. W. Crellin, resigned. Mr. Bramwell also fills the office of vice-president.

Walter Macleod & Co., Pearl St. and Produce Alley, Cincinnati, Ohio, has been awarded a contract by the J. Baum Safe Co., Cincinnati, Ohio, for a large plate heating furnace; also a complete furnace equipment for the Southern Motor Works, Nashville, Tenn., and W. H. Clore Mfg. Co., Washington, Ind.

Black & Decker Mfg. Co., 113-115 So. Calvert St., Baltimore, Md., is prepared to build special jigs, fixtures and tools for automobile, truck and airship parts, special engines, aeroplane engines, etc. The company has new equipment of high-class machine tools and small tools installed in a new building specially adapted to its purpose.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has received an order from the Simonds Mfg. Co. for six 500-KVA transformers and two 200 H. P. type HF rolling mill motors to be used in the new Lockport, N. Y., plant of the purchaser. The transformers will be used in stepping down the power purchased, from 12,000 to 480 volts.

Victor Appliance Co., Watervliet, N. Y., has been incorporated under the laws of the state of New York, to manufacture automobile and motor boat specialties, and to do a general repair business. Their leading specialty will be a new flexible shaft coupling. The directors are Augustus Bigelman, Gustavus Garrow and Dewitt Tappan, all of Watervliet, N. Y. Capital $5000.

Goldschmidt Thermit Co., 90 West St., New York, is now managed by Mr. William C. Cuntz, who succeeds Mr. E. Stutz, vice-president and general manager. Mr. Cuntz brings to his position a thorough knowledge of steel business and a wide acquaintance with railway and street railway officials of the country, having been connected for eighteen years with the Pennsylvania Steel Co.

Toledo-Massillon Bridge Co., Toledo, Ohio, reports that its crane business so far has been very satisfactory and the outlook for new business is bright. Owing to the volume of business secured, the company has found it necessary to increase its capacity, and has recently purchased a number of new tools and rented an additional machine shop. The plant is running night and day.

Northern Engineering Works, Detroit, Mich., crane builder, is completing an addition to its crane erecting shop. The new building is approximately 160 feet by 60 feet, of fireproof structural steel and brick construction, and steel window sash. Three cranes and two overhead trolley runs will serve the floor. Electric and pneumatic hoists will be used. The machinery was installed and the building made ready in October. A new storage yard for structural steel has been laid out alongside the addition and is covered by a 60-foot span, three-motor electric "Northern" gantry crane of special construction. The company reports the largest demand for its electric Northern cranes and other products in its history.

J. Fillmore Cox & Co., 26th St., Bayonne, N. J., manufacturer of pipe and tube bends and pipe coils of all kinds, special machinery, etc., is building a new plant at the foot of 37th St. and Ave. E, Bayonne, N. J., which will be equipped with modern machinery throughout. The company is in the market for power house equipment, office and factory heating systems, hangers, shafting, shop furniture, electric welding machinery, pipe threading and cutting machinery of all kinds, and pipe bending machinery, drafting-room equipment, cranes, conveyors, hoists, trucks, cars, etc. The company will be a large consumer of pipe tubing, fittings, and all appliances required in high-pressure work. Catalogues of manufacturers are requested.

Foos Gas Engine Co., Springfield, Ohio, has received another order from the United States Government for the Foos vertical gas engines for the Ohio River improvement works. The success of two previous installations resulted in the third order which was for six engines, four of which are 100 horsepower three-cylinder vertical type, embodying a new feature of design. These engines will be operated by natural gas, but each unit will be so arranged that it can be quickly adapted for the use of gasoline or kerosene. These engines will be used for the operation locks which the government is building in the upper Ohio Valley to provide water to maintain trade navigation in the dry season. The locks are operated through the medium of compressed air and the gas engines will drive the air compressors.

Stark Rolling Mill Co., Canton, Ohio, has developed a rust-resisting sheet metal product known as "Toncan" metal, which is being introduced for use where it is impracticable or impossible to paint black or galvanized sheet metal to preserve it. Its durability enables it to be used for irrigating flumes, culverts and other parts of water systems where unprotected metal would soon be destroyed. It is being used in the electrical field, for transformer, motor and oil switch cases, and for the construction of tubular telegraph and trolley poles. Another important use is for grain bins in grain elevators, where the carbonic acid formed by fermentation of the grain is very destructive of ordinary unprotected sheet metal. Obviously many other important uses have been found for this new non-corrosive sheet metal.

Gisholt Machine Co., Madison, Wis., and Joseph T. Ryerson & Son, Chicago, Ill., announce an association of interests in the manufacture and sale of machine tools. Messrs. E L. Ryerson and Clyde M. Carr of Joseph T. Ryerson & Son, have been made directors of the Gisholt Machine Co. New shops and buildings which will add greatly to the present capacity will be erected by the Gisholt Machine Co., and these, supplemented by the combined efforts of the sales organizations of the two companies, will greatly increase the capacity to serve the rapidly growing business. Joseph T. Ryerson & Son, by this announcement, signalize their entrance into the general machine tool field. This new line, with the machinery lines which they have heretofore been interested in, will be further strengthened by other new lines which will be added by the associated interests, as conservative business policy dictates.

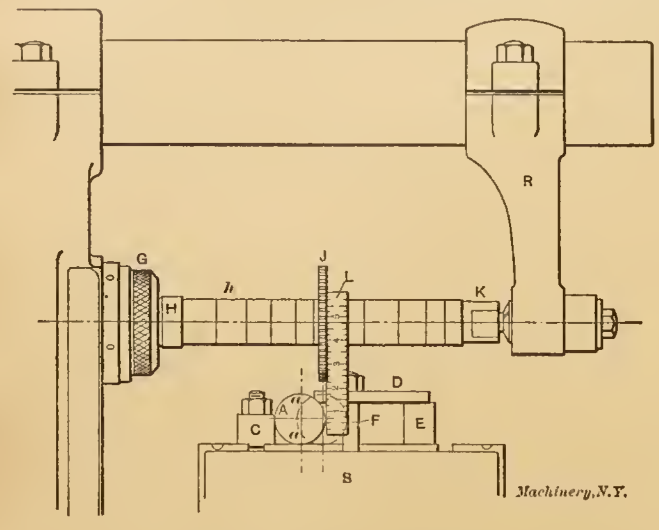
Society of Automobile Engineers, 1461 Broadway, New York, has now started work on standardizing the construction of automobiles. A division of its Standards Committee met in Cleveland in October to take up the matter of standardizing frames for the various sizes and types of automobiles now built. It is believed that a smaller number of sections would be sufficient, giving the following advantages: 1. Reduction of tool cost. 2. Increasing the output of presses by reducing change of tools. 3. Reducing the number of different sizes of stock required. 4. Reducing the number of variations in the size of all parts fastened to the frame. Besides the Frame

Supplement to MACHINERY, December, 1910

Operations for the Article in this number entitled "Machine Shop Practice—Milling a Keyway in a Shaft"

SHOP OPERATION SHEET NO. 154

John Edgar MACHINERY, December, 1910



Milling a Keyway in a Shaft—
Setting Work and Cutter Central

NOTE.—The keyway is to be milled with semi-circular ends, and it is designed to be fitted with a fixed key or feather. The keyway is supposed to have been laid out, and a hole somewhat smaller than its width drilled at each end and within the limits of its length.

1. To the table *B*, of the milling machine, bolt two liner blocks *C* (only one shown) having tongues to fit the T-slots.

2. Lay the shaft *A* on the table *B*, and against the liner blocks *C*, with the center line *a—a*, which coincides with the center of the keyway, vertical, as shown by a square on the table. Clamp the shaft by the use of two straps *D*, the blocks *E*, and bolts *F*. Run the carriage and table *B* close up to the machine pedestal.

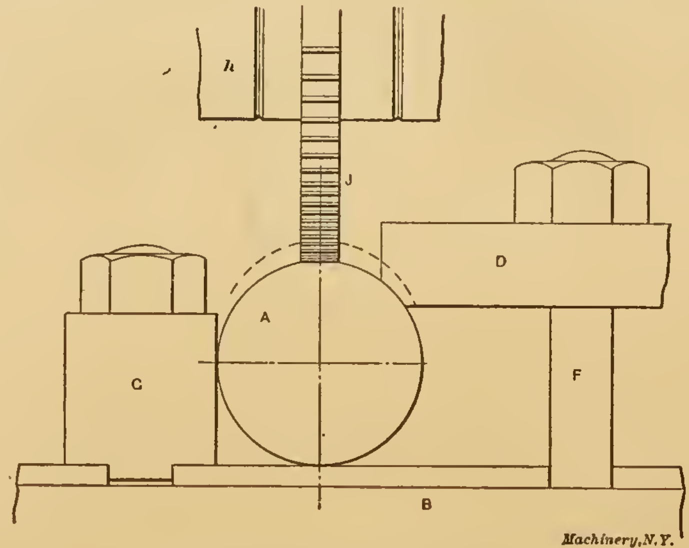
3. Clean the taper hole in the main spindle *G*, and insert the cleaned taper shank of arbor *H*. Place upon it a number of collars *h*, to reach entirely over the shaft *A*. Select a milling cutter *J* as thick as the width of the keyway to be milled. Place it on the arbor *H*, add collars as necessary, put on the nut *K*, and screw it up tightly. Bring up the outer arm support *R*, adjust it to support the outer end of the arbor *H*, and clamp it.

4. Place the scale *L* edgewise against the outer face of the milling cutter as shown, and adjust the table *B* until the scale touches the shaft *A*. As most cutters used for this work are ground concave, the scale should reach across the cutter and bear on the points of the teeth.

5. With the cross feed screw, move the table *B* forward a distance equal to one-half the diameter of the shaft *A*, less one-half the thickness of the cutter *J*, reading the distance on the graduated dial.

SHOP OPERATION SHEET NO. 155

John Edgar MACHINERY, December, 1910



Milling a Keyway in a Shaft—
Setting Cutter to Depth and Milling

NOTE.—It is assumed that the shaft *A* is secured in the proper position on the milling machine table *B*, that the cutter is mounted upon its arbor, and the work set in the proper position to bring the cutter exactly over the center of the shaft and ready to be set for the given depth.

1. Start up the machine at the proper speed, which will depend upon the diameter of the cutter and the quality of the material of which the shaft *A* is made.

2. With the crank for operating the vertical feed screw, raise the knee and table *B*, and consequently the shaft *A*, up to the milling cutter *J*. Continue the upward movement until the cutter has scored the shaft the full width of its face. Since a keyway is always measured for depth from the side, it is obvious why the shaft is first scored as described.

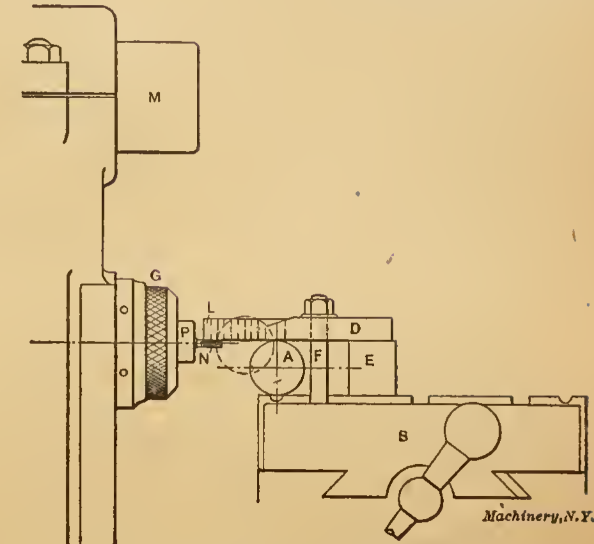
3. With the lateral feed screw, move the table *B* until the milling cutter *J* is at the end of the keyway where it should begin to cut. The cut should not extend past the center of the drilled hole.

4. Set the elevating dial index at zero, taking up all backlash between screw and nut, and carefully raise the work the exact given distance for the depth of the keyway, reading the amount on the dial, the cutter sinking into the shaft *A* to this depth and the shaft being in the position shown by dotted lines. Clamp the knee in this position.

5. With the lateral power feed adjusted to suit the material of which the shaft *A* is made, and the speed of the cutter *J*, start the lateral cut, and continue it until the cutter *J* has cut nearly half-way through the drilled hole at the far end of the keyway.

SHOP OPERATION SHEET NO. 156

John Edgar MACHINERY, December, 1910



Milling a Keyway in a Shaft—
Finishing the Semi-circular Ends

1. Remove the outer supporting arm, and push the overhanging arm *M* back out of the way. Remove the cutter arbor from the main spindle *G*.

2. Select and end mill N of a diameter exactly equal to the width of the keyway. Provide for it a collet *P*, the outside fitting the taper hole in the spindle *G*. Clean these carefully, put the end mill in the collet and the latter in the taper hole in the spindle.

3. Remove the liner blocks used in last operation. Place the shaft *A* in the inner T-slot, or in the shallow groove near the edge of the table *B*, if the machine is so provided. Clamp the shaft *A* lightly by the straps *D*, blocks *E*, and bolts *F*, applied as shown.

4. Move the table *B* inward until the shaft *A* comes near the end mill *N*. Place the scale *L* edgewise upon the end mill, with one end resting upon the cutting edge of one of the mill teeth, and the other end projecting over the shaft *A*. Raise the knee, table *B*, and the work until the scale *L* just touches the shaft *A*. Set the index to the graduated dial on the elevating screw at zero. Raise the work a distance equal to one-half the diameter of the shaft *A*, less one-half the diameter of the end mill *N*, measuring the distance with the micrometer dial on the elevating screw. The cutter will now be central with the axis of the work. Clamp the knee in this position.

5 Turn the shaft *A* until the end mill *N* enters the keyway. Clamp the shaft in this position. Move the table *B* inward until the end of the end mill touches the bottom of the keyway. Start the machine, and with the hand feed mill out each end of the keyway to the required length.

HORSEPOWER REQUIRED TO COMPRESS AIR—I

In the accompanying Tables II, III and IV is given the horsepower required for compressing one cubic foot of free air per minute (isothermally and adiabatically) from atmospheric pressure (14.7 pounds) to various gage pressures, for one-, two-, and three-stage compression.

The formula for calculating the horsepower required to compress, adiabatically, a given volume of free air to a given pressure is:

$$H.P. = \frac{144\,NPVn}{33000(n-1)}\left[\left(\frac{P_3}{P}\right)^{\frac{n-1}{Nn}}-1\right]$$

in which N = number of stages in which compression is accomplished,

P = atmospheric pressure in pounds per square inch,

P_3 = absolute terminal pressure in pounds per square inch,

V = volume of air, in cubic feet, compressed per minute, at atmospheric pressure,

n = exponent of the compression curve = 1.41 for adiabatic compression.

For different methods of compression and for one cubic foot of air per minute, this formula may be simplified as follows:

For one-stage compression:

$$H.P. = 0.015\,P\,(R^{0.29}-1)$$

For two-stage compression:

$$H.P. = 0.030\,P\,(R^{0.145}-1)$$

For three-stage compression:

$$H.P. = 0.045\,P\,(R^{0.0975}-1)$$

For four-stage compression:

$$H.P. = 0.060\,P\,(R^{0.0725}-1)$$

In these latter formulas $R = \frac{P_3}{P}$ = number of atmospheres to be compressed.

The formula for calculating the horsepower required to compress isothermally a given volume of free air to a given pressure is:

$$H.P. = \frac{144\,PV}{33000}\left(\text{Nap. log. } \frac{P_3}{P}\right)$$

Napierian logarithms are obtained by multiplying common logarithms by 2.302585.

Contributed by J. William Jones

HORSEPOWER REQUIRED TO COMPRESS AIR—II

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.

Single-Stage Compression.

Initial Temperature of Air taken as 60°F. – Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Isothermal Compression: Mean Effective Pressure	Isothermal Compression: Horsepower	Adiabatic Compression: Mean Effective Pressure, Theoretical	Adiabatic Compression: Mean Eff. Pressure plus 15 per cent Friction	Adiabatic Compression: Horsepower, Theoretical	Adiabatic Compression: Horsepower plus 15 per cent Friction
5	19.7	1.34	4.13	0.018	4.46	5.12	0.019	0.022
10	24.7	1.68	7.57	0.033	8.21	9.44	0.036	0.041
15	29.7	2.02	11.02	0.048	11.46	13.17	0.050	0.057
20	34.7	2.36	12.62	0.055	14.30	16.44	0.062	0.071
25	39.7	2.70	14.68	0.064	16.94	19.47	0.074	0.085
30	44.7	3.04	16.30	0.071	19.32	22.21	0.084	0.096
35	49.7	3.38	17.90	0.078	21.50	24.72	0.094	0.108
40	54.7	3.72	19.28	0.084	23.53	27.05	0.103	0.118
45	59.7	4.06	20.65	0.090	25.40	29.21	0.111	0.127
50	64.7	4.40	21.80	0.095	27.23	31.31	0.119	0.136
55	69.7	4.74	22.95	0.100	28.90	33.23	0.126	0.145
60	74.7	5.08	23.90	0.104	30.53	35.10	0.133	0.153
65	79.7	5.42	24.80	0.108	32.10	36.91	0.140	0.161
70	84.7	5.76	25.70	0.112	33.57	38.59	0.146	0.168
75	89.7	6.10	26.62	0.116	35.00	40.25	0.153	0.175
80	94.7	6.44	27.52	0.120	36.36	41.80	0.159	0.182
85	99.7	6.78	28.21	0.123	37.63	43.27	0.164	0.189
90	104.7	7.12	28.93	0.126	38.89	44.71	0.169	0.195
95	109.7	7.46	29.60	0.129	40.11	46.12	0.175	0.201
100	114.7	7.80	30.30	0.132	41.28	47.46	0.180	0.207
110	124.7	8.48	31.42	0.137	43.56	50.09	0.190	0.218
120	134.7	9.16	32.60	0.142	45.69	52.53	0.199	0.229
130	144.7	9.84	33.75	0.147	47.72	54.87	0.208	0.239
140	154.7	10.52	34.67	0.151	49.64	57.08	0.216	0.249
150	164.7	11.20	35.59	0.155	51.47	59.18	0.224	0.258
160	174.7	11.88	36.30	0.158	53.70	61.80	0.234	0.269
170	184.7	12.56	37.20	0.162	55.60	64.00	0.242	0.278
180	194.7	13.24	38.10	0.166	57.20	65.80	0.249	0.286
190	204.7	13.92	38.80	0.169	58.80	67.70	0.256	0.294
200	214.7	14.60	39.50	0.172	60.40	69.50	0.263	0.303

Contributed by J. William Jones

HORSEPOWER REQUIRED TO COMPRESS AIR—III

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.
Two-Stage Compression.
Initial Temperature of Air taken as 60°F.—Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Correct Ratio of Cylinder Volumes	Intercooler Gage Pressure	Isothermal Compression: Mean Effective Pressure	Isothermal Compression: Horsepower	Adiabatic Compression: Mean Eff. Pressure, Theoretical	Adiabatic Compression: Mean Eff. Pressure plus 15 per cent Friction	Adiabatic Compression: Horsepower, Theoretical	Adiabatic Compression: Horsepower plus 15 per cent Friction	Percentage of Saving over One-Stage Compression
50	64.7	4.40	2.10	16.2	21.80	0.095	24.30	27.90	0.106	0.123	10.9
60	74.7	5.08	2.25	18.4	23.90	0.104	27.20	31.30	0.118	0.136	11.3
70	84.7	5.76	2.40	20.6	25.70	0.112	29.31	33.71	0.128	0.147	12.3
80	94.7	6.44	2.54	22.7	27.52	0.120	31.44	36.15	0.137	0.158	13.8
90	104.7	7.12	2.67	24.5	28.93	0.126	33.37	38.36	0.145	0.167	14.2
100	114.7	7.80	2.79	26.3	30.30	0.132	35.20	40.48	0.153	0.176	15.0
110	124.7	8.48	2.91	28.1	31.42	0.137	36.82	42.34	0.161	0.185	15.2
120	134.7	9.16	3.03	29.8	32.60	0.142	38.44	44.20	0.168	0.193	15.6
130	144.7	9.84	3.14	31.5	33.75	0.147	39.86	45.83	0.174	0.200	16.3
140	154.7	10.52	3.24	32.9	34.67	0.151	41.28	47.47	0.180	0.207	16.7
150	164.7	11.20	3.35	34.5	35.59	0.155	42.60	48.99	0.186	0.214	16.9
160	174.7	11.88	3.45	36.1	36.30	0.158	43.82	50.39	0.191	0.219	18.4
170	184.7	12.56	3.54	37.3	37.20	0.162	44.93	51.66	0.196	0.225	19.0
180	194.7	13.24	3.64	38.8	38.10	0.166	46.05	52.95	0.201	0.231	19.3
190	204.7	13.92	3.73	40.1	38.80	0.169	47.16	54.22	0.206	0.236	19.5
200	214.7	14.60	3.82	41.4	39.50	0.172	48.18	55.39	0.210	0.241	20.1
210	224.7	15.28	3.91	42.8	40.10	0.174	49.35	56.70	0.216	0.247	
220	234.7	15.96	3.99	44.0	40.70	0.177	50.30	57.70	0.220	0.252	
230	244.7	16.64	4.08	45.3	41.30	0.180	51.30	59.10	0.224	0.257	
240	254.7	17.32	4.17	46.6	41.90	0.183	52.25	60.10	0.228	0.262	
250	264.7	18.00	4.24	47.6	42.70	0.186	52.84	60.76	0.230	0.264	
260	274.7	18.68	4.32	48.8	43.00	0.188	53.85	62.05	0.235	0.270	
270	284.7	19.36	4.40	50.0	43.50	0.190	54.60	62.90	0.238	0.274	
280	294.7	20.04	4.48	51.1	44.00	0.192	55.50	63.85	0.242	0.278	
290	304.7	20.72	4.55	52.2	44.50	0.194	56.20	64.75	0.246	0.282	
300	314.7	21.40	4.63	53.4	45.30	0.197	56.70	65.20	0.247	0.283	
350	364.7	24.80	4.98	58.5	47.30	0.206	60.15	69.16	0.262	0.301	
400	414.7	28.20	5.31	63.3	49.20	0.214	63.19	72.65	0.276	0.317	
450	464.7	31.60	5.61	67.8	51.20	0.223	65.93	75.81	0.287	0.329	
500	514.7	35.01	5.91	72.1	52.70	0.229	68.46	78.72	0.298	0.342	

Contributed by J. William Jones

HORSEPOWER REQUIRED TO COMPRESS AIR—IV

Horsepower Required for Compressing One Cubic Foot of Free Air per Minute (Isothermally and Adiabatically) from Atmospheric Pressure (14.7 pounds) to Various Gage Pressures.
Three-Stage Compression.
Initial Temperature of Air taken as 60°F.—Jacket-Cooling not considered

Gage Pressure, Pounds	Absolute Pressure, Pounds	Number of Atmospheres	Correct Ratio of Cylinder Volumes	Intercooler Gage Pressures—First and Second Stages	Isothermal Compression: Mean Effective Pressure	Isothermal Compression: Horsepower	Adiabatic Compression: Mean Eff. Pressure, Theoretical	Adiabatic Compression: Mean Eff. Pressure plus 15 per cent Friction	Adiabatic Compression: Horsepower, Theoretical	Adiabatic Compression: Horsepower plus 15 per cent Friction	Percentage of Saving over Two-Stage Compression
100	114.7	7.8	1.98	14.4 / 42.9	30.30	0.132	33.30	38.30	0.145	0.167	5.23
150	164.7	11.2	2.24	18.2 / 59.0	35.59	0.155	40.30	46.50	0.175	0.202	5.92
200	214.7	14.6	2.44	21.2 / 73.0	39.50	0.172	45.20	52.00	0.196	0.226	6.67
250	264.7	18.0	2.62	23.8 / 86.1	42.70	0.186	49.20	56.60	0.214	0.246	6.96
300	314.7	21.4	2.78	26.1 / 98.7	45.30	0.197	52.70	60.70	0.229	0.264	7.28
350	364.7	24.8	2.92	28.2 / 110.5	47.30	0.206	55.45	63.80	0.242	0.277	7.64
400	414.7	28.2	3.04	30.0 / 121.0	49.20	0.214	58.25	66.90	0.253	0.292	8.33
450	464.7	31.6	3.16	31.8 / 132.3	51.20	0.223	60.40	69.40	0.263	0.302	8.36
500	514.7	35.0	3.27	33.4 / 142.4	52.70	0.229	62.30	71.70	0.273	0.314	8.38
550	564.7	38.4	3.38	35.0 / 153.1	53.75	0.234	65.00	74.75	0.283	0.326	8.80
600	614.7	41.8	3.47	36.3 / 162.3	54.85	0.239	66.85	76.90	0.291	0.334	8.86
650	664.7	45.2	3.56	37.6 / 171.5	56.00	0.244	67.90	78.15	0.296	0.340	9.02
700	714.7	48.6	3.65	38.9 / 180.8	57.15	0.249	69.40	79.85	0.303	0.348	9.18
750	764.7	52.0	3.73	40.1 / 189.8	58.10	0.253	70.75	81.40	0.309	0.355	
800	814.7	55.4	3.82	41.4 / 199.5	59.00	0.257	72.45	83.25	0.315	0.362	
850	864.7	58.8	3.89	42.5 / 207.8	60.20	0.262	73.75	84.90	0.321	0.369	
900	914.7	62.2	3.95	43.4 / 214.6	60.80	0.265	74.80	86.00	0.326	0.375	
950	964.7	65.6	4.03	44.6 / 224.5	61.72	0.269	76.10	87.50	0.331	0.381	
1000	1014.7	69.0	4.11	45.7 / 233.3	62.40	0.272	77.20	88.80	0.336	0.383	
1050	1064.7	72.4	4.15	46.3 / 238.3	63.10	0.275	78.10	90.10	0.340	0.391	
1100	1114.7	75.8	4.23	47.5 / 248.3	63.80	0.278	79.10	91.10	0.344	0.396	
1150	1164.7	79.2	4.30	48.5 / 256.8	64.40	0.281	80.15	92.20	0.349	0.401	
1200	1214.7	82.6	4.33	49.0 / 261.3	65.00	0.283	81.00	93.15	0.353	0.405	
1250	1264.7	86.0	4.42	50.3 / 272.3	65.60	0.286	82.00	94.30	0.357	0.411	
1300	1314.7	89.4	4.48	51.3 / 280.8	66.30	0.289	82.90	95.30	0.362	0.416	
1350	1364.7	92.8	4.53	52.0 / 287.3	66.70	0.291	84.00	96.60	0.366	0.421	
1400	1414.7	96.2	4.58	52.6 / 293.5	67.00	0.292	84.60	97.30	0.368	0.423	
1450	1464.7	99.6	4.64	53.5 / 301.5	67.70	0.295	85.30	98.20	0.371	0.426	
1500	1514.7	103.0	4.69	54.3 / 309.3	68.30	0.298	85.80	98.80	0.374	0.430	
1550	1564.7	106.4	4.74	55.0 / 317.3	68.80	0.300	86.80	99.85	0.378	0.434	
1600	1614.7	109.8	4.79	55.8 / 323.3	69.10	0.302	87.60	100.8	0.382	0.438	

Contributed by J. William Jones

MACHINERY

December, 1910

CLAMPING AND LOCKING DEVICES APPLIED TO MACHINE TOOLS*

By JOSEPH G. HORNER†

DEVICES for clamping and locking various parts are found on practically all machine tools, and the different methods used afford a very interesting study. In considering this subject we disregard permanent fastenings—that is those which are not released and tightened as part of the operation of the machine—and take into account only those devices which are expressly designed to permit of more or less rapid loosening and tightening, to allow of adjustments. There are a great many conditions under which these devices are required, and the particular type adopted may vary widely in character; a design that is exactly suited to one case may be utterly unsuitable for another. For instance, the pressure from the point or end of a screw is sufficient for holding some parts, but in other cases this would be an unsatisfactory method to adopt. Again, friction may be ample to hold a certain part, while in another case a positive device is necessary.

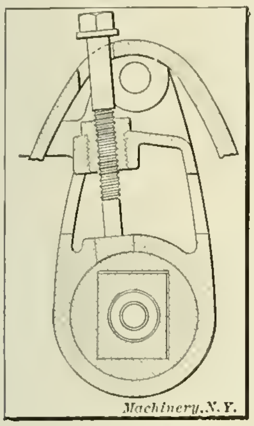


Fig. 1. Set-screw with Shoe for Clamping Sleeve

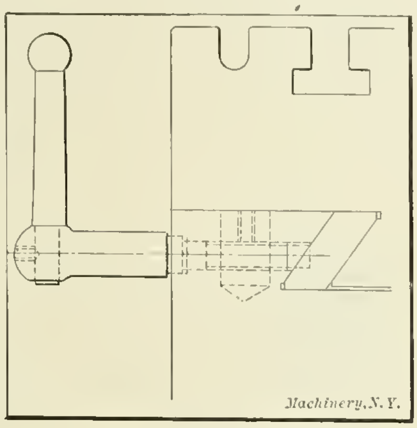


Fig. 2. Screw Recessed into Strip for Clamping Slide

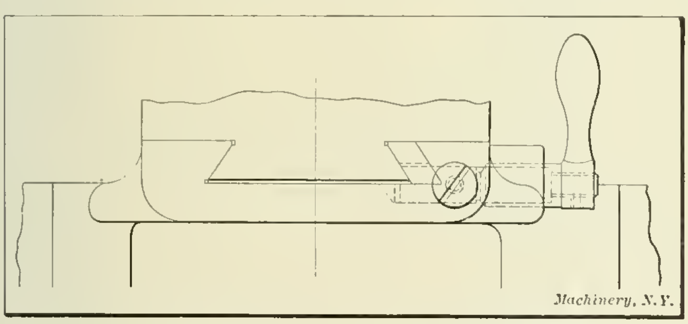


Fig. 3. Screw and Notched Shoe for Clamping Slide

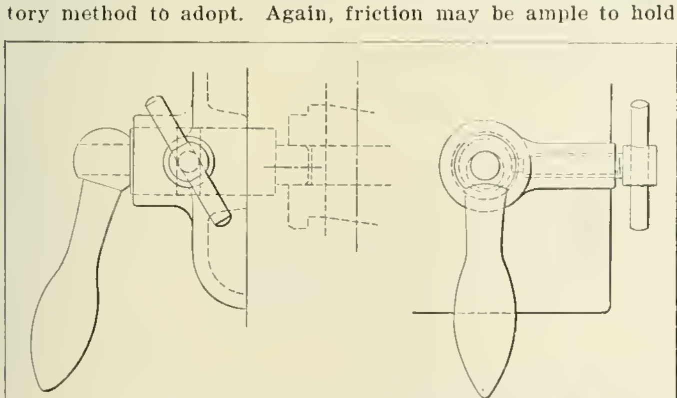


Fig. 4. Clamping Screw with End entering Groove for Clamping Stud

* See MACHINERY, September, 1910: "Machine Stops, Trips and Reversing Mechanisms."

† Address: 45 Sydney Buildings, Bath, England.

The distinction which will be made in the following between clamping and locking is this: Clamping produces a decided pressure, sufficient to enable a part of a machine to resist the shocks or vibration tending to shift it, while locking is only a method of temporarily holding a piece in position, by means of a plunger or other medium, sufficient to retain it, but without giving a powerful clamping or squeezing action. A locking device, therefore, might not be powerful enough to act as a clamping device, so that these two functions must be regarded as distinct from each other. As a matter of course we say that a slide is locked, when we ought to say that it is clamped, because the parts are drawn together powerfully, and not merely prevented from shifting by a pin or other means. As a general rule it may be said that locking holds a machine part in a definite position, or in one of a series of positions previously known, by means of holes, slots, or grooves, which determine these positions; but a part may be clamped at any location, with or without the use of graduations or other means to determine the setting. In some cases, although these are not very common, locking and clamping are combined, the latter supplementing and assisting the former.

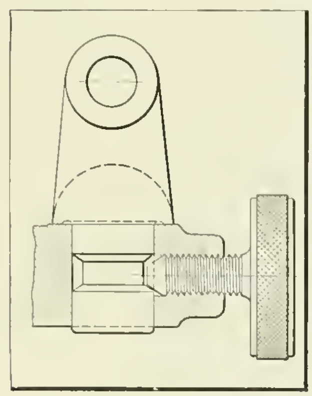


Fig. 5. Clamping Screw with Pull-down Action for Clamping Bearing

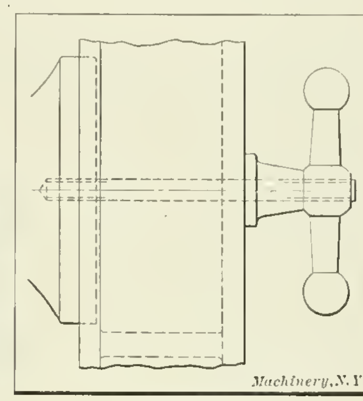


Fig. 6. Bolt and Handle for Clamping Drill Head

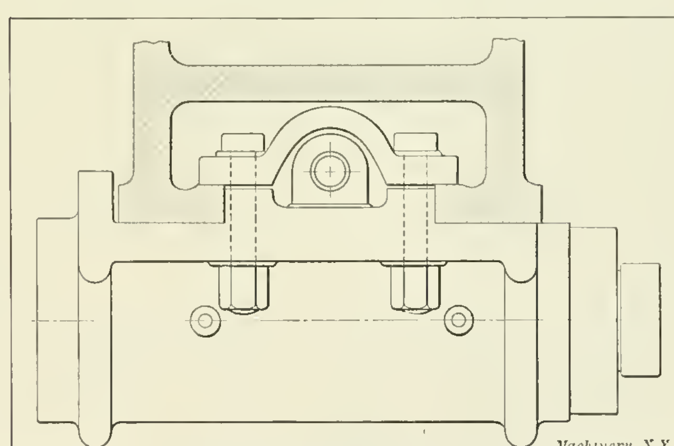


Fig. 7 Showing Use of Bolts and Strap for Clamping

The following selection of typical devices, representative of American, English, and German practice, will serve to illustrate the principles of clamping and locking devices. A large number of other examples, which might be shown, are but modifications of those here selected.

Clamping Devices

Dealing first with clamping, the simplest example is a set-screw pressing upon the portion that has to be secured.

This is a cheap device, but is open to objections. On a flat surface it is efficient, but the pressure is too local, and this construction is not adapted to withstand heavy strains without slipping. Moreover it has the bad effect of forcing the parts away from each other when screwed up, so that a fruitful source of vibration is introduced, whereas other and better methods of clamping pull the parts together and act as clamps in the true sense of the word. Usually the pressure of a set-screw point is objectionable, and a soft pad or shoe is employed to avoid the marring effect otherwise met with. This pad or shoe may be shaped to correspond with the form

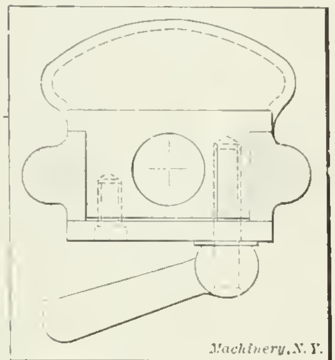


Fig. 8. Clamping Screw Located on One Side

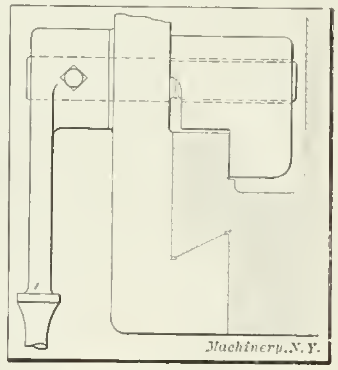


Fig. 9. Clamping Device for Drill Saddle

of the surface against which it bears. Fig. 1 is an example of a set-screw in an awkward situation, this example being taken from one of the Seller's tool-grinders; the screw passes through a bushing, and presses upon a pad shaped to fit the outside of the cylindrical sleeve. In some cases the shoe or pad may be notched out to press against the V of a slide, as

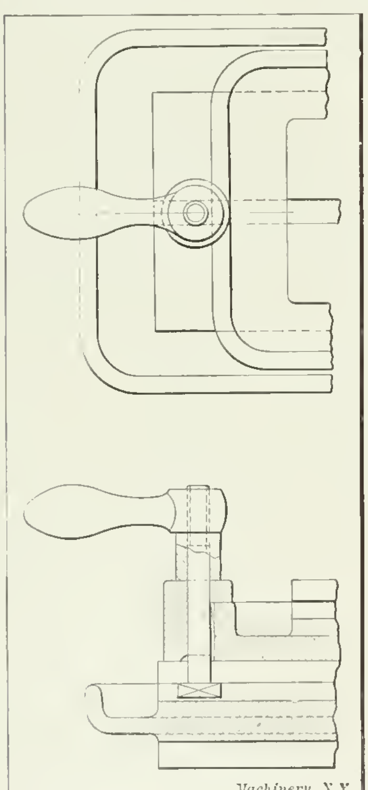


Fig. 10. Clamp for Grinding Machine Swivel Table

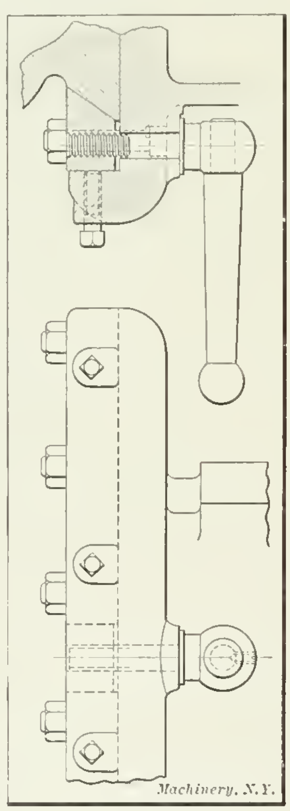


Fig. 11. Clamping Arrangement for V-slide

in Fig. 3, for locking purposes. This example is taken from a cutter-grinder. The necessity for a shoe is sometimes avoided by sinking the end of the screw into the metal, as in Fig. 2, which shows a gib clamp for a milling machine slide. In the case of a circular part, Fig. 4, a groove is turned for the locking screw to enter, this construction also preventing endwise motion of the pin to be locked. The function of the pin is to actuate a clutch for a drilling machine head. Sometimes the groove is arranged so that the screw draws the piece tightly downward to a bearing, as shown in Fig. 5.

There are numerous instances where ordinary bolts are employed for clamping purposes; some special form of clamp or strap is often used in this connection, in order to utilize the pressure to the best advantage. Thus in the work-spindle slide of a gear-cutter, Fig. 7, four bolts are employed, and a

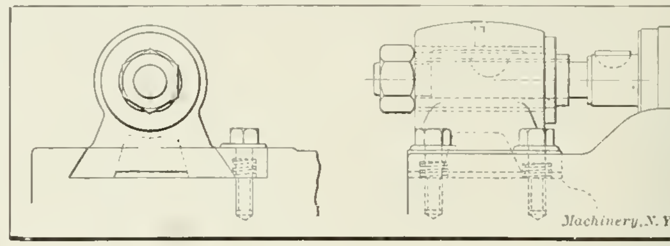


Fig. 12. Clamping Strip with Springs for Raising the Strip when Released

dished clamping plate is used to clear the nut at the back of the slide. When rapid manipulation without using a spanner is desirable, a handle takes the place of the hexagon nut, as on the sensitive drill shown in Fig. 6. Another case

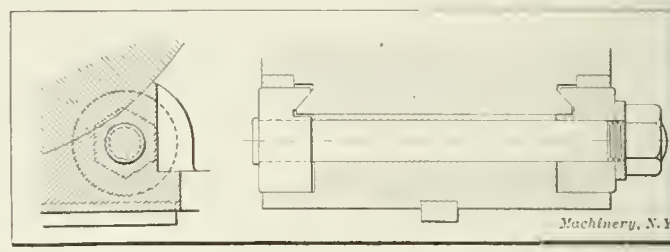


Fig. 13. Clamping Action on Opposite Sides of Swivel-block

where the clamping screw is set to one side, owing to the presence of a central hole, is seen in Fig. 8; a fillister-head screw retains the plate in position on one side, and the tightening of the handle clamps the slide against the face

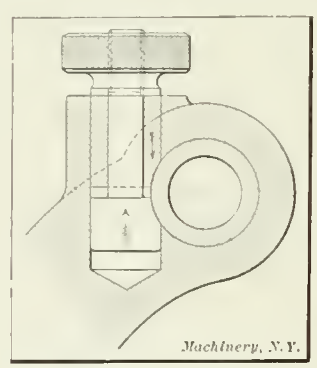


Fig. 14. Clamping with Bolt and Bushing

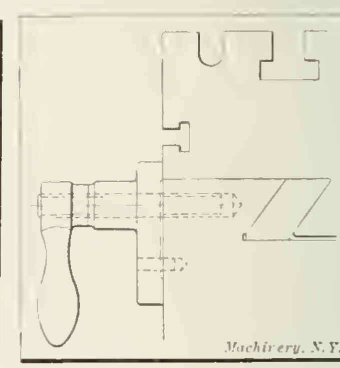


Fig. 15. Clamping Plate for Edge of Milling Machine Table

of the casting. This detail is taken from a cutter-grinding machine. After some time, a clamping handle will assume a position which renders its proper operation difficult, and provision may be made to compensate for wear to prevent this

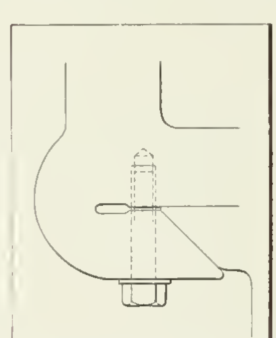


Fig. 16. Clamping Arrangement based on the Spring Action of the Metal

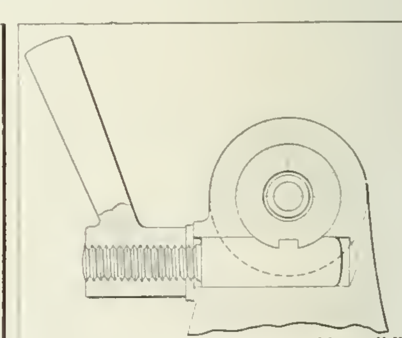


Fig. 17. Clamping Bolt for Poppet or Tailstock Spindle

trouble. Thus, in Fig. 9, the handle turning the screw which pulls the clamping block up is secured by a set-screw. By loosening the latter, the handle can be readjusted into the most convenient position. This particular example represents the clamp for the saddle of a radial drill.

Fig. 10 illustrates the table clamp of a grinding machine, which permits of the swiveling motion for angular grinding. This design differs from the previous instance in that the bolt is adjustable in its slot to allow for the radial movement of the table. Another specimen of clamping with a block drawn up by a bolt and handle is shown in Fig. 11, and is used for a milling machine slide. The threaded end of the bolt is tapped into the block, and the latter presses against the beveled edge of the slide. Another variation of this type

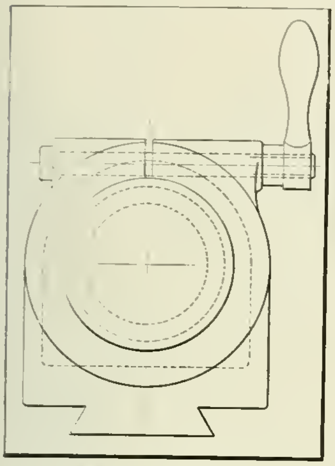


Fig. 18. Method of Clamping with a Split Bracket

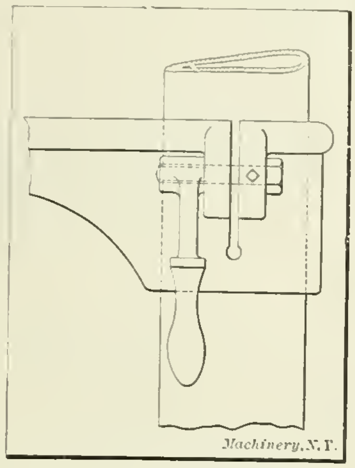


Fig. 19. Clamping a Partially Split Bracket to a Column

of device is shown in Fig. 12, illustrating the outer bearing for a gear-cutter spindle. This spindle must be adjusted endwise; by loosening the two set-screws, the clamping strip is raised by the coiled springs, and the bearing is free to slide. Under certain conditions it is necessary to have a perfectly balanced clamping effort, as, for example, in dividing

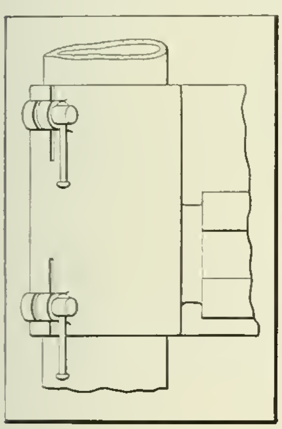


Fig 20. Sleeve Split at Ends for Clamping

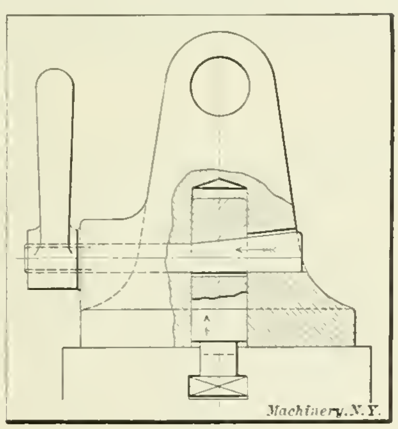


Fig. 21. Example of Wedge Clamping

heads. An instance of this is illustrated in Fig. 13. The swivel-block has beveled edges turned at each side, and the correspondingly shaped blocks are drawn together simultaneously by the tightening of the nut; the clamps are guided in the solid metal, so that distortion is prevented. A similar

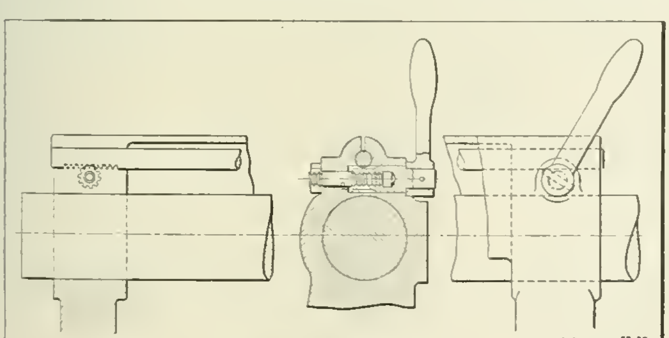


Fig. 22. Clamping Two Bearings simultaneously

principle is employed in many classes of clamping devices for cylindrical parts, such as the spindle in Fig. 14, which is secured by the pressure of the bolt head and the bushing, suitably formed to fit the spindle, and drawn down upon it by tightening the nut. The spindle is not marred, and there is no need of weakening the bearing by splitting it for the purpose of clamping.

Three other types of clamping devices are shown in Figs.

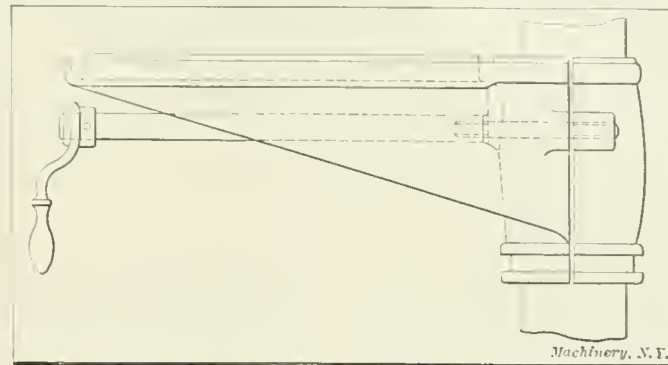


Fig. 23. Clamping Handle carried out to Edge of Table for Convenience of Operation

15, 16, and 17, the first being a plate forced against the side of a milling machine table, this being an alternative construction to that in Fig. 2. Fig. 16 is a form that is only possible in a few cases, the metal being left solid, except for a split or slot, and the clamping effected by its springing action only. This detail shows the method of attaching a milling machine brace to the knee. Fig. 17 shows a clamping arrange-

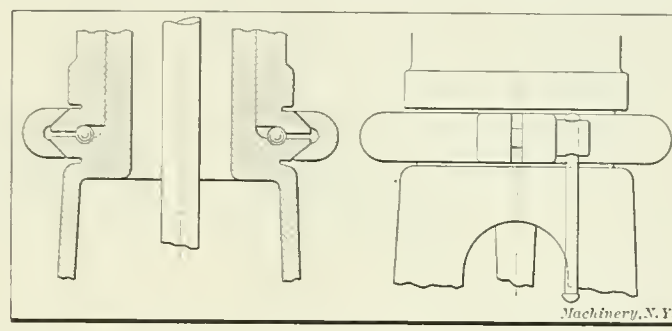


Fig. 24. Clamping Radial Drill Sleeve to Column

ment for a poppet or tailstock spindle, which also serves the purpose of keeping the spindle from turning.

One of the most popular methods of clamping is by the split lug, boss or collar, drawn together by a screw or screws. This provides for a very powerful grip. There are so many examples of this device that it is only possible to show a few types. In small lugs, fillister-head screws are suitable for the drawing-together action, but a bolt is better for large parts, as in Fig. 18, which shows the bracket of a cutter-grinder

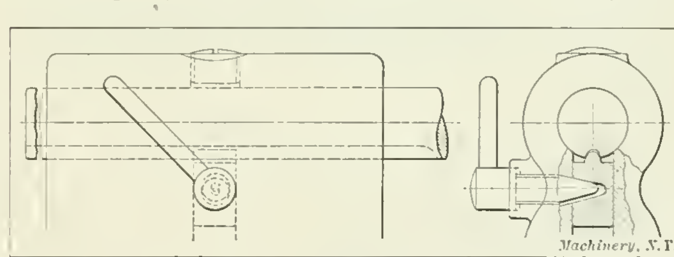


Fig. 25. Wedge Action Clamp for Grinder Tailstock

clamped on its pillar. It is not always necessary to carry the split right through the boss; it may only pass partly through, as in Fig. 19. The bolt in this case is held by a set-screw, so that it may be turned partly around to bring the clamping handle into the most convenient position, this constituting a variation of the method in Fig. 9. Fig. 20 is another instance of partial splitting of a sleeve of a radial drill arm. An interesting type of such a method of clamping is found in the Brown & Sharpe milling machine arm; the two tightening screws are situated at the opposite ends of the frame, but are coupled together by a rack-bar which causes the two screws to turn simultaneously. It is, therefore, necessary to turn one screw only, as indicated in Fig. 22.

The tightening nut or lever for a split clamp is usually

placed close to the boss, but in some cases it may be necessary to vary the position for convenience of manipulation. Thus in the drilling machine table, Fig. 23, the screw is prolonged into a long spindle, thus bringing the clamping handle to the front of the table, where the operator can reach

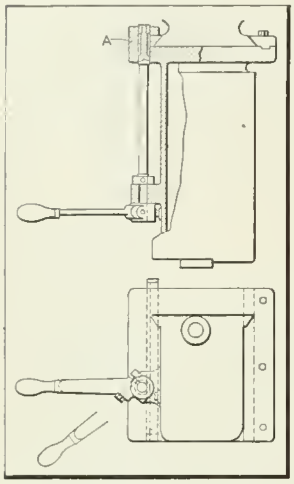


Fig. 26. Long Strip for Clamping Knee of Milling Machine

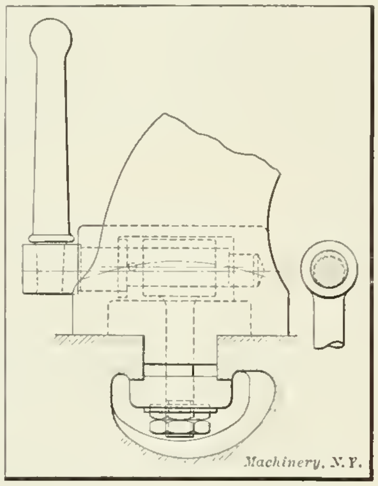


Fig. 27. Eccentric Clamp for Tailstock

it without effort or straining. Fig. 24 illustrates a split clamp which does not act in the usual manner, but serves

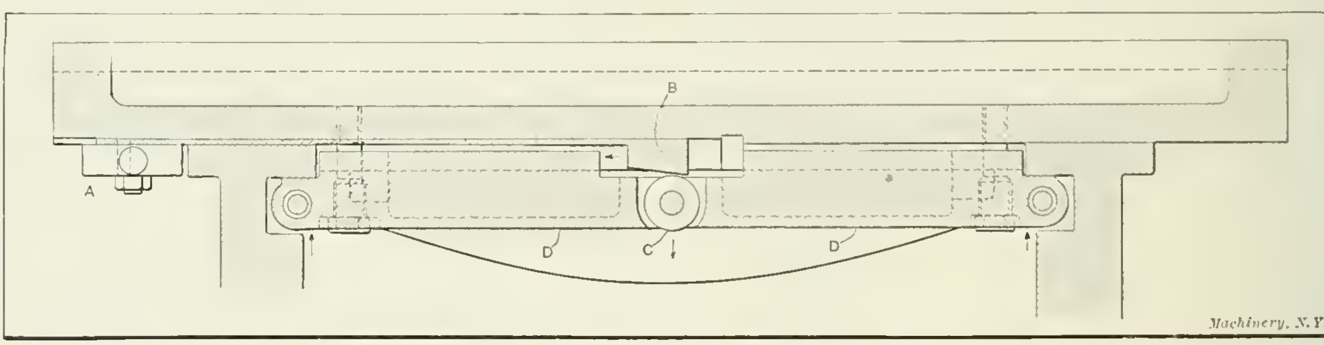


Fig. 28. Clamping Device for Planer Cross-rail

to draw two beveled surfaces together (this example being a pillar and sleeve of a radial drill), to prevent rotation. When

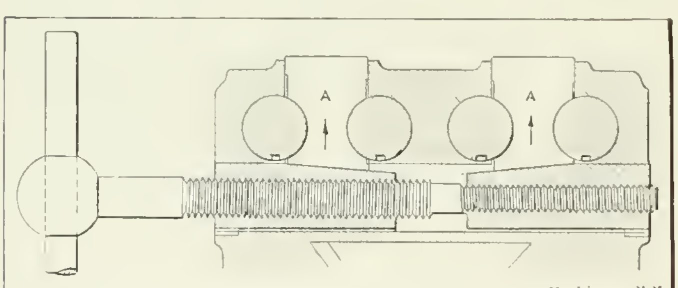


Fig. 29. Clamping Four Spindles simultaneously

the clamp is loosened, the sleeve is free to turn on its ball-race.

Wedge action is utilized for clamping, in numerous cases,

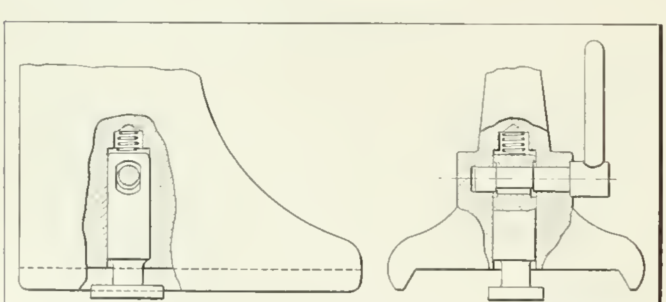


Fig. 30. Eccentric Action Clamping Device used on Bench Lathe

instead of direct screw pressure, and is often more suitable for certain purposes. Fig. 21 is representative of several such designs, this example being the clamp for a grinder tailstock; the action is like that of a cotter. A similar principle is employed in Fig. 25 where the overhanging arm of a special grinding machine is held by the forcing upward of a block through the screwing in of a tapered plug. The groove in the arm also prevents the latter from twisting.

Fig. 26 shows the principle of a clamping arrangement used

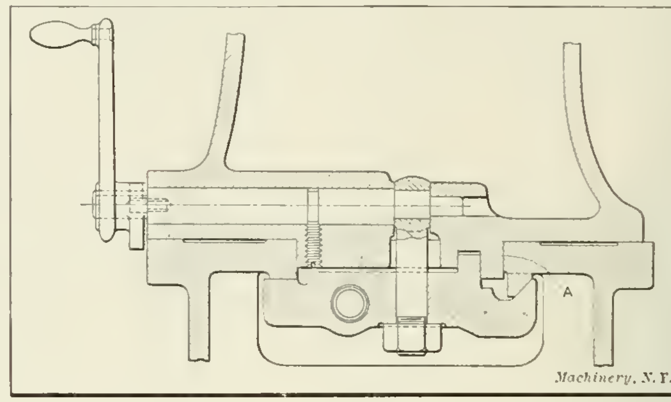


Fig. 31. Eccentric Action Clamping Device used on Chucking Lathe

by Messrs. Alfred Herbert, Ltd., on their milling machines. The object is to clamp the entire length of the knee, instead of clamping at one location only, the wedge strip being forced downward by turning the handle, which causes the pinion *A* to rotate and force the strip along. Another instance of wedge action combined with levers, is seen in Fig. 28, which shows the Whitcomb-Blaisdell planer cross-rail fastening. When the handle in the disk *A* is pulled over, it draws the strip and wedge *B* along, and the latter presses against the roller *C*, which is mounted on the pivot pin of the levers *D*. These levers are forced outward, and as they pivot on the

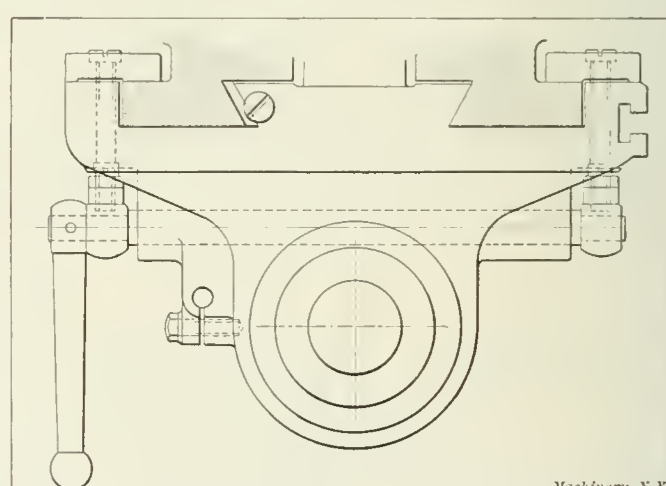


Fig. 32. Eccentric Clamping Arrangement for Vertical Milling Machine Head

screws near their ends, they are caused to press against the inside of the uprights, and thus pull the cross-rail tightly against the faces of the housings. Fig. 29 shows a multiple clamping arrangement, used on multiple dividing centers. The object is to bind the four spindles simultaneously. When the right- and left-hand screw is turned, it draws the two wedges

together, and these push the blocks A upward, thus binding the spindles.

Eccentric action is also employed extensively, and has the advantage of being more rapid and convenient for some

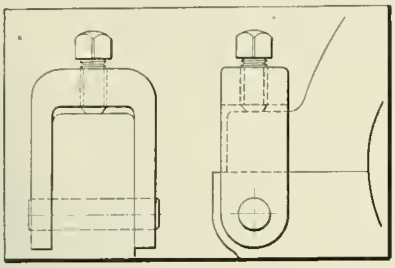


Fig. 33

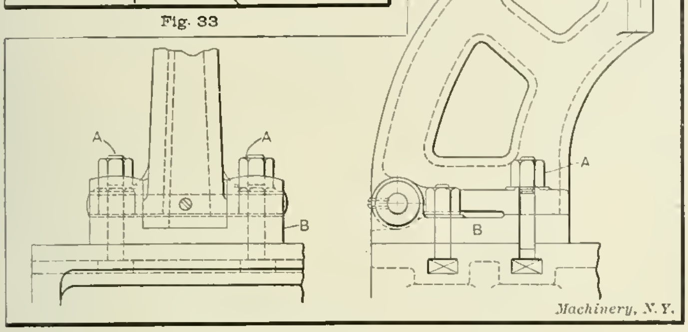


Fig. 34. Clamping Device for a Bracket

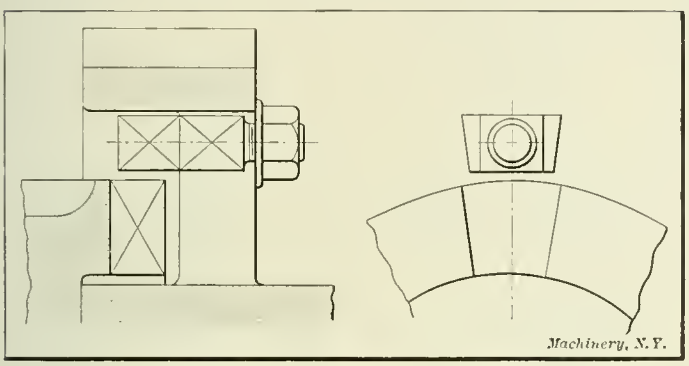


Fig. 35. Locking Pin for Lathe-head Gears

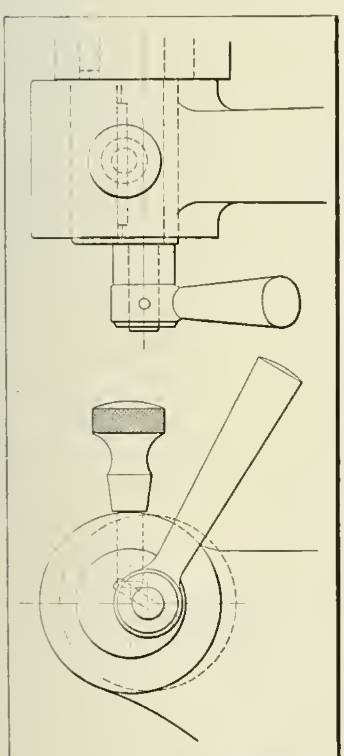


Fig 36. Eccentric Spindle Locking Pin

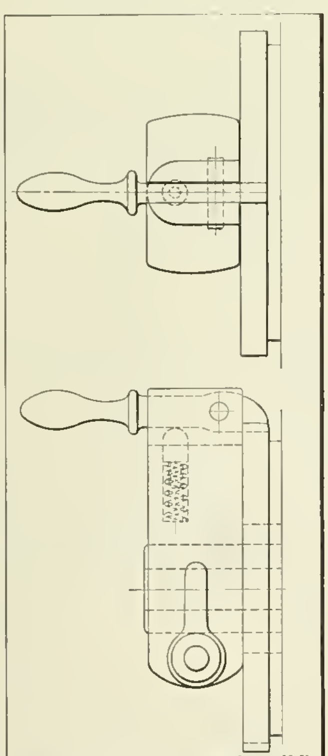


Fig. 37. Locking Arrangement for Indexing Lever

kinds of clamping than a screw or wedge. This action is particularly handy when the clamping and unclamping is very frequent. An eccentric device applied to a lathe tailstock is illustrated in Fig. 27. The nuts at the bottom of the clamping plate allow for adjustment to make the eccentric act at the proper position of the handle. A modified form of the same type is seen in Fig. 30, which is used for a bench lathe, while an arrangement for the turret saddle of a chucking lathe is shown in Fig. 31. The clamping plate here is designed to pull the saddle over against the edge A of the bed, so that a constant alignment is preserved. The tightening lever has stop lugs, which abut against studs, screwed into the face adjacent to the boss, and arrest the lever

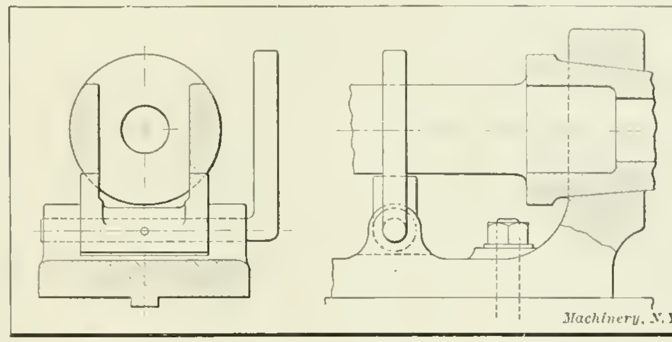


Fig. 38. Lock for Open Spindle of John Lang & Sons Turret Lathe

at definite positions. An instance of duplex clamping, applied to the head of a vertical milling machine, is shown in Fig. 32. The clamping rod passing through the casting has slightly eccentric ends, and these force the lugs upon them in an outward direction when the lever is pulled, thus drawing the plates or clamping strips against the back edges of

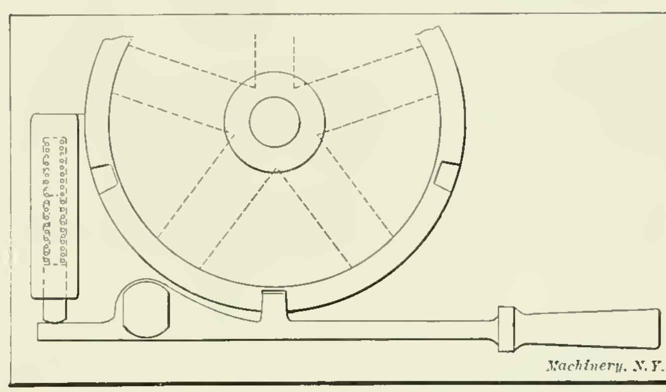


Fig. 39. Locking Turret with External Lever

the projecting ways of the column. Adjustment is made by means of the threaded ends and the nuts.

Provision has occasionally to be included for permitting a pivoting or "throw-back" action in connection with clamping. Very frequently a pivoted eye-bolt meets the requirements, or alternatively a loop or strap fitted, as shown in

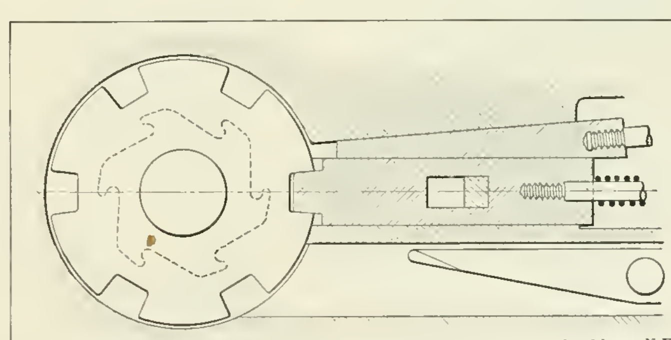


Fig. 40. Plunger Lock for Turret

Fig. 33, to a hinged steady-rest. A different method is to employ bolts in T slots, Fig. 34, the two marked A being used to hold the bracket down, for steadying the arbor support of a gear-cutter. The bracket is hinged on the pivot-pin in the plate B, and the latter remains clamped in position by its two bolts. When the bracket has to be thrown back, it is only necessary to slacken the nuts A, and slide the bolts out of the slots. Another point with reference to

clamping is that power is sometimes gained by using gears for effecting a specially tight grip. There is one type of lathe tailstock in which the clamping bolt is turned by a spur gear actuated by a pinion, on the shaft of which the spanner is placed, thus giving a very powerful grip for high-speed work.

Locking Devices

Taking up now the consideration of locking devices, it should be mentioned that these may be classified as positive locks

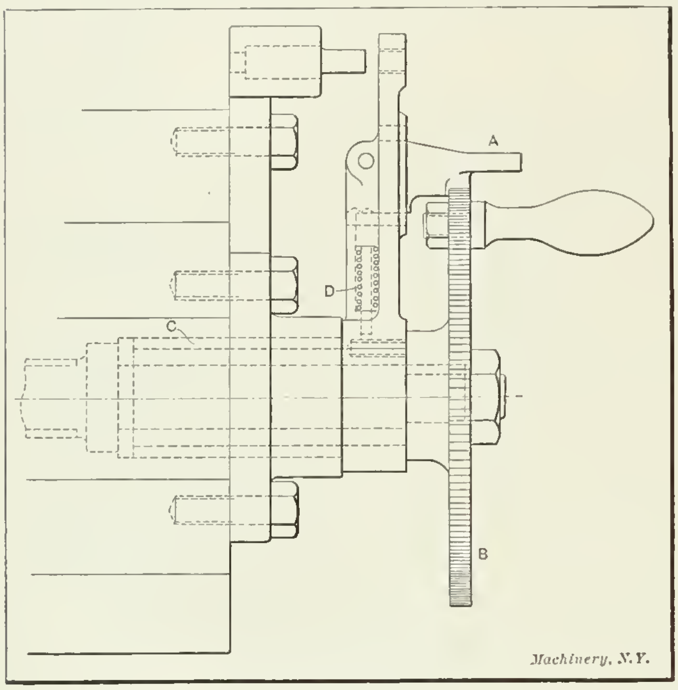


Fig. 41. Locking Arrangement for Quick Withdrawal Device on Threading Lathe

and friction locks, the latter being obviously unsatisfactory in many cases where the risk of any slip would be detrimental. The simplest lock, perhaps, is that used for the back-gears

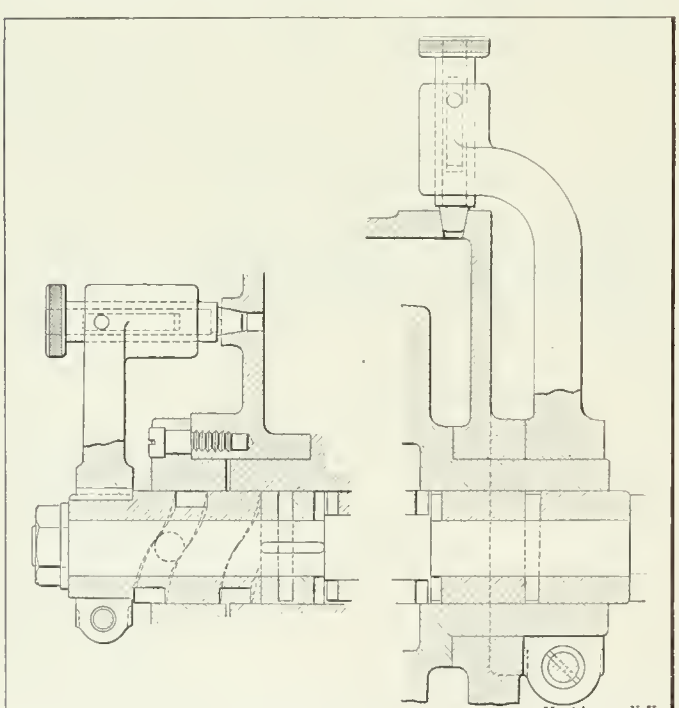


Fig. 42. Locking Plungers with Knobs for Withdrawal

of a lathe or other machine, where a bolt is slid into a slot to encounter a projection on the cone pulley. The pin may also be pushed endwise into a hole, the relative positions of in- and out-of-gear being controlled by a spring. This kind of device is also employed to lock the pulleys of grinding heads when dead-center work is being done. Fig. 35 represents a lock adopted on a high-speed lathe, the locking bolt being tapered to fit in the slot in the adjacent gear, the object being to prevent back-lash. A typical positive lock is shown in Fig. 36, this example being the pin for securing the eccentric spindle of a back-gear. The pin may be straight or parallel, as shown, but more frequently it is tapered. Slides or other parts are frequently locked by tapered pins.

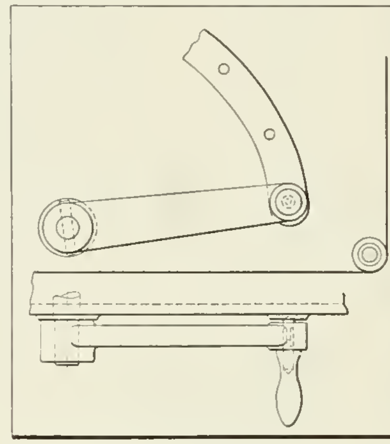


Fig. 43. Common Type of Spring Plunger for Locking Lever

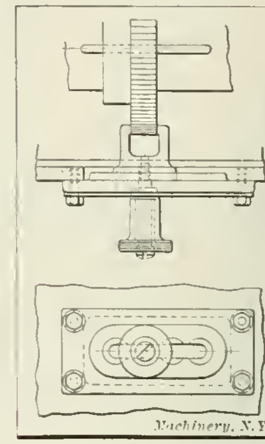


Fig. 44. Plunger Locking Arrangement for Gear Box

Fig. 38 is a locking device employed on the open-spindle turret lathes of Messrs. John Lang & Sons, to hold the spindle while the chuck on the nose is being tightened or loosened with a spanner. When the lock is thrown downward, the spindle is free to rotate. Two other positive locks are illustrated in Figs. 39 and 40, one for a turret lathe of

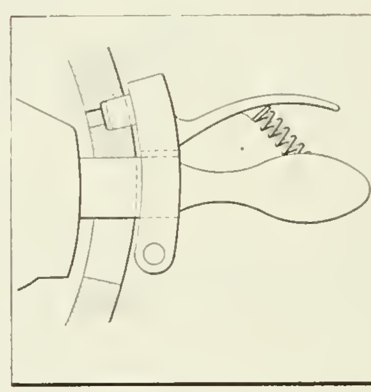


Fig. 45. Withdrawing and Locking Device on Change-gear Box

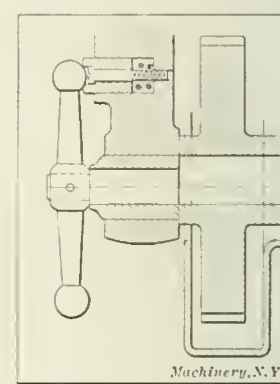


Fig. 46. Spring Lock for Back-gear Lever

the type used largely in England, the other for a central-hole type of turret. In both cases a tapered part enters slots in the periphery of the indexing disks. The wedge strip beside the plunger in Fig. 40 takes up play due to wear.

Positive locks are also seen in Figs. 37 and 41. In Fig. 37 a disk on the body of a sleeve has notches, into any one of which the pivoted catch drops, under the action of a coiled spring, thus holding the sleeve in one position. Fig. 41 shows a quick-withdrawing device for screw-cutting; when

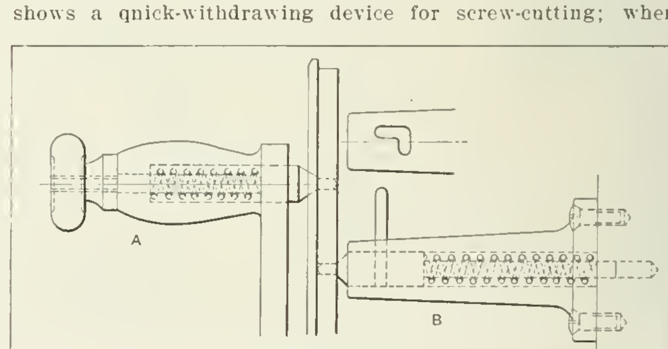


Fig. 47. Locking Plungers for Index Plate and Lever

the catch *A* drops into engagement with the toothed disk *B* the rotation of the latter has the effect of turning the quick-pitched screw *C*. The spring plunger *D* in the lever which carries *A*, locks the latter in either the "in" or "out" position, according to whether the plunger point slips into either the

one or the other of the countersinks in the inner end of *A*.

The spring plunger is a familiar locking device, and is found in varied forms, usually embodying a pointed or tapered plunger which obviates back-lash. A common instance is that shown in Fig. 43, used for a speed- or feed-change lever. The plunger is contained within the handle, and its point slips into any one of the countersinks in the quadrant. The arrangement may also be as in Fig. 42, with a pull-back device for each plunger, as the latter in this case enter more deeply into their locking holes. An alternative construction is shown in Fig. 44, where the block which moves or slides the spur gears endwise is locked by a tapered sleeve entering any one of four tapered recesses in the locking plate. A spring inside the sleeve keeps it in position. Fig. 45 illustrates another method of withdrawing a plunger, this method being used on the familiar Hendey-Norton change-gear device, in which the act of grasping the handle firmly withdraws the plunger, ready for the movement to another hole. Still another method, employed on a milling machine divid-

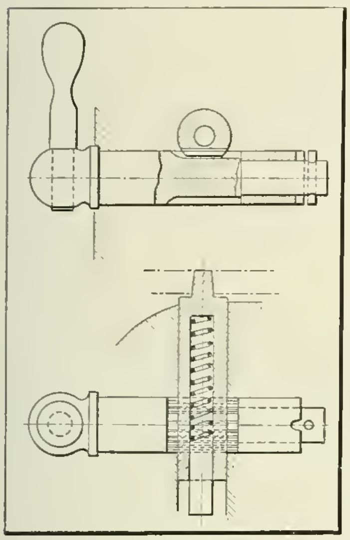


Fig. 48. Withdrawing and Locking Device for Spring Plunger

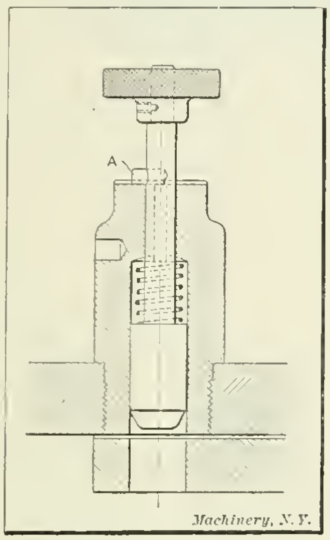


Fig. 49. Locking Plunger with Locking Pin

ing head is represented in Fig. 48; the locking plunger in this example is pulled back by a rack and pinion device, and the pinion sleeve is itself locked by drawing it backward until the pin near its end slips into the slot in a bushing as shown.

Fig. 47 shows a different construction, also for a dividing head; the plunger *A* has only a pull-back action, without a positive lock, while the other plunger *B* is provided with a pin which slips into a sort of bayonet catch, and prevents the plunger from moving forward under the action of the spring.

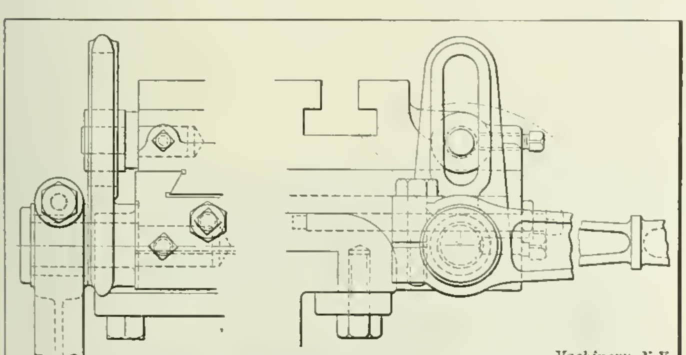


Fig. 50. Cross-slide Lever with Split Hub for Locking in Various Positions

The locking plunger in Fig. 49 (for coupling in the back-gears of a vertical milling machine), is held out of position by the pin *A*, but a quarter turn of the plunger allows this pin to slip into a groove inside the bore and thus let the plunger into any one of the holes in the disk below. Finally, the Brown and Sharpe back-gear lock, Fig. 46, represents an ingenious method of retaining automatically the ball ends of a lever in position.

The succeeding illustrations are those of friction locking devices. Fig. 50 might be classed as a clamping device, but as its only purpose is to allow of locking in different positions, it should logically be classed in the latter category. The split handle or lever is employed to work the cross-slide of a turret lathe. In order that the operator may have the handle in the most convenient and least fatiguing position, it is adjustable around the pin on which it is mounted, by simply loosening the binding screw. An alternative method

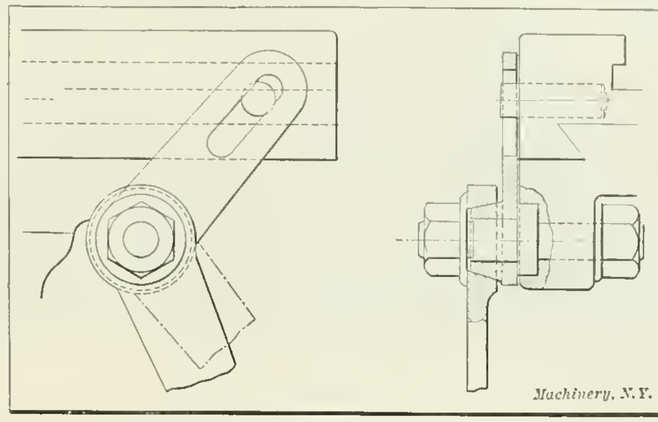


Fig. 51. Cross-slide Lever with Friction Lock

is to taper the inside of the lever, as in Fig. 51, to match the outside of the slotted levers shown, and force the two together by a nut. This constitutes a friction clutch, and is an idea that is found in many locking devices, especially for locking gears and other parts together temporarily, and for micrometer and similar devices. Other arrangements for micrometer dials are shown in Figs. 52 and 53, for locking the dials at zero when desired. Fig. 52 has a small bolt tightened by a knurled-head nut, the head of the bolt lying in a circular T-slot in the dial. When the nut is screwed up, the dial is locked to the handwheel and turns with it. In Fig. 53 the point of the central threaded plunger forces a small block outward against the bore of the dial, and locks the latter.

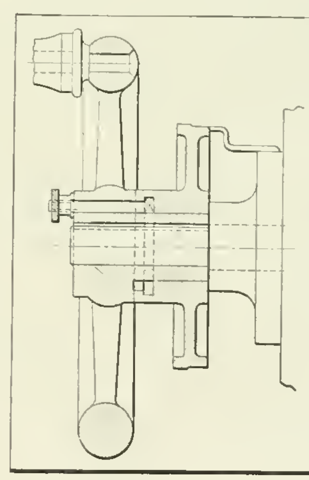


Fig. 52. T-bolt Friction Lock for Micrometer Dial

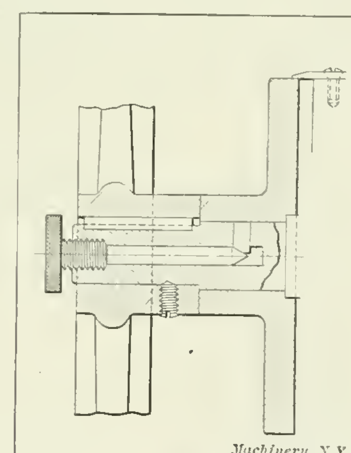


Fig. 53. Pin Friction Lock for Micrometer Dial

Ratchets are occasionally utilized for locking purposes, one instance being in wire-feeds, where the feeding dog is held on its supporting rod by a pawl entering into the teeth of the ratchet bar.

* * *

In an address before the Hartford Manufacturers' Association, Mr. B. M. W. Hanson of the Pratt & Whitney Co. deplored the fact that there does not seem to be any unity of action throughout the country to educate more mechanics in a systematic way, and said that too little thought had been given to make the machine shops attractive to the American boy. One of the chief reasons, he believed, is that the wages offered to an apprentice boy under modern conditions are entirely too low, and that the labor supply is more often obtained from the immigrant office and the street than from the graduating class of the public schools.

ENGLISH 24-INCH LATHE

By W. H. HAGGAS*

The 24-inch lathe illustrated in the accompanying halftones and line engravings is made by Messrs. Ward, Haggas and Smith, Eastwood Tool Works, Keighley, and its new and im-

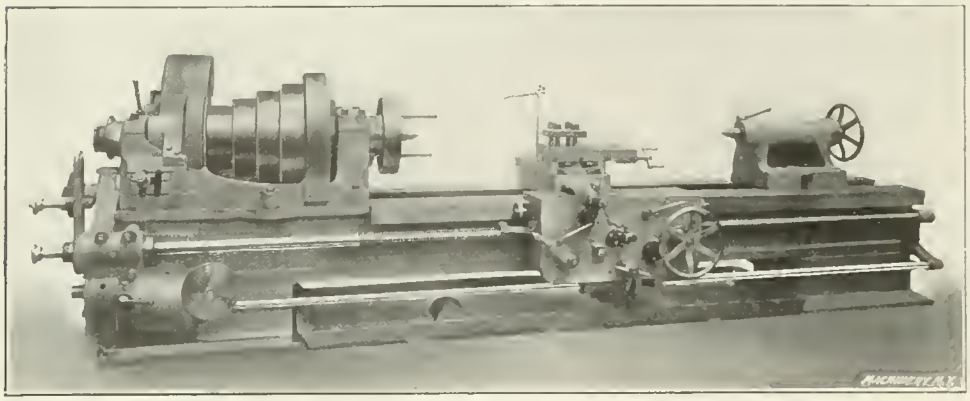


Fig. 1. Twenty-four-inch Lathe, built by Ward, Haggas & Smith, Keighley, England

portant features are patented in England and the Colonies. It is a good example of modern English lathe design, and possesses many interesting features, chief of which is the

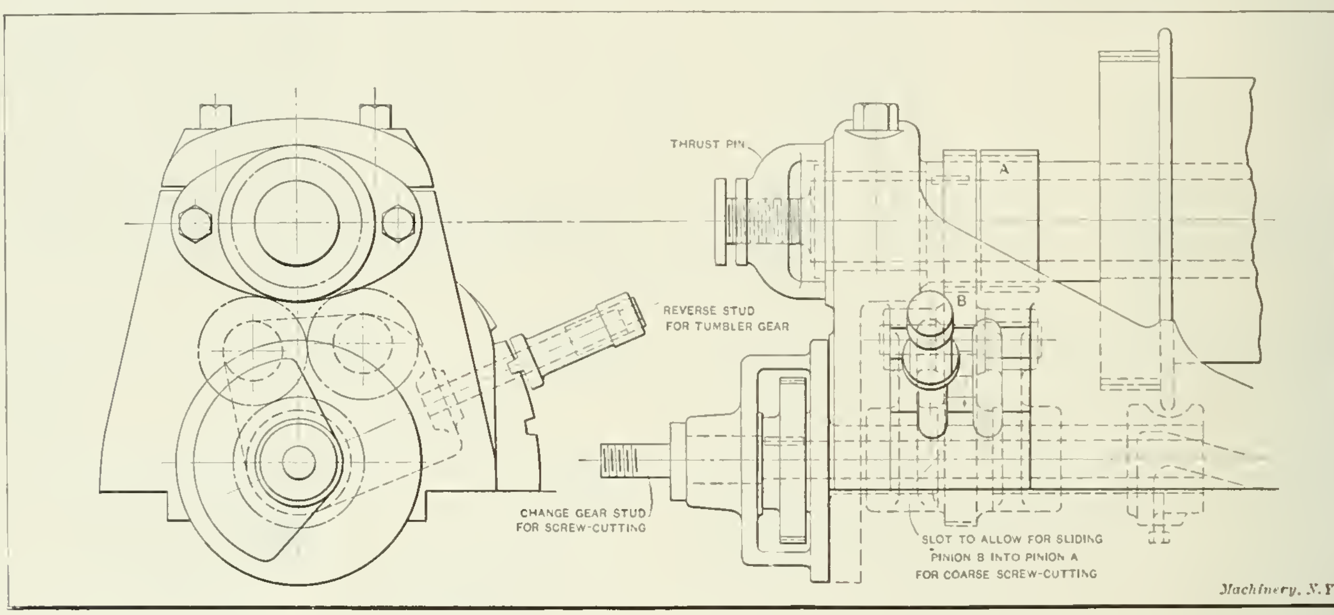


Fig. 2. End and Side Elevations of Left-hand End of Headstock

method of gearing the lead-screw to the drive.† The halftone, Fig. 1, gives a good general idea of the design of the machine.

The headstock has a four-step cone, the diameter of the largest step being 18 inches. The driving belt is 4 inches wide. Two ratios of back-gearing are provided, being 4 to 1 and 16 to 1, respectively, thus providing for twelve spindle speeds from a one speed countershaft; by means of a two-speed countershaft twenty-four speeds can thus be obtained. The countershaft speeds are so selected that two consecutive speeds can be obtained on the same step of the driving cone pulley by simply shifting the countershaft speed. The total speed ratio is 45 to 1, the ratio between any two speeds with a one-speed countershaft being 1.4 to 1.

The feed-rod and lead-screw are reversed by the handle shown at the left end of the head in Figs. 1 and 2. It will be seen that there are two slots for the reverse handle, connected by a cross-slot. The object of this is to make it possible to engage gears either with a gear keyed to the spindle or to the cone pinion, as indicated in Fig. 2. Hence the cone gear can be used directly for driving the change gears in certain cases, and in this way three different pitches of screw threads can be cut with the same change gears. For example, suppose that the lathe is geared for cutting a screw of one-inch pitch, when the tumbler gear is engaged with the gear on the spindle. By shifting the lever so that the tumbler gear engages with the cone gear, we would cut a 4-inch or 16-inch pitch screw, according to which set of back-gears was thrown in. Hence it is apparent that the size of the change gears can be kept within reasonable limits with this arrangement and yet screws of unusual lead can be cut. In fact, a screw of 26 inch lead has been cut on a lathe of this type without difficulty. It is also possible to remove more metal per hour by a double back-geared lathe than is possible with a lathe using a much larger cone and single back-gearing, and the belt is much easier for the operator to handle.

The bed is of a complete box section as will be seen from Fig. 4, making it from four to twelve times as strong to resist twisting moments as an ordinary lathe bed section of the girder type. Holes are provided in the bed for the chips to drop through, and in addition the bed is provided with some features of especial value, the principal ones of which are the front or "narrow" guide for the carriage, and the locking arrangement for the tailstock, both of which features are protected by patents. It will be seen that the front or narrow guide is entirely removed from chips and dirt and

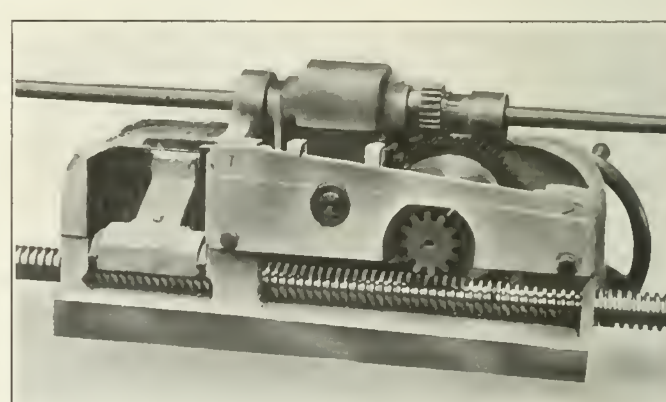


Fig. 3. View of Apron Upside-down and Reversed, showing Construction

that it is directly over the lead-screw and feed-shaft, hence eliminating any tendency of cross binding in the carriage. It may be mentioned, as illustrating how freely the carriage moves, that in the 16-inch lathe of the same type as that il-

* Address: 26 Ashleigh St., Keighley, York, England.

† This feature is not new, however, as such an arrangement was used on a Putnam lathe many years ago.—EDITOR.

lustrated, the carriage can be pushed along the bed by hand when under working condition.

Fig. 4 shows how the locking of the tailstock on the bed is effected. When the bolts are tightened the bracket is drawn up on the beveled surface and clamps the tailstock securely. The base of the tailstock is so arranged that it is always drawn tightly against the back square edge of the bed, which is subjected to no other wear, thus securing permanency of alignment with the headstock. In the ordinary English lathe, as well as in many lathes of other than English construction, the tailstock is fitted between the ways of the bed and hence the locating surfaces are subjected to a considerable amount of wear as the head is moved along the bed. The tailstock in the lathe described is provided with a side adjustment for taper turning, as shown.

Since the carriage, as stated before, is provided with a guide in the front, the usual back-wing for the carriage is unnecessary. It is rigid under the heaviest cut, the headstock being set well back so that the strain of the cut falls entirely within the bed. Six rates of feed are provided—4, 8, 12, 16, 24 and 48 per

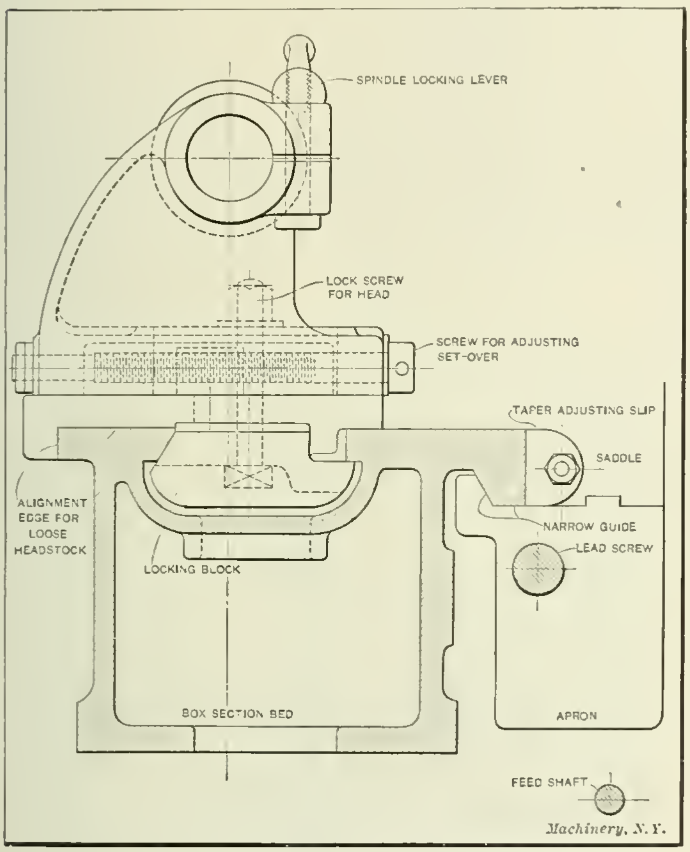


Fig. 4. Section of Bed and End Elevation of Tailstock

inch—which are obtained through a feed gear-box. This gear-box has a spring key operated by the handle on the dial, and a double gear operated by a small handle, both of which are shown in Fig. 1. The feeds are engaged from the apron by means of a knob shown near the screw-cutting handle. The knob is connected with a drop worm running in an oil bath, the thrust of the worm being taken by ball thrust washers. As shown in Fig. 3, the shafts in the apron have a double bearing. The lead screw and feed-rod can be engaged at will, and the machine is, of course, so designed that they cannot both be in gear at the same time.

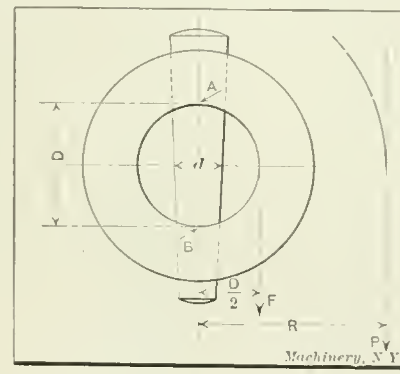
The following examples of work that can be done on this lathe under ordinary working conditions may be of interest. The figures have been supplied by one of the customers of the builders. A steel shaft, 0.25 per cent. carbon, 6 inches in diameter, was reduced to 5⅜ inches with a cutting speed of 60 feet per minute and a feed of ¼ inch per revolution. The reduction in weight per minute was 11.3 pounds. A shaft 5⅜ inches in diameter was reduced to 4½ inches with a cutting speed of 81 feet per minute; the feed per revolution was 1/12 inch, and the reduction in weight was 7.7 pounds per minute.

SHEARING STRENGTH OF TAPERED PINS

By J. H. C.

Frequently in using tapered pins the shearing strength must be looked into. The following shows the derivation of formulas necessary to do this. These formulas are found in convenient terms and may be useful to those using this style of pin.

In the illustration the external force F, tending to shear the pin at points A and B is $\frac{2\,PR}{D}$



Shearing Strength of Tapered Pins

$$\text{For } PR = \frac{FD}{2} \text{ or } F = \frac{2\,PR}{D}$$

and the internal force $= 2\,(0.7854d^2\,S)$ where $S =$ unit working stress.

Equating internal and external forces.

$$\frac{2\,PR}{D} = 2 \times 0.7854d^2\,S$$

$$\text{or } S = \frac{1.27\,PR}{Dd^2} \qquad (1)$$

$$\text{and } d = 1.13\sqrt{\frac{PR}{DS}} \qquad (2)$$

(1) and (2) being formulas in terms of resisting moment, D and S.

Number of horsepower (HP) transmitted around circle of R radius equals $\frac{\text{foot-pounds per minute}}{33000}$.

Number of foot-pounds transmitted around circle of R radius equals $P\,\frac{2\,\pi\,R}{12}\,N$

where $N =$ revolutions per minute or $HP = \frac{PR\,\pi\,N}{6 \times 33000}$

$$PR = \frac{6 \times 33000\,HP}{\pi\,N} = \frac{63025\,HP}{N}$$

Substituting in (1) and (2)

$$S = \frac{1.27}{Dd^2} \times \frac{63025\ HP}{N}$$

$$\text{or } S = \frac{80000\ HP}{NDd^2} \text{ (nearly)} \qquad (3)$$

$$\text{and } d = 283\sqrt{\frac{HP}{NDS}} \qquad (4)$$

formulas (3) and (4) being in terms of horsepower transmitted, N, S and D.

Examples

1. A lever secured to a 2-inch round shaft by a steel tapered pin, whose dimension $d = 3/8$ inch, has a pull of 50 pounds at a 30-inch radius from shaft center. To find S, the unit working stress on the pin, substituting numerical values in formula (1)

$$S = \frac{1.27\,PR}{Dd^2} = \frac{1.27 \times 50 \times 30}{2 \times (\frac{3}{8})^2} = 6773$$

pounds per square inch (nearly) which is a safe unit working stress for machine steel in shear.

2. Again as in the above, let $P = 50$ pounds, $R = 30$ inches, $D = 2$ inches and $S = 6000$ pounds unit working stress. Using formula (2) to find d

$$d = 1.13\sqrt{\frac{PR}{DS}} = 1.13\sqrt{\frac{50 \times 30}{2 \times 6000}} = 1.13\sqrt{\frac{1}{8}} =$$

0.4 inch diameter (nearly). Say $d = \frac{3}{8}$ inch.

3. A ½ horsepower motor pinion meshes into a gear wheel running at 100 revolutions per minute. A tapered pin whose d dimension equals ¼ inch, passes through the gear and a 1-inch round shaft. To find S, the unit working stress, using formula (3)

$$S = \frac{80000\,HP}{NDd^2} = \frac{80000 \times (\frac{1}{2})}{100 \times 1 \times (\frac{1}{4})^2} = 6400$$

pounds per square inch, unit working stress.

4. Using the same conditions to find the average diameter of pin, with a working unit stress S, equal to 6000 pounds, using formula (4),

$$d = 283\sqrt{\frac{HP}{NDS}} = 283\sqrt{\frac{\frac{1}{2}}{100 \times 1 \times 6000}} =$$

$$283\sqrt{\frac{1}{1{,}200{,}000}} = 0.258. \quad \text{Say } d = \tfrac{1}{4} \text{ inch.}$$

* * *

INDUSTRIAL ACCIDENTS AND EMPLOYERS' LIABILITY

In an editorial comment on industrial accidents, the *Practical Engineer*, London, in its issue of October 28, states that the average annual expense per capita in the metal trades in England for an efficient system of insurance against accidents has been estimated at about one-half cent a day, or a trifle more. It is also mentioned that a satisfactory feature of the working of the law in Great Britain has been the increase of the number of compensation disputes settled out of court, the compensation having been arranged directly between the parties interested in accordance with the law, thus avoiding delay and saving the expense of litigation. The primary principle upon which employers' liability laws rest is, of course, that the particular industry in which any accident occurs should bear the financial responsibility of the accident. It is not intended that the employer personally is to bear the expense, nor will the enforcement of the law work out in practice in that way. It is the industry as such, not the employer, that will bear the expense.

In this connection it is of interest to note the opinion stated by Mr. W. B. Dickson, first vice-president of the United States Steel Corporation, in a paper entitled "The Betterment of Labor Conditions in the Steel Industry," which paper was read before the American Iron and Steel Institute in New York City. "Personally," said Mr. Dicksou, "I believe that compensation to injured workmen is a legitimate charge against the cost of manufacture, and that the victim of an industrial accident, or his dependents, should receive compensation, not as an act of grace on the part of his employer, but as a right."

* * *

Some of the smaller European towns of economical habits, says the *Scientific American*, have been complaining because they are obliged to light their streets all night for the benefit of a few belated citizens, and have been trying to discover a method whereby the citizen who needs to have his pathway lighted in the small hours of the night shall pay the costs himself. On one of the streets of a small German town, such a system has actually been put into operation. The street is a little over half a mile long, and is provided with nine lamps. At each end of the street is a penny-in-the-slot machine, and whenever anyone wishes to light up the street, he has merely to drop in a ten-pfennig piece (2½ cents), which turns on the current for twelve minutes. This allows him ample time (in the majority of cases, we presume) to walk the length of the street. The street is normally lighted until 10 o'clock. Thereafter the prepayment meter must be resorted to.

* * *

When you think you are at the top of the ladder in your trade, don't stop self-satisfied—just holler for more ladder.

THE RAVIGNEAUX MANOGRAPH

By W. F. BRADLEY*

There are some distinctive features in the manograph designed by M. Ravigneaux for testing internal combustion motors. Communication between the cylinder under test and

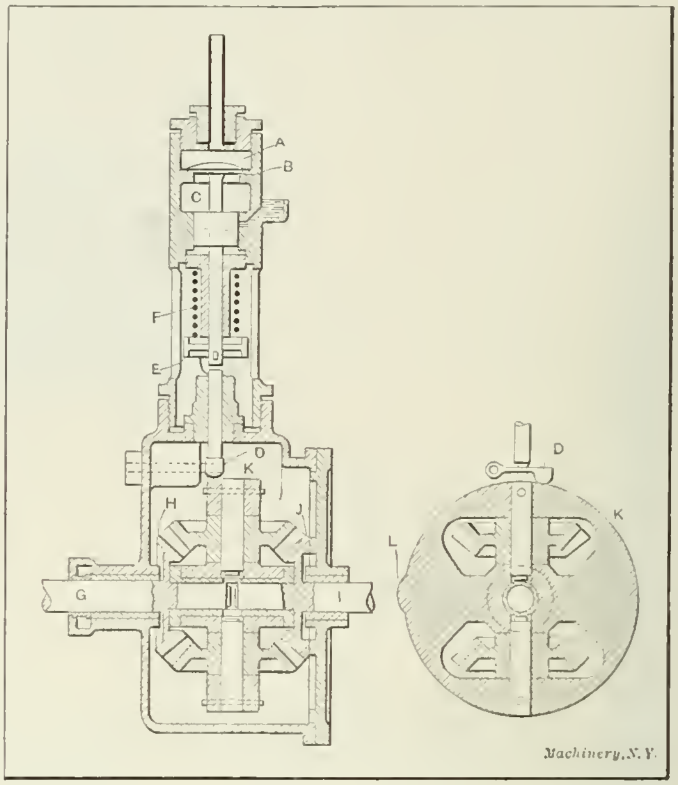


Fig. 1. Section of the Ravigneaux Manograph, showing Principal Working Parts

the pressure indicator is normally intercepted by the balanced valve B, shown in the line engraving Fig. 1. The valve can be raised by the finger D operated by the lobe L on the drum

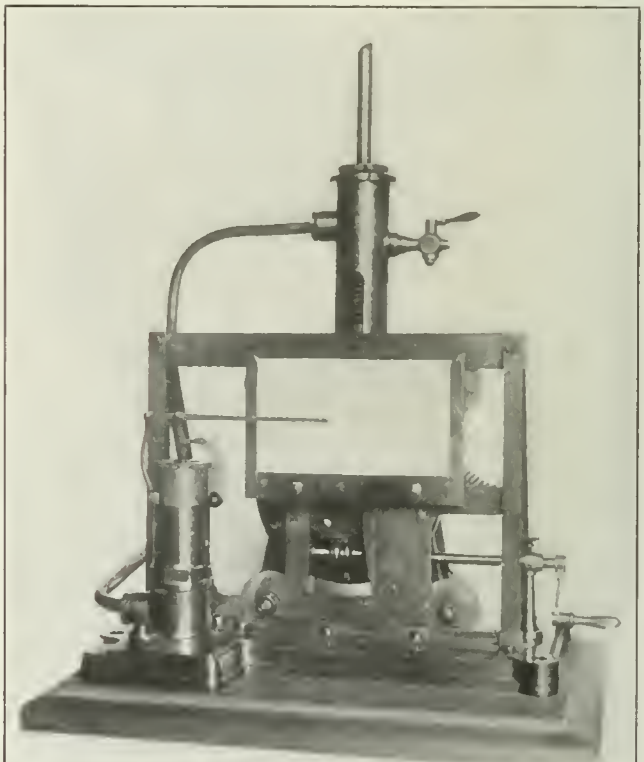


Fig. 2. Front View of the Manograph, showing Method of Obtaining Indicator Diagram

K. This drum is driven by a differential gear operated through shaft G coupled to the motor shaft. Through the shaft I it is also capable of being turned by hand at the will

* Address: Box 27, Times Square Station, New York City.

of the operator. If the shaft I is locked, the differential gear, and in consequence the drum K, will revolve at half the motor speed. The valve B is thus raised once during every cycle, and always at the same point of the cycle, putting into communication the chamber C, communicating with the cylinder, and the chamber A, communicating with the pressure indicator.

If the shaft I is turned a certain distance, the opening of the valve occurs in an advanced or retarded position in relation to the original position of the shaft. By means of a crank and a connecting-rod, the shaft I operates a frame fitted with a diagram card having a horizontal motion in relation to the point of the recording needle. (See Figs. 2 and 3.) The apparatus is set so that when the lobe L is under the push-rod and the valve is raised, the positions of the piston and of the indicator card are correlative.

It is evident from this that for a given position of the indicator card, and also of the piston, the valve is raised and the indicator shows a certain pressure which will be preserved throughout the cycle, that is, until the valve is again raised. If the frame is moved during this time, the point of the indicator will trace a straight line on the card. When the valve is opened again, a sudden change of pressure takes place and the indicator traces a vertical line. The extremity of this line is evidently a point on the indicator diagram. By turning the shaft I very slowly, it is possible to obtain closely located points of pressure, or a practically continuous line. In short, the use of the differential gear allows the opening of the valve at any known point of the stroke of the piston, the indicator card at this moment occupying a position in correlation to that of the piston. This, of course, is all that is required for obtaining a correct indicator diagram.

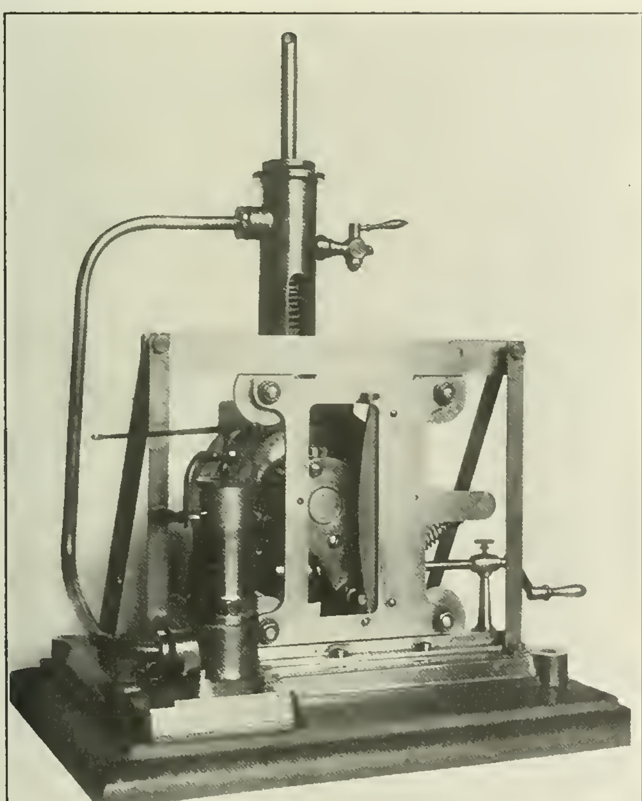


Fig. 3. Front View of Device, showing how Motion is transmitted to Frame on which Indicator Diagram is mounted

[The device described in the foregoing is noteworthy because it makes possible the tracing of a very accurate indicator diagram, and overcomes the great difficulty inherent in most indicators because of the inertia of the moving parts. No matter how light the lever arm holding the indicating point and its connections are made, the rapid motion of the indicator point, when under the sudden action of the pressure from the cylinder gives it a "fling," that is, makes it move further than it should in order to correctly indicate the pressure. In the apparatus just described the individual movements of the indicating point are so small that the inertia of the moving parts may be disregarded, and a diagram which truly represents the average pressure conditions in the cylinder for a large number of strokes, is traced on the indicator card. Another feature of interest is the simple method used for imparting a motion to the frame holding the indicator

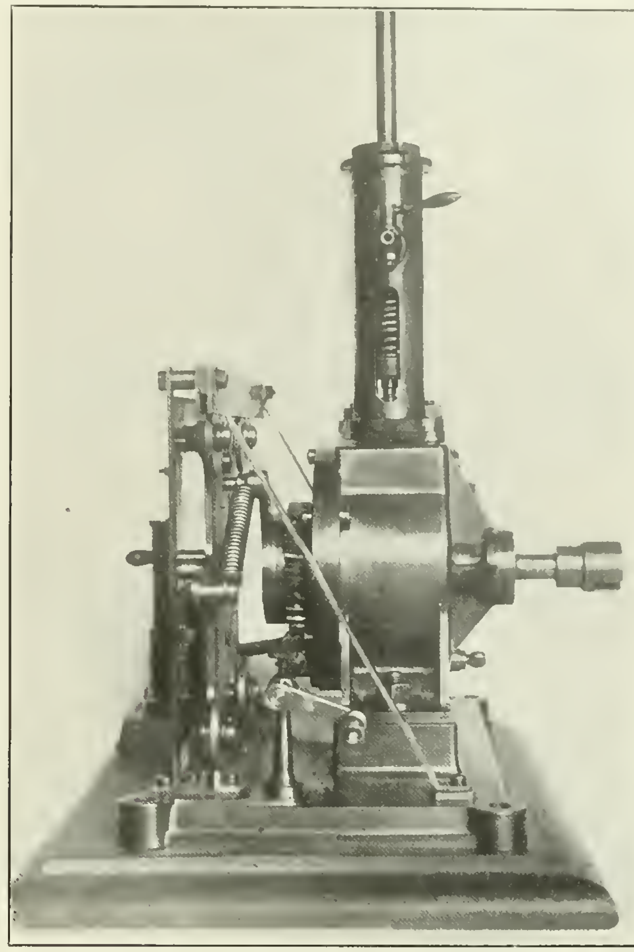


Fig. 4. A Side View of the Manograph

card which corresponds accurately with the motion of the piston. As will be seen in Fig. 3, the frame is operated by a pin on the end of a crank working against a cam surface, which is curved so that the motion imparted by the hand-operated crank is modified to agree with the motion of the piston at every point in the stroke.—EDITOR.]

* * *

Isaac Smith Remsen, president of the I. S. Remsen Mfg. Co., Brooklyn, N. Y., who died October 13, has provided in his will that as "a certain amount of success in general business is due to faithful employes, they are entitled to a share of the assets which have naturally been increased by their cooperation." Therefore, the officers and employes of the company have been left certain sums to be reckoned as follows. After one year's service and up to five years, \$100 for all or a portion of the first five years' service; after five years' service the sum of \$50 per year up to ten years; after ten years, \$100 per year for the entire length of further continued service, no fraction of years to be allowed. The company was formed in 1890 and is thus twenty years old. It builds wagons and manufactures automobile accessories.

* * *

According to the specifications of the United States Navy Department, high speed tool steel furnished to the department must have the following chemical analysis: tungsten, from 18.5 to 19.5 per cent; chromium, from 5.25 to 6 per cent; vanadium, from 0.1 to 0.35 per cent; carbon, from 0.55 to 0.75 per cent; the manganese content must not exceed 0.15 per cent; silicon not more than 0.11 per cent; phosphorus not more than 0.02 per cent; and sulphur not more than 0.02 per cent. There must be no other impurities, and particularly not molybdenum.

DESIGN OF AUTOMOBILE TRANSMISSION GEARS—2*†

By M TERRY‡

Let I = polar moment of inertia of a square,
y = distance from the center of the square to extreme fiber, in inches,
h = side of the square, in inches,
z = polar section modulus.

$$I = \frac{h^4}{6} = (2 \times \frac{1}{12} h^4 = \text{twice the moment of inertia in bending}).$$

$$y = \frac{h}{\sqrt{2}} \text{ (Fig. 7).}$$

$$z = \frac{I}{y} = \frac{h^4}{6} \times \frac{\sqrt{2}}{h} = \frac{\sqrt{2}}{6} h^3 = 0.236\, h^3.$$

This value of z is true only as a mathematical proposition.

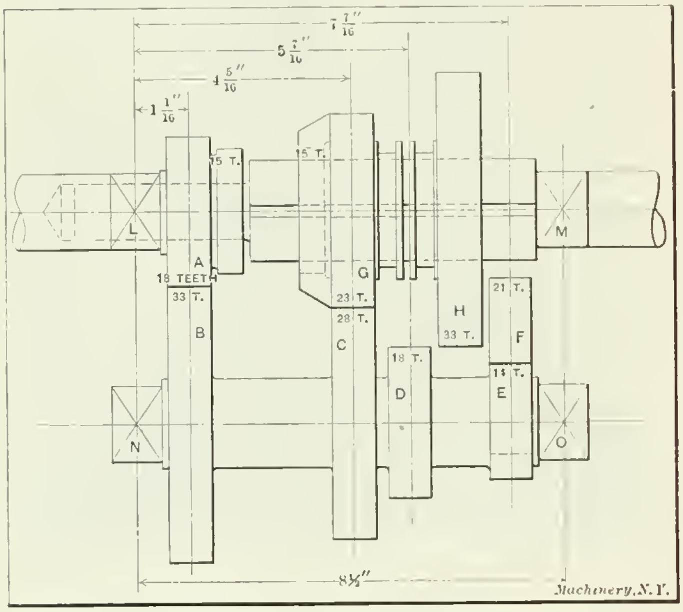


Fig. 2. Typical Automobile Transmission Gear of Sliding-selective Type (Reproduced from October issue)

When shafts of other sections than circular are used in torsion, the stresses existing in them are quite complex, and not subject to simple calculations. (See Report of Chief Engineers, U. S. A., for 1895, p. 3041, part IV.)

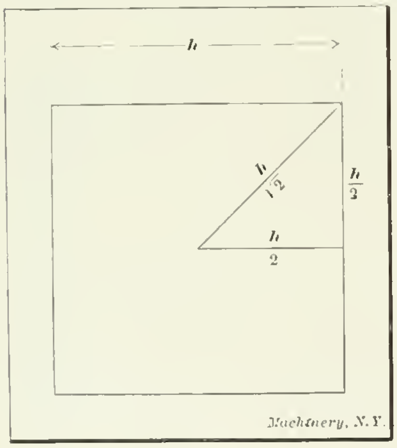


Fig. 7

Hütte & Freytag give the value of

$$z = \frac{2}{9} h^3 = 0.222\, h^3$$

American practice puts the value of z at $0.208\, h^3$. Since the extreme edges of square shafts used in automobile transmissions are invariably trimmed off, the value of z probably does not exceed $0.200\, h^3$. To find the size of section of the square shaft, apply the following formula:

$$T_E = zf = 0.200\, h^3.$$

Where T_E = 11,390 inch-pounds = equivalent torsional moment on slow speed.

and f = safe unit stress = 13,000 to 15,000 pounds per square inch.

$$h = \sqrt[3]{\frac{5\, T_E}{f}} = \sqrt[3]{\frac{5 \times 11{,}390}{14{,}000}} = 1\tfrac{5}{8} \text{ inch. } (A, \text{Fig. 8.})$$

If a splined shaft is to be used, the keys may be assumed to take the shear and the shocks and the remaining circular part of the shaft to resist torsion and bending. Since

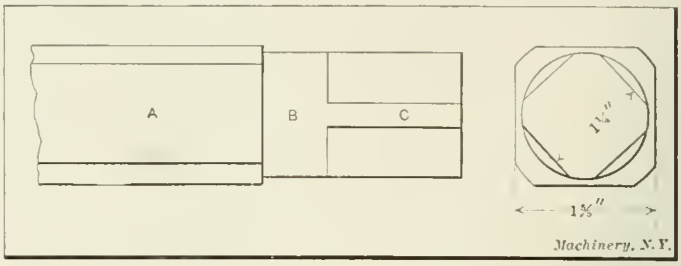


Fig. 8. Typical Automobile Transmission Squared Shaft

the polar section modulus of a round shaft = $0.196\, d^3$ (d = diameter) as compared with $0.200\, h^3$ of a square shaft, the diameter of the main part of the spline shaft will be 1⅝ inch. The keys are usually made by proportion.

In Fig. 8 B represents a journal of a square shaft on which a ball bearing is to be mounted. In addition to their radial load, the bearings employed in transmission are often required to carry a certain amount of thrust load which owes its origin either to the tension of the clutch spring, or angularity of the universal joint or to the driver's effort in shifting gears. The existence of this thrust makes it imperative that A should form a shoulder for B, or, in other words, B must be smaller than A. The end of the shaft, C, is again squared off and fitted into the driving member of the universal joint. In

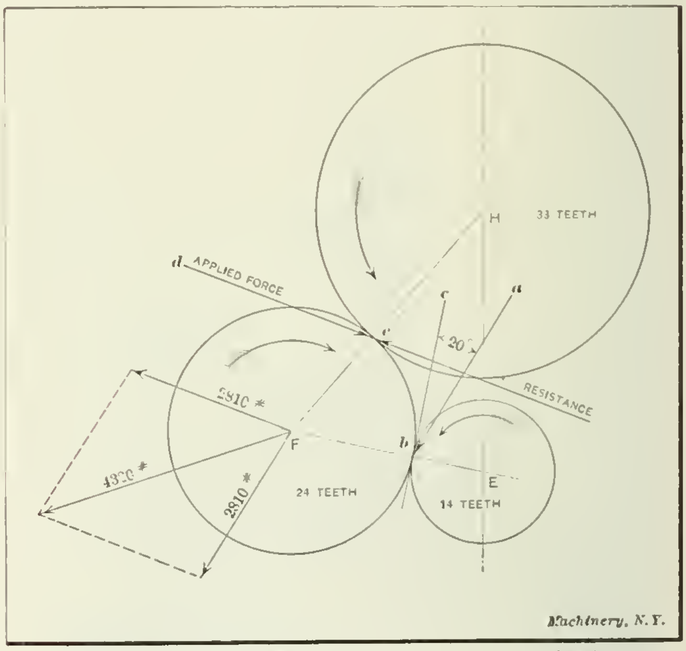


Fig. 9. One of Two Possible Arrangements of Reverse Gearing

order to permit of mounting a ball-bearing on the journal B, C must of necessity be smaller than B. It is clear that C is not subject to the bending moments which exist in A, as explained in the October installment, and consequently C must be designed to transmit merely the twisting moment on the slow speed.

M_T = 5650 inch-pounds. (See Table II.)
f = 13,000 to 15,000 pounds per square inch, safe fiber stress,
h_1 = side of the square C, in inches.
$M_T = 0.200\, h_1^3\, f$.

$$h_1 = \sqrt[3]{\frac{5\, M_T}{f}} = \sqrt[3]{\frac{5 \times 5650}{14{,}000}} = 1\tfrac{1}{4} \text{ inch.}$$

Bearing Pressure.—Postponing for a while all questions relating to the secondary shaft we shall presently turn our attention to the matter of bearing pressures. The first thing

* The first installment of this article appeared in the October number.
† An error appeared in the title of Table II, published in the October installment of this article. Instead of "Twisting and Bending Moments and Tangential Pressures in Transmission," it should read "Twisting and Bending Moment and Bearing Reactions in Transmission." EDITOR.
‡ Address: 302 Williams St., Flint, Mich.

to settle is the location of the idler gear. Perhaps many readers of this article were never directly connected with the automobile industry and never owned a car. For the benefit of such it may be stated that the vast majority of automobile engines are incapable of reversing (except when they "kick"), *i.e.*, they always turn either in a right-hand or left-hand direction. To provide for the reverse motion of the car, an idler gear is placed between the secondary and primary shafts. The pitch circle of the idler gear *F*, Fig. 9, must be tangent to the pitch circles of the gears *E* and *H*. There are two positions in which the idler gear can be tangent to the

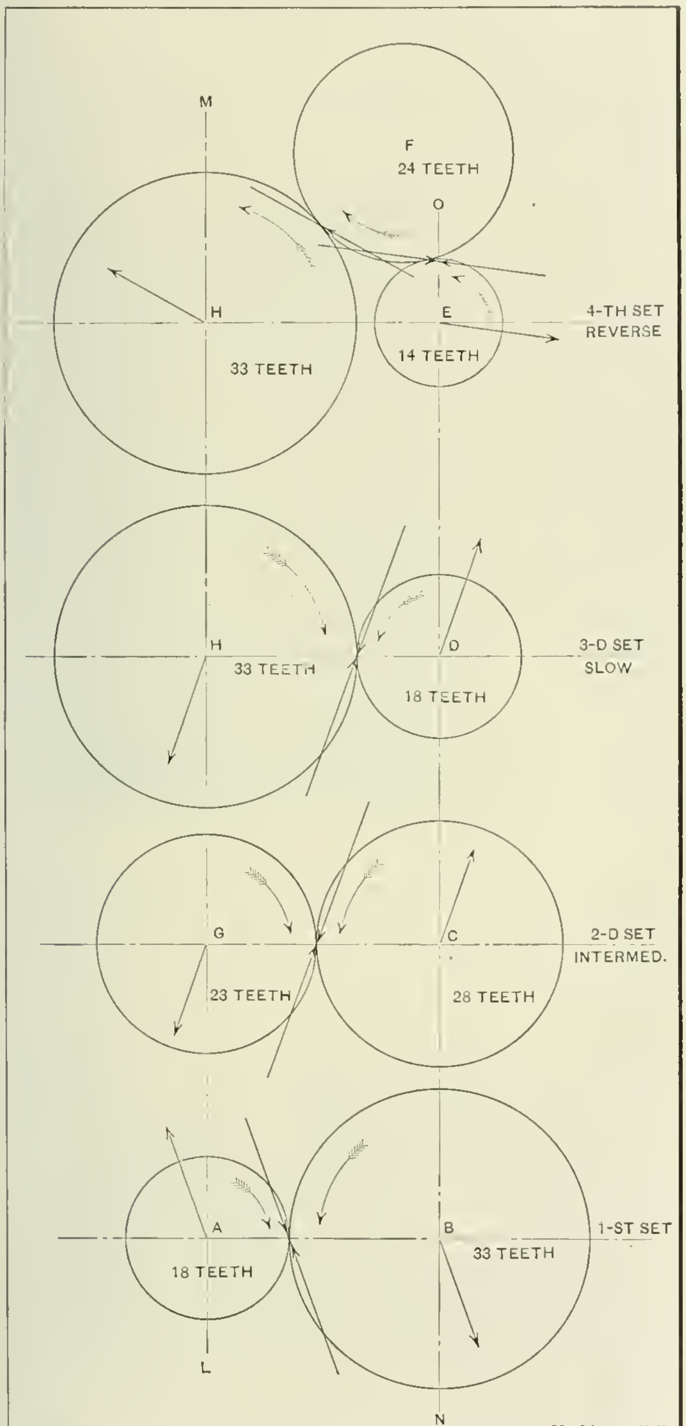


Fig. 10. Diagram of Automobile Transmission Gears

other two gears, and one position is correct while the other is wrong.

Figs. 9 and 11 represent the two possible arrangements of the three gears as they would appear to an observer stationed in front of the car. The engine turns in a right-hand direction. The secondary shaft, of which *E* is an integral part, turns in a left-hand direction (see Figs. 2 and 10).

Considering *E* and *F* first, *E* is the driver and the pressure takes place along the line *a-b*, making an angle of 20 degrees with the line *c-b*, which is perpendicular to the line of centers. The pressure is transmitted unchanged in amount and direction to the bearing of the idler gear *F* (as explained in the October installment, Fig. 3). This pressure is equal to

$$\frac{\text{Torque on secondary shaft}}{\text{Radius of } E \times \cos 20^\circ} = \frac{3080}{1/2 \times 14/6 \times 0.93969} = 2810$$

pounds.

F being an idler transmits equal pressure to *H* along the

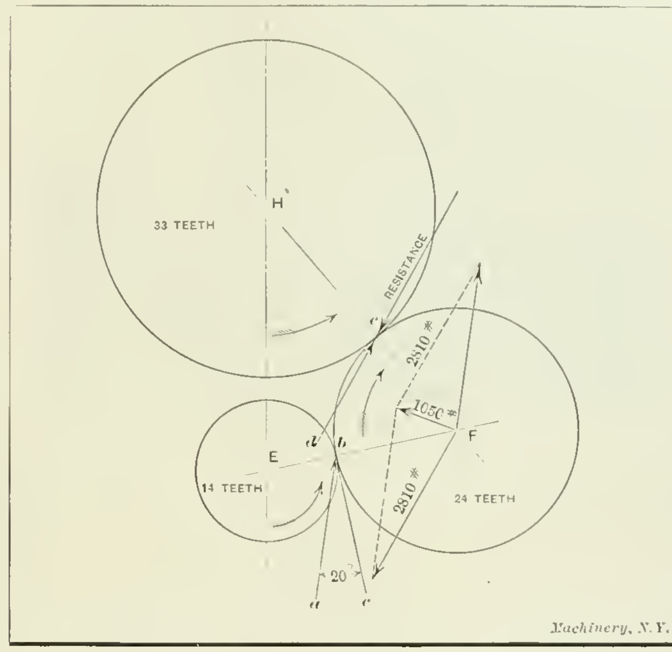


Fig. 11. Arrangement of Reverse Gearing Giving Least Pressure on Bearings

line *d-e*, which is balanced by an equal and opposite force due to the resistance of *H*. This resisting force produces a pressure on the idler gear bearing as explained before. Thus, the idler gear bearing is subject to two equal pressures making an angle with each other. In Fig. 9 the angle is such as to

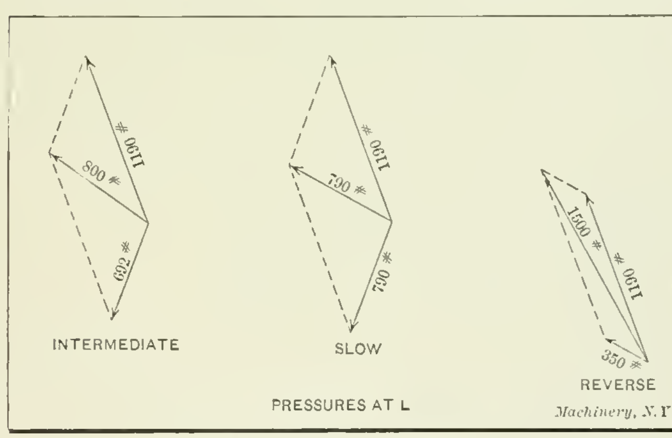


Fig 12. Resultant of Pressures

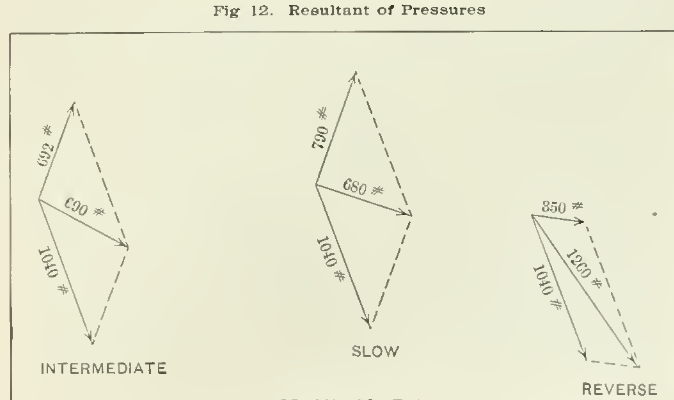


Fig. 13. Resultant of Pressures

make the resultant of the two pressures equal to 4320 pounds. In Fig. 11 the resultant is only 1050 pounds. It is needless to add that Fig. 11 represents the correct position of the idler gear.

Referring to Fig. 2 it will be noted that the distance L-M is the same as N-O. These were made equal merely to simplify the case, as the pressures at L and M then (Table 11) become identical with those at N and O. These pressures are produced by either C and G or D and H or by E-F-H. But, with the exception of direct drive, there are always two sets of gears engaged in transmitting power from the clutch to the universal joint, the first set consisting of gears A and B, which are in mesh on all speeds.

As before, the torque of the engine shaft as well as of the gear $A = 1680$ inch-pounds.

Pitch radius of $A = 1/2 \times 18/6 = 1\frac{1}{2}$ inch.

$$\text{Tangential pressure} = \frac{1680}{1.5} = 1120 \text{ pounds.}$$

$$\text{Total pressure} = \frac{1120}{\cos 20^\circ} = \frac{1120}{0.93969} = 1190 \text{ pounds.}$$

$$\text{Pressure at } O = \frac{1190 \times 1\ 1/16}{8\frac{1}{2}} = 150 \text{ pounds, about.}$$

Pressure at $N = 1190 - 150 = 1040$ pounds.

This pressure of 1040 pounds at N exists in addition to 692 pounds on intermediate speed, 790 pounds on slow, and 350

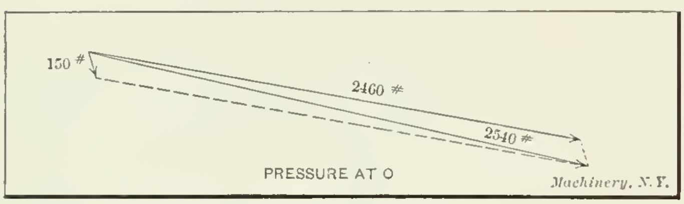


Fig. 14. Resultant of Pressures

pounds on reverse. The same is true of O. At L the ball-bearing supports the gear A, which, in turn, affords a support for the square shaft, making the case identical with N and O. M, however, is subject to only one pressure at a time, since the pressure on the gear A (1190 pounds) is borne entirely by the ball bearing at L.

Fig. 10 is a diagrammatic representation of transmission gears. Curved arrows indicate direction of rotation of gears. Straight arrows at the points of tangency represent direction of applied and resisting pressures, while those at the gear centers represent the direction of bearing pressure.

In Figs. 12, 13 and 14, these bearing pressures are combined geometrically. To tabulate the results:

Maximum pressure at L = 1500 pounds.
Maximum pressure at M = 2460 pounds.
Maximum pressure at N = 1260 pounds.
Maximum pressure at O = 2540 pounds.
Maximum pressure on reverse idler gear bearing = 1050 pounds.

* * *

The House of Representatives of Australia adopted last August by a vote of 35 to 2 a resolution pledging the Government to seek the approval at the next Imperial Conference of the adoption of metric weights and measures throughout the British Empire. The resolution further provides that if this proposition is not adopted, the Government will proceed with the consideration of this reform in Australia, and invite the cooperation of New Zealand. The Russian Government has also prepared a proposition for the introduction of metric weights and measures in Russia. That country is the only one of importance outside of the English-speaking nations, that has not adopted the metric system.

* * *

The taxes on automobiles in Great Britain are determined according to the horsepower, on a rising scale. A car not over $6\frac{1}{2}$ horsepower pays about \$10 a year, while a machine of from 35 to 40 horsepower pays a trifle over \$50, and one of from 40 to 60 horsepower, slightly over \$100 a year. Automobiles with engines rated at over 60 horsepower are taxed at the rate of \$202.70 a year. Of the revenue raised by this tax, a part is to be devoted to road improvements.

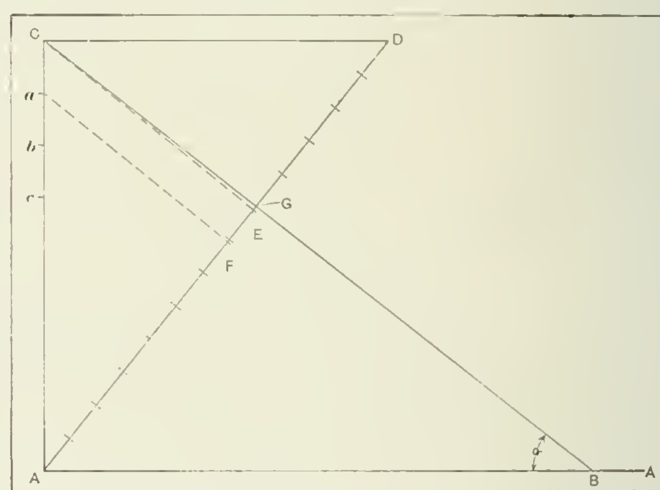
GASHING SPIRAL FLUTED HOBS

By ALPHA

In making worm-wheel hobs of small diameter and of a long lead, it is impossible to get good results in hobbing, if the hob is made with straight flutes, because one side of the teeth will have a drag cut.

There is one objection, however, to spiral flutes with the gash at right angles to the thread, and that is, there is more or less trouble encountered in clearing or backing-off the hob, as the hob-tool will have to advance and drop off in one revolution of the hob, for a different number of flutes than there are in the hob. In fact a hob gashed at right angles to the thread invariably figures out in fractional parts of a flute, as 8.623. If, however, the gashing is changed slightly, it is possible to get a whole number of flutes. The accompanying illustration shows how to plan the gashing graphically.

First, lay off a base line A-A of any convenient length. Then erect the perpendicular A-C making it equal to the developed length of the pitch circumference of the hob. From C draw line C-D parallel to the base line A-A and of a length equal to the lead of the hob. Now draw diagonal A-D which represents the thread. Divide A-C into as many equal parts as there are flutes in the hob, as a, b and c. From C and a draw lines through and at right angles to the diagonal A-D, as C-E and a-F. Then length E-F equals the pitch of the flutes on the thread when the gashing is at right angles to the thread. To proceed, divide A-D into a certain number of equal parts, the length of these parts to be as near to the length E-F as possible. Step off these divisions on A-D, and through the division nearest to E, as at G, draw a line from C to the base line intersecting the base line at B. This line C-B represents the gash, line A-B the lead of the gash, and the number of divisions in the line A-D equals the number of



Graphical Method of Finding Gashing Angle and Number of Flutes for which Backing-off Attachment should be set for Spiral Fluted Hobs

flutes to one revolution of the hob, for which we must gear the machine.

To get the exact length of A-B, divide the number of divisions in A-G by the number of divisions in G-D and multiply the result by the length of the line C-D or the lead of the hob. The angle α which is the angle for gashing can be found by scaling the diagram. For example, let the hob be 2 inches pitch diameter, lead 5 inches, and number of flutes 8.

We first draw base line A-A, and the line A-C 6.28 inches long which is the pitch circumference. Now draw C-D 5 inches long, and then draw line A-D. We now divide A-C into eight equal parts and draw lines from C and a through and at right angles to A-D, intersecting A-D, at E and F. Setting the dividers to length E-F we step off line A-D and find that this length E-F will go into A-D a little over thirteen times; so we divide this line A-D into thirteen equal parts. It is now necessary to gear the machine for thirteen flutes to one revolution of the hob.

The division nearest to E is G, so by drawing a line from C through G we intersect the base line at B. In the line G-D

there are five divisions, and in the line A-G there are eight divisions. The lead of the hob is five inches, so that the length of the lead for the gash or A-B is $\frac{8}{5} \times 5 = 8$ inches. By scaling the diagram we find the gashing angle is 38¼ degrees. Therefore, we will gear the machine used in backing-off the hob for 13 flutes to one revolution, and we will gear the milling machine to cut a lead of 8 inches, and at a gashing angle of 38¼ degrees.

* * *

ORNAMENTAL LATHE WORK

By JOHN PEDDIE*

For wasting time which might be profitably devoted to studying Differential Calculus, or otherwise qualifying for a post as moral instructor in a rolling mill, a lathe is as good as anything. Mine is a No. 5 Barnes lathe, having an 11-inch swing to which has been added an overhead works as shown in Fig. 1.

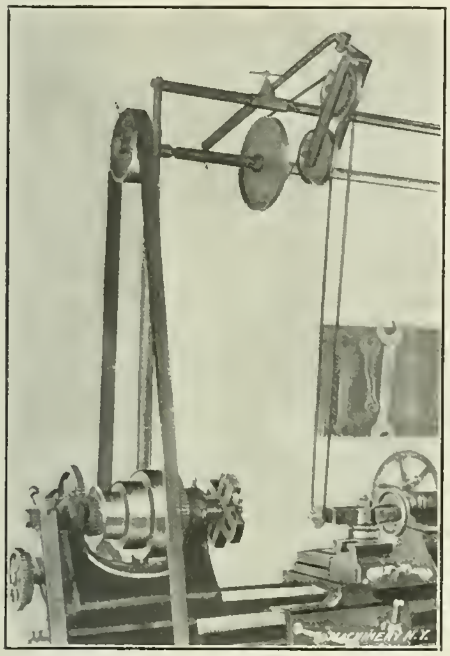


Fig. 1. No. 5 Barnes Lathe Fitted with Special Overhead Works

While a man may be content to use a lathe for nothing else than making foolish trifles called tools, or equally ridiculous masses of mechanism, it is sometimes wise in the interests of domestic felicity to prove to his better half that a lathe is not merely an expensive toy, but a really useful and beneficial invention which enables him to make pretty things for the house, similar to those shown in Fig. 2. These are all made of native New Zealand woods—Kauri and Ironwood, and the simple ornamentations shown on them were produced by means of the drilling spindle shown in

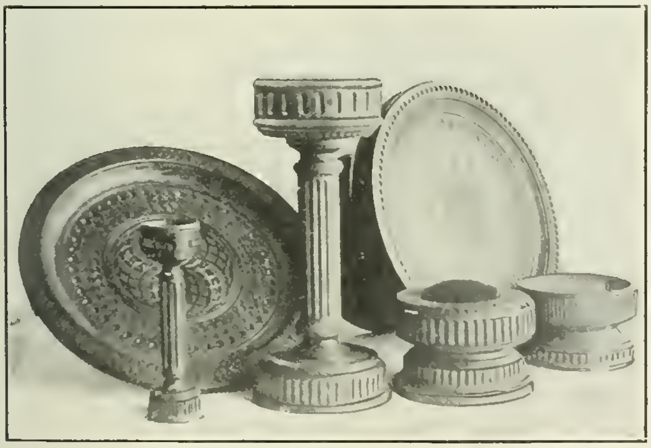


Fig. 2. Ornamental Work Performed on the Lathe with the Attachments shown

position in the toolholder in Fig. 1. The drills were made from steel wire about 3/16 inch diameter, being made straight or bent into crank form as required. The indexing was done as shown in Fig. 3, using suitable change gears as dividing plates. As this method of indexing was somewhat imperfect owing to possibility of play on the key, the writer recently made a division plate which will go on the end of the spindle in the same way as the change gears, and which has a spring index arm attached to the same fastening. To prevent play on the key, the hub of the division plate was made as shown in Fig. 4, the taper cotter with the nut on the threaded end, binding the key firmly.

*Address: Mataura Paper Mill, Southland, New Zealand.

Fig. 5 shows a division plate in process of being drilled. The method used is thought by some to be well known,

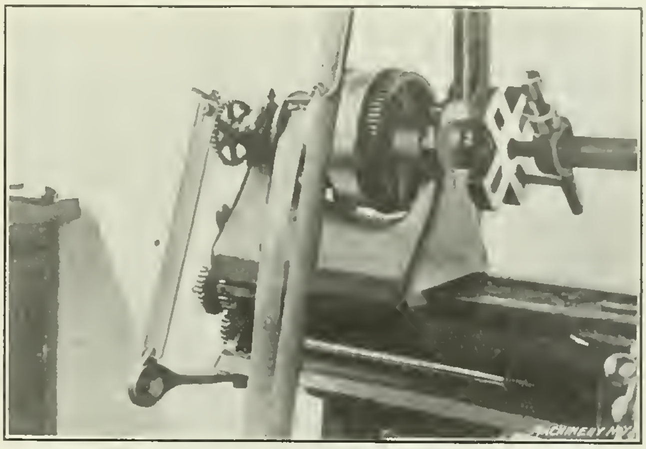


Fig. 3. Indexing Mechanism used in doing Ornamental Work

although the writer has only seen it described in "Hasluck's Lathe Work"; but in case any reader may be unfamiliar with this class of work, it might be well to mention that the

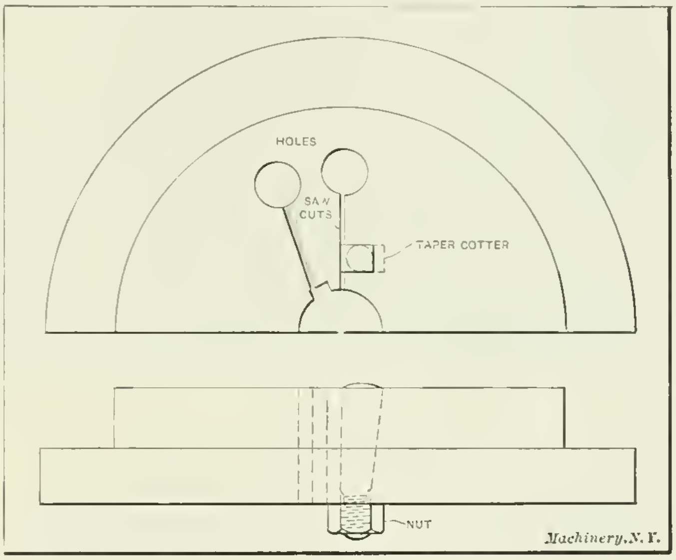


Fig. 4. Improved Indexing Attachment

plan consists in drilling a strip of steel, usually a clock spring, with as many holes as you propose to use in your largest circle. The holes are accurately spaced by means of a jig

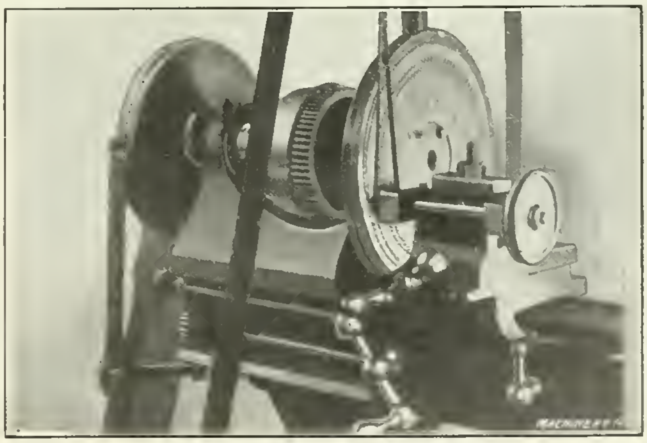


Fig. 5. How Division Plate is drilled

which has a pair of holes in it the required distance apart. This strip is then soldered to form a hoop, suitable precautions being taken to insure the pitch of holes at the joint being correct; it is then fitted on a temporary wooden disk on the lathe spindle, an index being arranged to fit the holes. When

this circle is drilled, the hoop is cut down to the next highest number of holes, again joined and fitted on the disk, and the process repeated until you have as many circles as you propose to drill.

This sort of work is not of much commercial value at the present time, but it provides a sort of romantic pleasure in repeating the work carried on by the early pioneers of lathe work. A better device than that given would be a worm-wheel to fit on the end of the spindle, with suitable means for indexing.

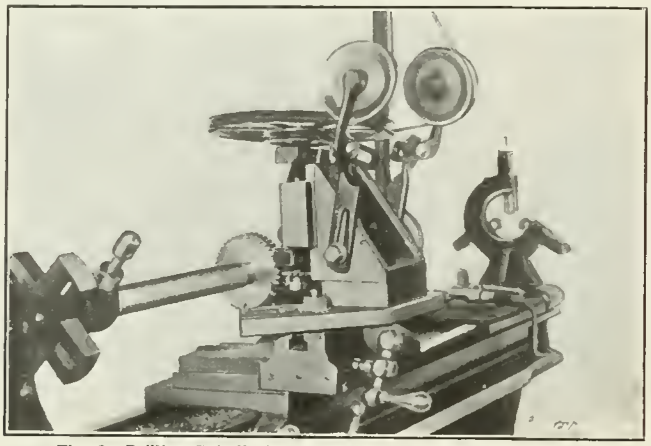


Fig. 6. Drilling Spindle in Process of Gashing a Worm-wheel

Fig. 6 shows the same drilling spindle which was used for the ornamental woodwork fitted on a vertical slide, in process of gashing a gunmetal worm-wheel of 1/4 inch pitch. A large grooved pulley has been temporarily fixed on the spindle, and with this drive the teeth were gashed quite easily.

* * *

LIMITATIONS IN DESIGN OF THE WÜST HERRINGBONE GEAR

By CHARLES AUGUSTUS

A type of herringbone gear lately brought out by C. Wüst of Subach Zurich, Switzerland, has been attracting much attention. A special machine has been developed for cutting the teeth, using two hobs located diametrically opposite which cut both of the gear faces simultaneously. They may be cut just as accurately, however, on a hobbing machine, on an ordinary universal milling machine, or on a spiral gear cutter if the proper form of cutter is provided and the proper indexing mechanism used.

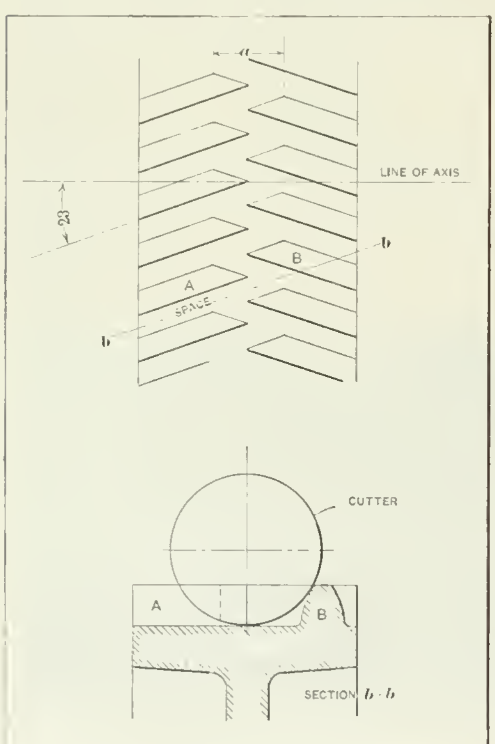


Fig. 1. Wuet Herringbone Gear of 23 Degrees

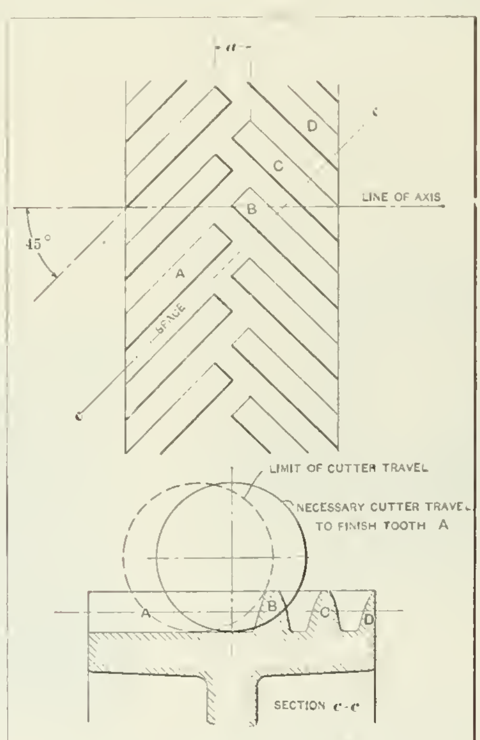


Fig. 2. Showing Action of Cutter at Angle of 45 Degrees

In cutting these gears it is necessary to stagger the teeth, so that the cutter or hob, on reaching the center of the face when cutting the left-hand spiral can enter the space of the right-hand tooth opposite. There is no other advantage in this. The trouble is that as the angle of the gear is increased, the diameter of the cutter must be reduced or it will cut into the teeth of the opposite hand before it can reach the center of the face and complete the space that it is cutting. As a matter of fact this type of gear is limited to a spiral angle approximating 23 degrees. A five diametral pitch gear containing five teeth, cut at an angle of 45 degrees with the smallest possible cutter could not finish the teeth to within five-eighths of an inch of the necessary distance without cutting into the opposite tooth. In Fig. 1 is shown the cutting of a gear of 23 degrees and in Fig. 2 one of 45 degrees, illustrating this point. It may be argued that this angle is sufficient. Perhaps it is under certain conditions, but not when the face is narrow and high speeds are required, for the steeper angle tends toward quiet operation, although it increases the wear of the teeth for a given load.

A groove turned in the center of the gear face is just as efficient, although not as unique in appearance. This groove, if not made wider than the distance *a* between the far ends of the Wüst teeth as in Fig. 1 does not reduce the face contact beyond that of the Wüst gear, as there is no contact inside the distance *a*. The only drawback is the extra cost of turning out the groove.

* * *

Some time ago the White Star Line placed two new liners in their Canadian service, the *Laurentic* and the *Megantic*. The *Laurentic* is equipped with a combination of turbine and reciprocating engines, while the *Megantic* is equipped with reciprocating engines exclusively. It was found during the trials of these steamships in regular service that with the same coal consumption the *Laurentic* developed a considerably higher speed, and with the same speed a decrease in coal consumption, amounting to as much as 14 per cent, was effected. This practical proof of the efficiency of a combination of turbine and reciprocating engines for the propulsion of steamships was the cause which induced the White Star Line to equip their new giant steamships, the *Olympic* and the *Titanic*, with a combination of reciprocating and turbine engines.

* * *

A model concrete cottage designed by Mr. Milton Dana Morrill, and which was awarded first prize in the competition of the National Congress for the Prevention of Tuberculosis for a sanitary, inexpensive home for workingmen, will be exhibited at the Cement Show to be held at the Madison Square Garden in New York, December 14 to 20. The house is inexpensive, light and airy, and fills all the requirements of a sanitary and moderate priced house. People who wax too enthusiastic about this house on account of its being so inexpensive, and, therefore, within the reach of workingmen, forget, however, that if houses of this type should become the rule, their cheap price would make the price of land rise in proportion, and as a house cannot be built unless there be a piece of ground on which to put it, the workingman would be just as far removed from the possibility of owning his home as ever.

A LARGE TOOL-ROOM AND ITS SYSTEM

METHODS EMPLOYED IN THE TOOLMAKING DEPARTMENT OF THE TAFT-PEIRCE MFG. CO.

By FRANKLIN D. JONES*

In a small general repair shop back in the country, which —if still in existence—belongs to a class rarely seen at the present time, the "tool-room" was the name given to a fenced-in corner in which a few tools, somewhat better than the general run, were kept, and from which there came an occasional tap of odd size—or perhaps a reamer—to replace one that had been broken by some awkward apprentice. The two toolmakers, who were the only ones ordinarily allowed within this enclosure, were often the objects of considerable envy, as they sat on a stool watching the chips roll from a tool with an infinitesimal feed, the greater part of the day. Considerable care was taken not to overstrain the machines by using anything but a very fine feed, and as the work was of a much higher grade than that done in the shop, it was thought that unlimited time was essential to accuracy; therefore, the time element was never taken into consideration. This tool-room in its inefficiency and its indifference to economical production is not unlike many larger and more pretentious establishments, for, while the importance of the toolmaker has increased with improvements in manufacturing methods, the same management and system effective in the manufacturing departments is not always found in the tool-room.

It is the purpose of this article to point out some of the elements which have a direct bearing upon economical tool production, particularly when conducted on a large scale, by describing a few of the methods employed in the toolmaking department of the Taft Peirce Mfg. Co., of Woonsocket, R. I.

General Description of Tool-room

Before referring to the system employed or the methods of handling work, a general description of the tool-room will be given. This tool-room, two general views of which are shown in Figs. 1 and 9, is, as far as we know, the largest in this country. It has a full working capacity of 250 men and is equipped throughout with modern tools. The length of the tool-room proper is 310 feet and the width 50 feet, which space is exclusive of that occupied by the small tool store room, the experimental, testing, and punch and die departments. The punch and die department, seen in Fig. 2, forms an extension to one end of the tool-room and contains all the equipment required for accurate die work. The foreman's

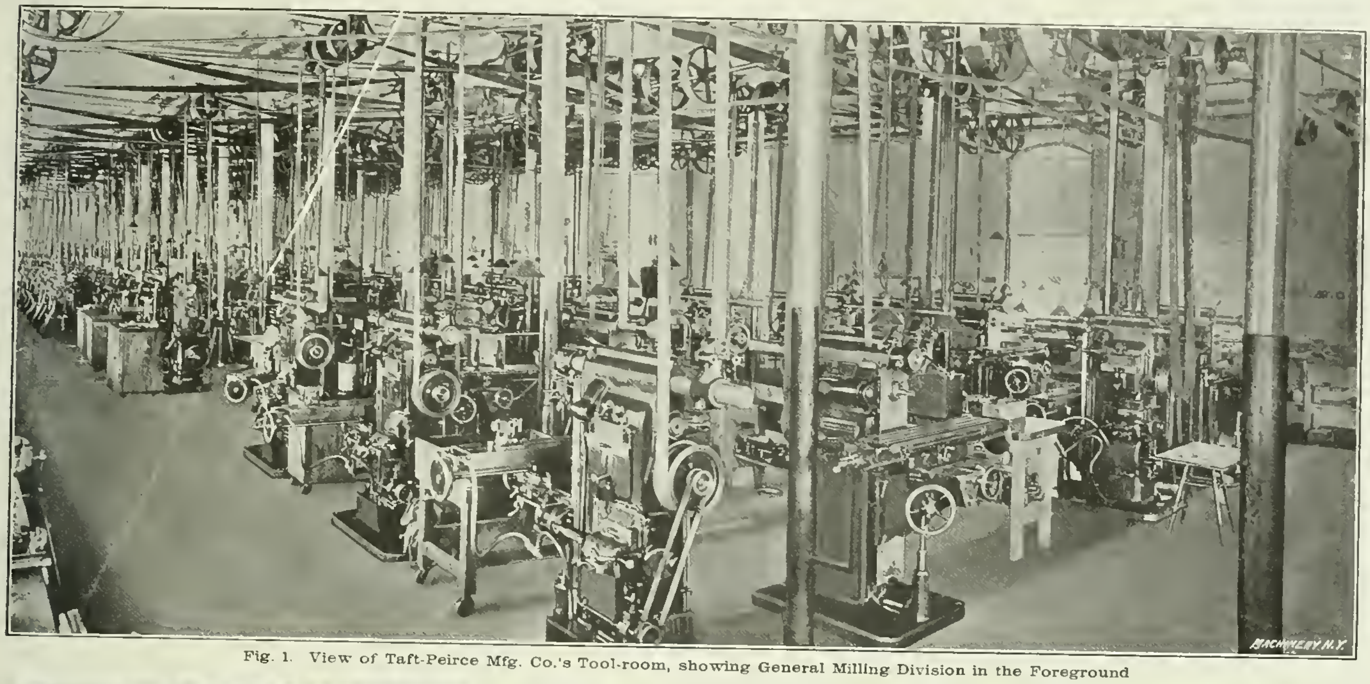


Fig. 1. View of Taft-Peirce Mfg. Co.'s Tool-room, showing General Milling Division in the Foreground

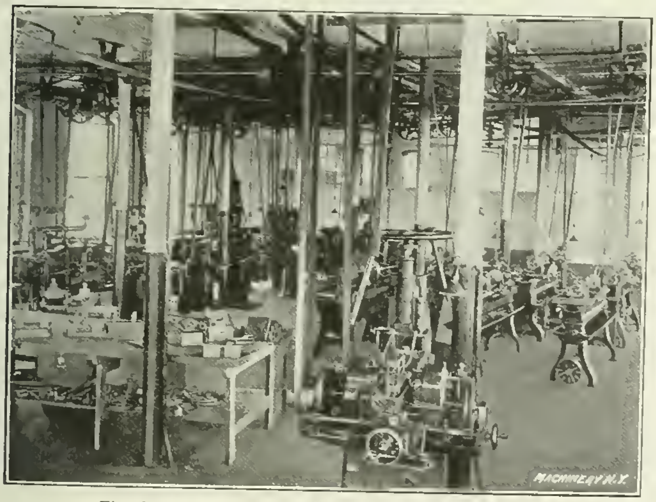


Fig. 2. Punch and Die Division of Tool Department

Fig. 3. Central Ordering and Distributing Station and Foreman's Office

office is centrally located, and directly opposite it is the ordering and distributing station (shown in Fig. 3), which is a unique and important feature that will be referred to in detail later. The experimental department (Fig. 4), which, as the name implies, is used in the development of special work, adjoins the main tool-room, as does the inspecting department (Fig. 5), where all finished parts are carefully inspected. The tool store-room, in which a complete stock of small tools, such as drills, reamers, milling cutters, gages, files, etc., is kept, is also centrally located. Fig. 6 shows one section of this store room, and also the way the various tools are kept. In the distribution of tools, the well-known check system is used, each man being given a certain number of

* Associate Editor of MACHINERY.

checks, which are exchanged for tools and show to whom the tools have been given. To avoid confusion and to facilitate the quick delivery of files, a cabinet (Fig. 7), containing all sizes and styles, is located just outside the delivery window. As the illustration shows, each kind of file in the cabinet is numbered, so that the workman can, after determining the size and style wanted, order it by number. This method has been found greatly superior to the old way of using names, which often resulted in confusion and a considerable waste of time.

Careful attention has been given to the arrangement of tools, so that their location will, as far as possible, contribute to the general efficiency. In the foreground of Fig. 9, which is a view from the west end of the room, there is a group of universal milling machines that are used exclusively for jig boring. Just beyond these, all the equipment required for general toolmaking is located, in which is included a group of twenty-four lathes. Adjoining this group of lathes on the far side are the drill presses and miscellaneous tools, such as centering machines, hardening furnaces, straightening

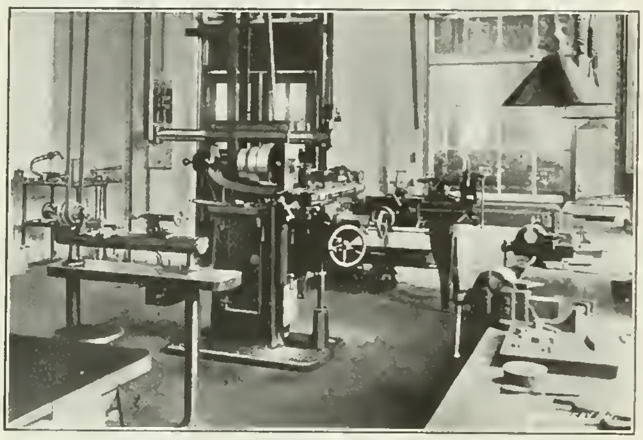


Fig. 4. Special Experimental Department

presses, together with a group of bench lathes, all of which are centrally located. The various tools referred to occupy about one-half the floor space and constitute what might be called the regular toolmaking division. The remaining space is occupied largely by the tools shown in Fig. 1; this view is taken from the east end of the room. The foreground of this illustration shows the general milling division of the tool-room, and just beyond this is the general lathe division. The function of these divisions and their application to the manufacture of fine tools, will be referred to sub-

Fig. 5. Inspection Department

sequently. In order to obtain an independent drive for different sections in the shop the main shaft is divided into ten 32-foot sections, each of which is driven by an electric motor.

Method of Handling Diversified Lines of Work

As the Taft-Peirce Mfg. Co. is engaged in miscellaneous manufacturing, experimental work, etc., the work in the tool-room is greatly diversified, so that it has been necessary to adopt a system that would make it possible to handle, on a commercial basis, the thousand-and one pieces constantly passing through the tool-room, and at the same time enable any of the parts to be identified with respect to the particular unit or machine of which they are to be a part. This system, as it is connected with the tool-room, and the means of identification, can best be explained by considering a practical illustra-

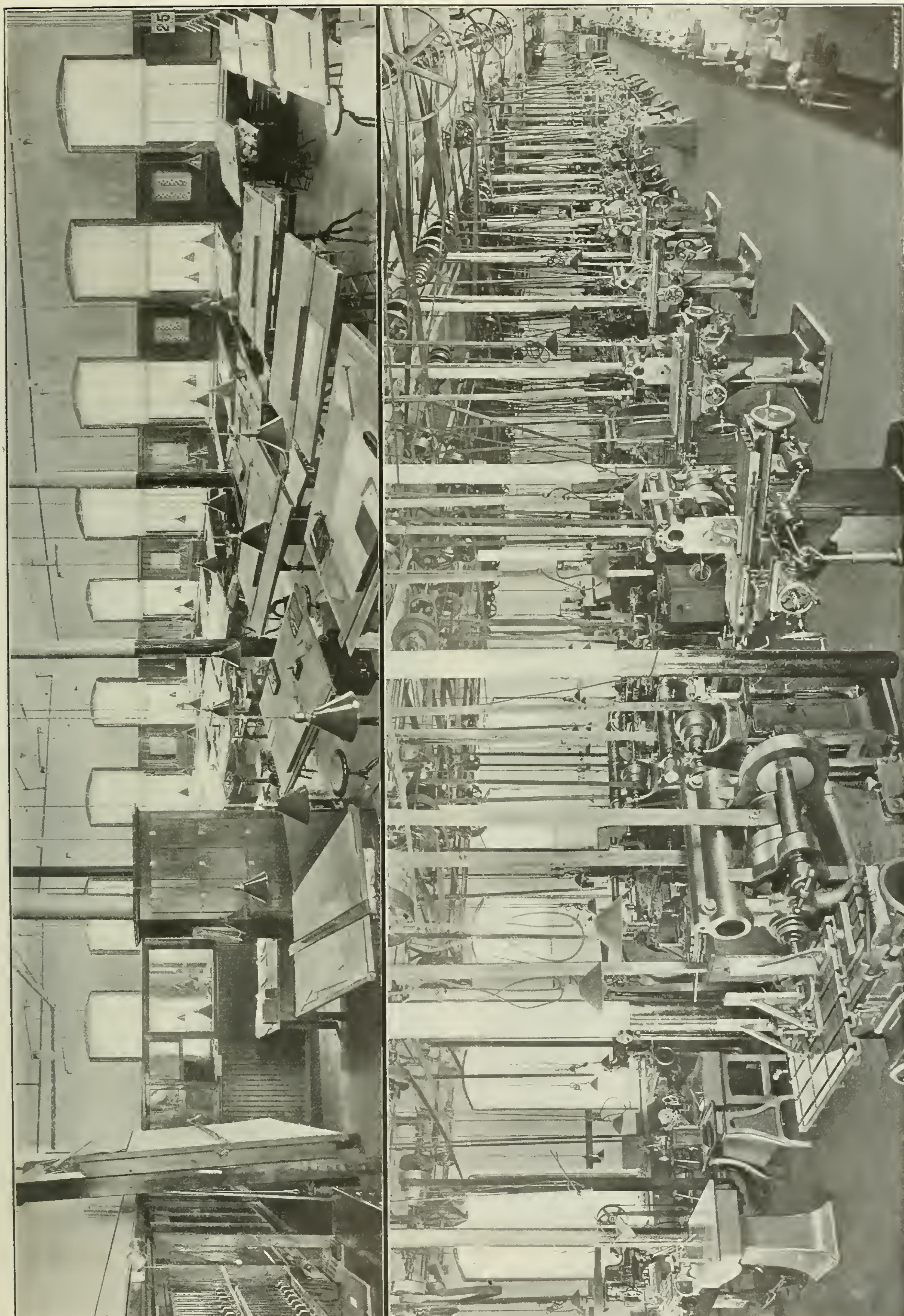
Fig. 6. Section of Tool Delivery Room

tion. When, for example, a jig has been designed, the drawings for this jig are sent from the drafting-room to the department shown in Fig. 3. From here the necessary stock is ordered and the stock-room, blacksmithshop, or wherever the raw materials are to come from, delivers it to this central department, where it is placed temporarily in a section of one of the partitioned benches shown, which section is numbered to correspond with the job number of the

Fig. 7. File Cabinet which facilitates Delivery of any Desired File

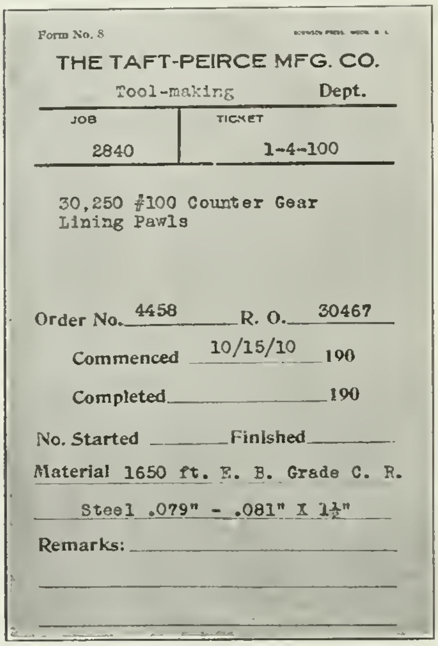
particular jig in question. The rough stock is then distributed, for machining, to the proper department, which again returns it to the central ordering-and-distributing station, whence it passes, if still unfinished, to some other department. In this way the various parts are transferred from one department to another through the distributing station, which is a kind of clearing house for the entire tool-room. By this means all confusion is avoided and the identity and location of any one of the thousands of parts constantly being handled, can be determined at any time, in the clearing house, by suitable slips and cards which give all the required information.

When a drawing is sent to the tool-room, it is accompanied by a card or "ticket" similar to the one shown in Fig. 10. This ticket is made out in duplicate by the engineering de-



Figs. 8 and 9. Panoramic View of Tool-designing Department—View of Tool-room showing Milling Machines Especially Equipped for Jig Boring, in the Foreground

partment where one copy is kept on file. The front of the ticket contains the job number, the name and number of the parts wanted, and other specific information, and on the back the raw material required is marked. From this duplicate ticket a "call card" (Fig. 11) is made out, which is used for ordering the raw material. This card shows just what is wanted, when the material will probably be needed and also to which department it should be sent. In addition to the call or order card, there is a "delivery card" (Fig. 12) which, if material is wanted at once, is sent out with the call card. This delivery card, which is placed on file, shows when the material was delivered and also serves an important purpose in connection with the cost department. As each individual piece of raw material is received at the distributing station, it is checked off on the back of the duplicate ticket, so that the foreman can see at a glance when all the material required for the particular job represented by that ticket has arrived. The material is then ready for the machines, but until actually sent out, it is kept in a numbered space on one of the benches, set apart for that particular work, so that all pieces, whether in the rough or partly finished, which are not actually being worked upon, are in plain sight of the foreman, and the number of the section in which they are kept enables immediate identification if this should be necessary. Another form or card which serves a useful purpose is shown in Fig. 13. This card, known as the "operation transfer," is used when parts are transferred from one department to another. When, for example, a piece is sent from the tool-room to the hardening room, the transfer card, which accompanies it, shows that the hardening room is its destination and also where it should be taken next. This card, as well as the others referred to, also shows by suitable numbers just what job the part is for and also its relation to that particular job.


Form No. 8
THE TAFT-PEIRCE MFG. CO.
Tool-making Dept.

JOB	TICKET
2840	1-4-100

30,250 #100 Counter Gear Lining Pawls

Order No. 4458 R. O. 30467
Commenced 10/15/10 190
Completed 190
No. Started Finished
Material 1650 ft. E. B. Grade C. R. Steel .079" - .081" X 1½"
Remarks:

Fig. 10. Duplicate Ticket which aids Foreman in Handling Diversified Lines of Work

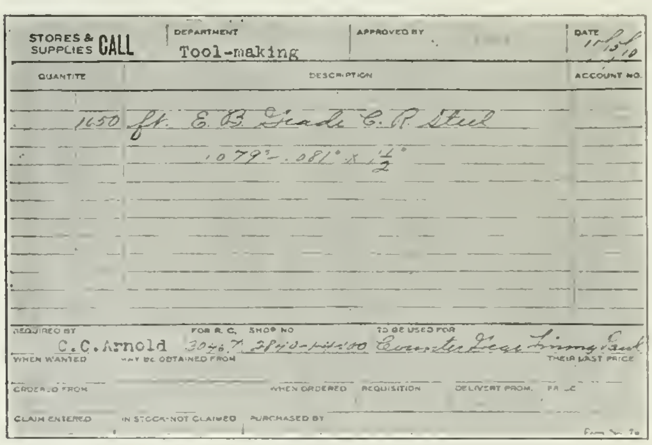

STORES & SUPPLIES CALL — DEPARTMENT Tool-making — APPROVED BY — DATE 11/5/10
QUANTITY — DESCRIPTION — ACCOUNT NO.
1650 ft. E. B. Grade C. R. Steel
.079"-.081" x ½"
REQUIRED BY C.C.Arnold — FOR R. C. — SHOP NO. 2840-1-4-100 — TO BE USED FOR Counter Gear Lining Pawls
WHEN WANTED — MAY BE OBTAINED FROM — THEIR LAST PRICE
ORDERED FROM — WHEN ORDERED — REQUISITION — DELIVERY PROM.
CLAIM ENTERED — IN STOCK-NOT CLAIMED — PURCHASED BY

Fig. 11. Card used for Ordering Raw Material

Specialization in Tool-room Practice

In most tool-rooms, the toolmaker, when given a certain piece of work, finishes it complete, regardless of the nature of the work or the number of operations which may be required for its completion. If turning, milling, drilling and grinding are necessary, all these operations are performed successively by one man. This method is undoubtedly preferable for certain classes of work, but it is inefficient in the production of other parts, particularly when considerable roughing is required. For this reason, the tool-room of the Taft-Peirce Mfg. Co. is equipped with the lathe and milling machine divisions previously referred to. The general lathe division is shown in Fig. 14, and the milling division, in the foreground of Fig. 1. In these departments that branch of tool-making which, for the most part, is on a par with high grade manufacturing, is performed. When considerable turning or milling is necessary on a certain part, it is sent to the general lathe or milling machine division, as the case may be, where the work is done by a specialist better fitted for this kind of work than a toolmaker, whose training and experience has been mostly on delicate and extremely accurate work. The machines in these departments are of modern high-power types, adapted to the line of work for which they are used. By this method the cost of producing a large percentage of the fine tool work done in this shop is greatly diminished, as the light and delicate and the heavier and, in most cases, less accurate machining are each done by a specialist. Specialization has also been applied, as far as practicable, to the machine work itself and to assembling. In the lathe division, chucking, taper turning, etc., are performed separately, and in assembling, parts that are similar are assembled, as far as possible, together.

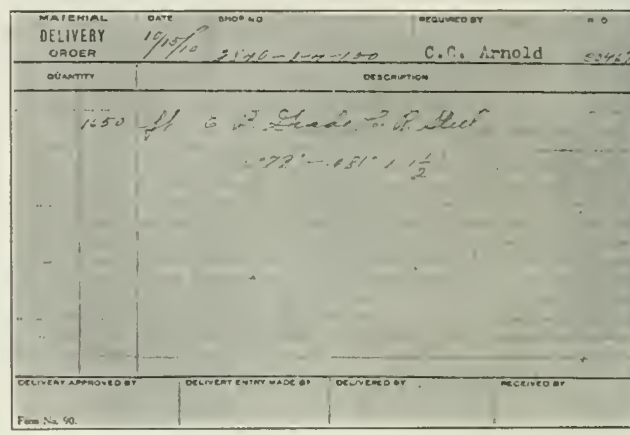

MATERIAL DELIVERY ORDER — DATE 10/15/10 — SHOP NO. 2840-1-4-100 — REQUIRED BY C.C. Arnold — R. O. 30467
QUANTITY — DESCRIPTION
1650 ft. E. B. Grade C. R. Steel
.079"-.081" x ½
DELIVERY APPROVED BY — DELIVERY ENTRY MADE BY — DELIVERED BY — RECEIVED BY
Form No. 90.

Fig. 12. Card for Ordering Delivery of Material

Jig Boring in Milling Machines

Owing to the wide variety of special tools, light machinery and mechanical specialties, manufactured by this company, much of the work in the tool-room consists in the making of high-grade jigs and fixtures. In the boring of these jigs the specialist is again utilized effectively. Milling machines are employed for this work, and, while the use of such machines for jig boring is not new, a general description of the method of procedure and the equipment employed will doubtless be of some interest. The seven universal machines shown in the foreground of Fig. 9 and the vertical miller to the left, are used exclusively for jig boring. All these machines are

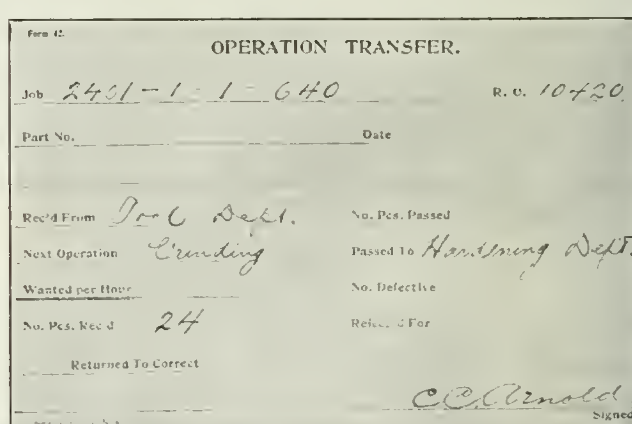

Form 42.
OPERATION TRANSFER.
Job 2401-1-1-640 R. O. 10420
Part No. Date
Rec'd From Tool Dept. No. Pcs. Passed
Next Operation Grinding Passed To Hardening Dept.
Wanted per Hour No. Defective
No. Pcs. Rec'd 24 Reiss. For
Returned To Correct
C.C.Arnold. Signed.

Fig. 13. Slip used when Transferring Work from One Department to Another

equipped with special scales and verniers which enable adjustments to be made in any direction, with accuracy. For a certain class of work, the setting obtained by the scales is relied upon, but when extreme accuracy is required, the center-to-center distances are checked by taking direct measurements with a vernier or micrometer across ground plugs which accurately fit the holes. An example of work requiring such measurements is shown set up in the machine in Fig. 15, it being necessary to bore the outer holes in correct relation with the center hole within 0.0005 inch. Another method of locating jigs, which is employed in certain cases, is shown in Figs. 16 and 17. At one end of the jig to be bored, an accurate angle-plate is set up as shown. This plate is set parallel with the machine spindle by the use of an indicator as illustrated in Fig. 18, which shows a larger plate being aligned. When the work is to be adjusted horizontally, a

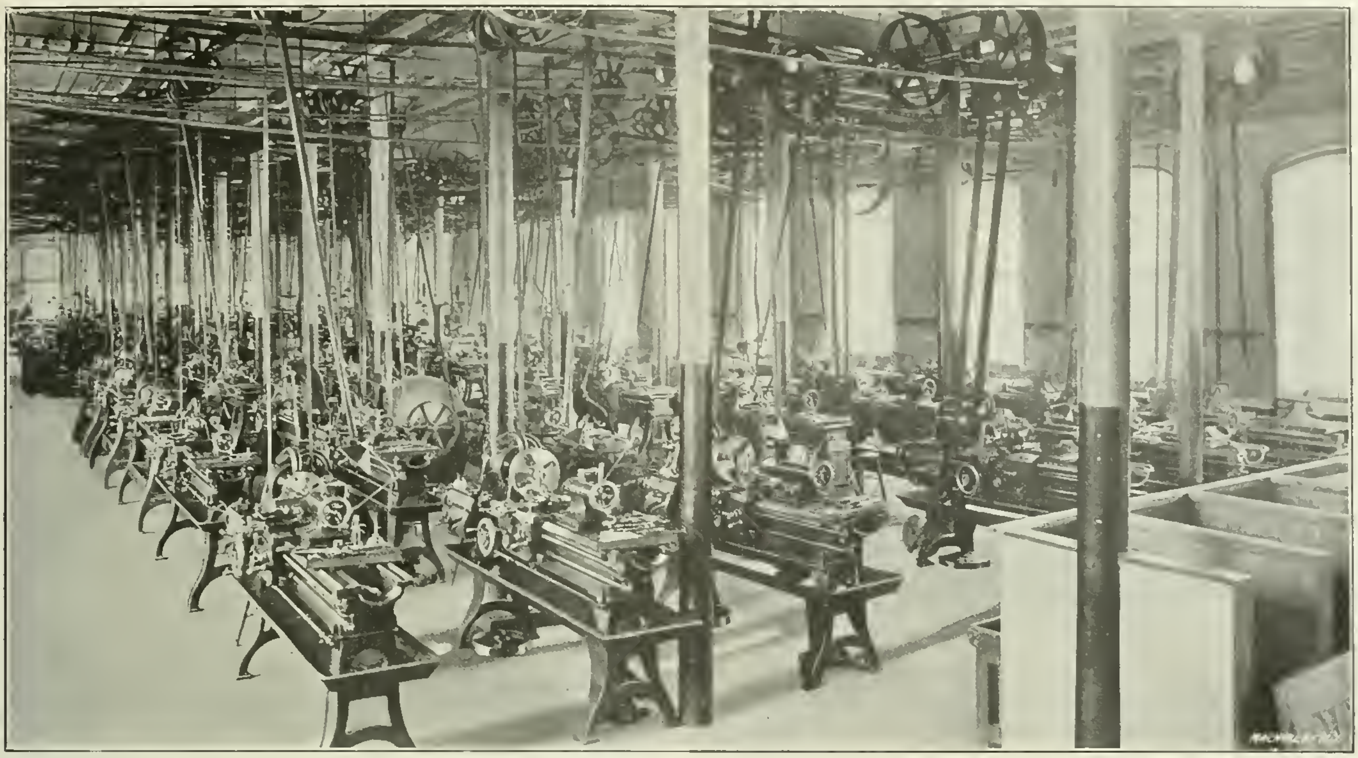


Fig. 14. General Lathe Division of Tool Department

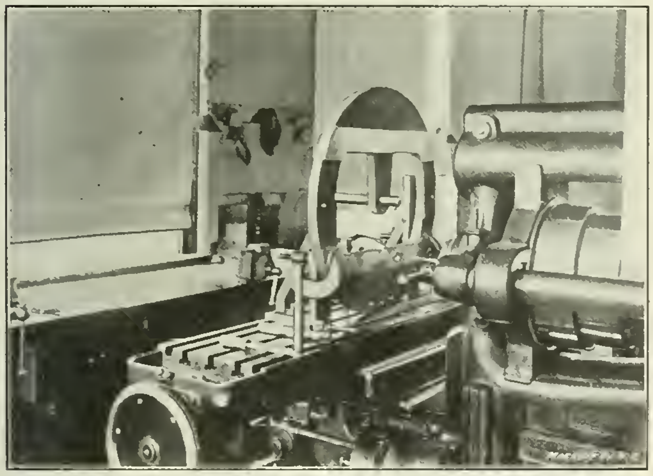


Fig. 15. Example of Jig Boring in Milling Machine

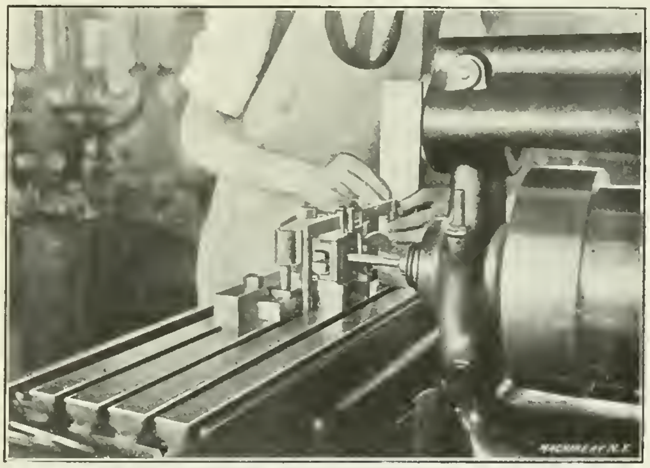


Fig. 16. One Method of Setting the Work—Making a Horizontal Adjustment

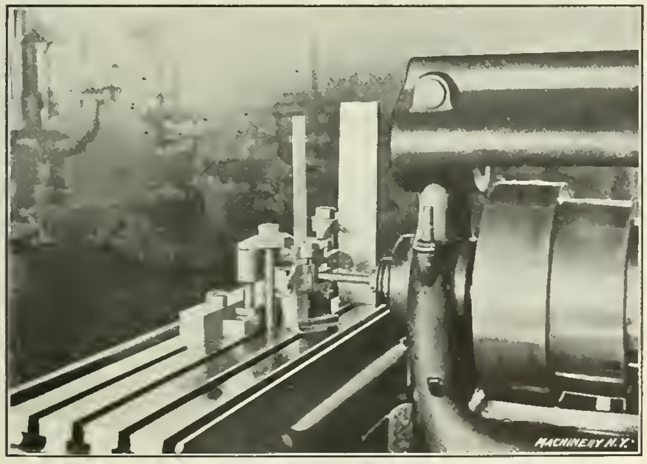


Fig. 17. Method of Making a Vertical Adjustment

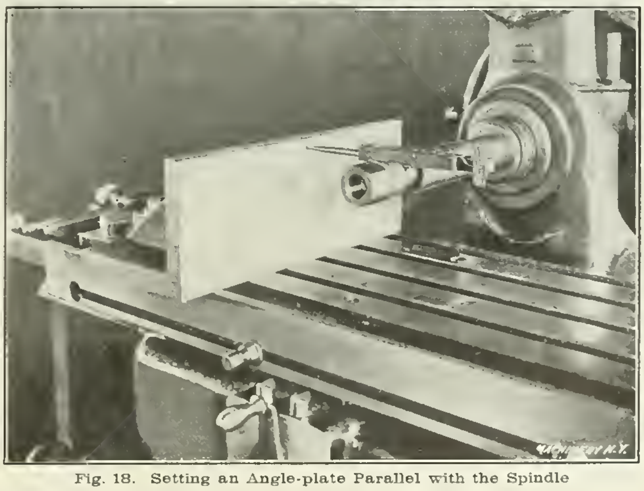


Fig. 18. Setting an Angle-plate Parallel with the Spindle

vernier height gage is used as in Fig. 16, the base of the gage resting on the angle-plate and the measurement being taken to an accurately ground and lapped plug in the spindle. For vertical adjustments, the measurements are taken between this ground plug and the machine platen as in Fig. 17.

Samples of the tools with which these machines are equipped are shown in Fig. 19. At *A* are the drills used; at *B*, the mills, or, more properly, the reamers for finishing; at *C*, a spindle collet for holding the various tools; at *D*, a test plug; at *E*, an adjustable boring tool; and at *F*, reducing collets

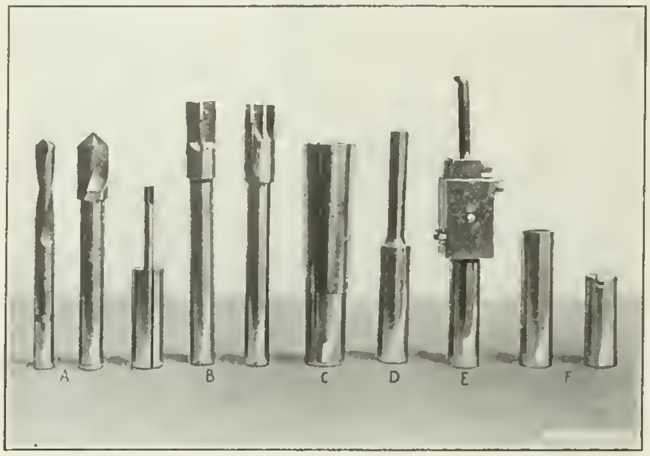


Fig. 19. Tools used for Jig Boring

for small drills. The reamers are in both roughing and finishing sizes, and the latter are of the split adjustable type, so that the size can be retained. There is a complete set of these reamers in various sizes, so that most of the bushing holes are finished to a standard diameter. One advantage incident to this method of finishing the holes, aside from the limited time required, is that holes of a standard size, permit the repeated use of test plugs, so that it is not necessary to be continually making new ones. When a hole of odd size is to be bored, the adjustable tool shown at *E* is used.

While most of the jig boring can be handled to the best advantage in a horizontal machine, for certain classes of

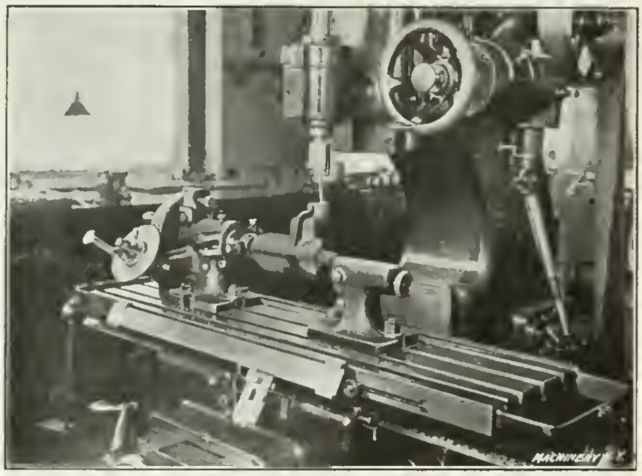
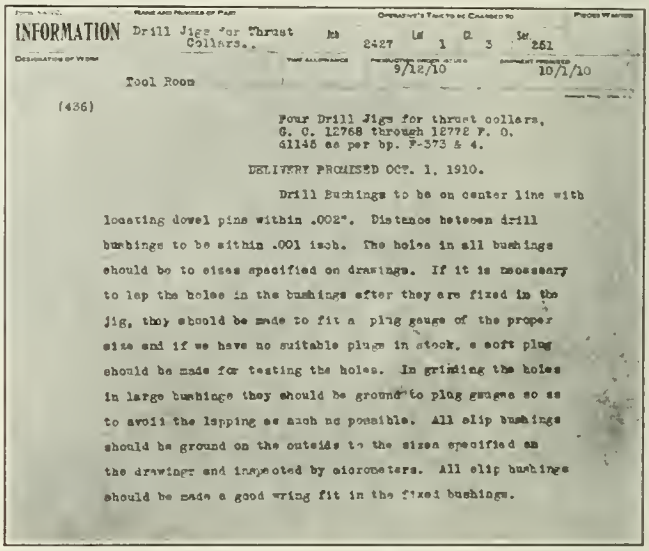


Fig. 20. Example of Jig Boring on a Vertical Milling Machine

work the vertical type has its advantages. An example of work adapted to the vertical miller is shown set up in the machine in Fig. 20. As the particular hole being bored had to be at an angle of 25 degrees with a finished surface on the base, the jig was mounted between the centers of a dividing head which was used for obtaining the angular setting after the surface referred to had been milled. This illustration also shows the scale and vernier for measuring longitudinal adjustments, the former being attached to the table and the latter to the saddle. The vernier and part of the scale for measuring the cross movement may also be seen just to the left of the knee. These scales greatly facilitate the operation of jig boring and they can be used to advantage on a variety of work.

Drafting-room

The cooperation between the drafting-room (Fig. 8) and the toolmaking department is such that this article would not be complete without reference to some of the features which have a direct bearing on the work of the tool-room. Noteworthy among these features is the plan to eliminate "double thinking," and at the same time give the workman a clear understanding of just what is needed on a given job as to accuracy, etc. This is accomplished by the use of information blanks such as the one shown in Fig. 21. These blanks are attached to the blueprints—when they can be used to advantage—and contain practical information for the guidance of the workman. The character of this information is such as to insure the production of work which, as regards accuracy and general finish, will meet the requirements. By this method, a part is made just as good as it needs to be, but unnecessary expense for accuracy and polish which would be useless is avoided. The general utility of these infor-



INFORMATION Drill Jigs for Thrust Collars.. 2427 1 3 251

9/12/10 10/1/10

Tool Room

(436)

Four Drill Jigs for thrust collars, G. C. 12768 through 12772 F. O. 41148 as per bp. F-373 & 4.

DELIVERY PROMISED OCT. 1, 1910.

Drill Bushings to be on center line with locating dowel pins within .002". Distance between drill bushings to be within .001 inch. The holes in all bushings should be to sizes specified on drawings. If it is necessary to lap the holes in the bushings after they are fixed in the jig, they should be made to fit a plug gauge of the proper size and if we have no suitable plugs in stock, a soft plug should be made for testing the holes. In grinding the holes in large bushings they should be ground to plug gauges so as to avoid the lapping as much as possible. All slip bushings should be ground on the outside to the sizes specified on the drawings and inspected by micrometers. All slip bushings should be made a good wring fit in the fixed bushings.

Fig. 21. Information Slip which accompanies Drawings when Necessary

mation slips will be more clearly understood by quoting the instructions given on the particular one illustrated. After the identification numbers and other miscellaneous data, the following instructions appear:

"Drill bushings to be on center line with locating dowel pins within 0.002 inch. The distance between drill bushings to be within 0.001 inch. The holes in all bushings should be to the exact sizes specified on drawings. If it is necessary to lap the holes in the bushings after they are fixed in the jig, they should be made to fit a plug gage of the proper size and if we have no suitable plugs in stock, a soft plug should be made for testing the hole. In grinding the holes in large bushings they should be ground to plug gages, so as to avoid lapping as much as possible. All slip bushings should be

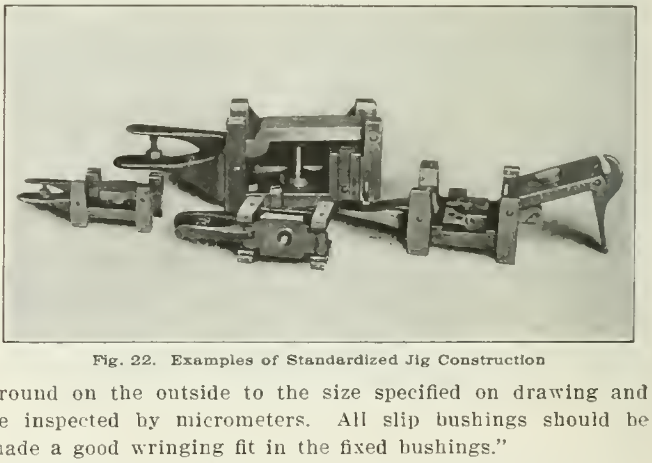


Fig. 22. Examples of Standardized Jig Construction

ground on the outside to the size specified on drawing and be inspected by micrometers. All slip bushings should be made a good wringing fit in the fixed bushings."

The "operation sheet" is another important aid which is given the tool-room from the engineering department. This sheet, which is issued in certain cases, gives all the opera-

tions required for finishing given parts in their respective order, and also a list of the tools required for each operation.

Owing to the diversified nature of the work, which ranges from the development of some small tool or machine to the designing of a complete tool equipment for the inter-

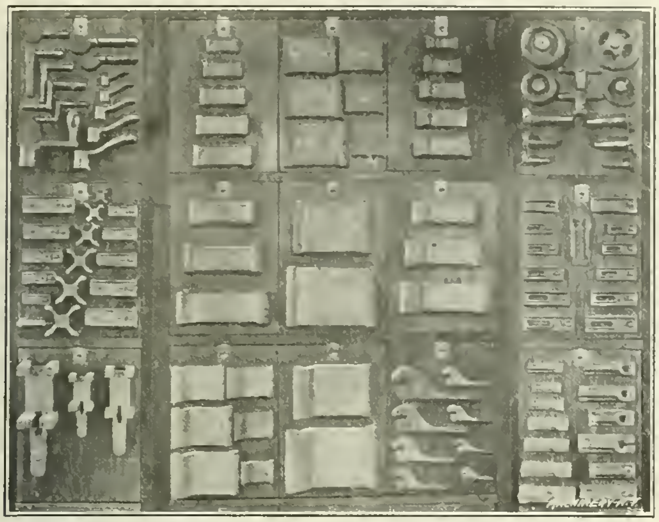


Fig. 23. Cabinet of Standard Parts for Reference of Draftsmen

changeable manufacture of a complicated mechanism, the standardization of parts presents, of course, unusual difficulties. Notwithstanding the nature of the work, however, much has been accomplished along this line. Fig. 22 shows a standard type of jig, in different sizes, which with certain

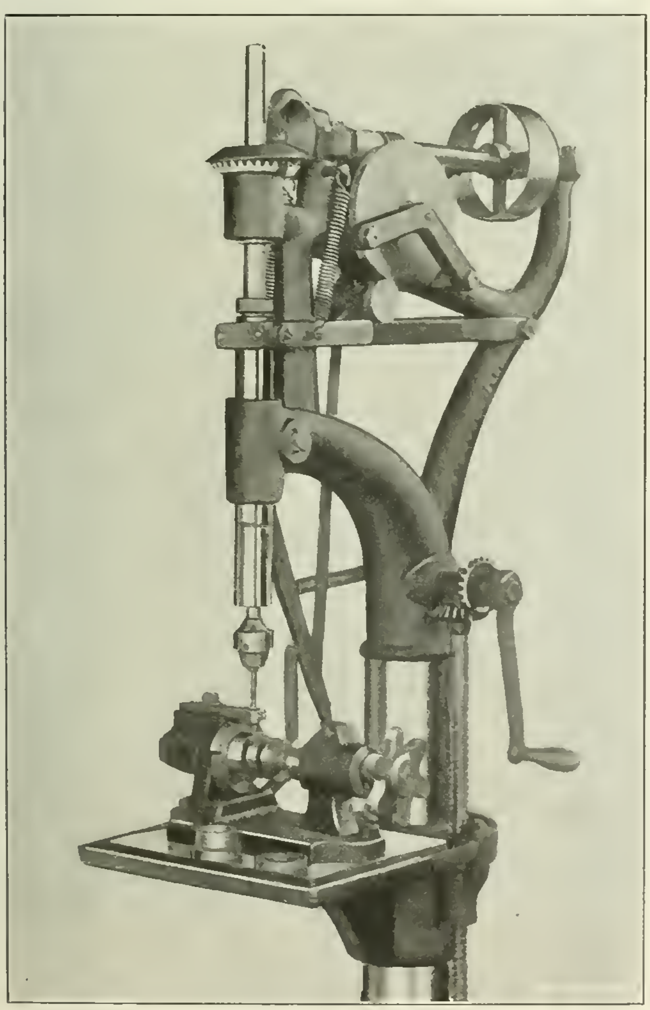


Fig. 1. Hoefer Drill Press Adapted to drill Spanner Holes in Locking Collars automatically

slight modifications can be used for a wide variety of work. This jig is simple in construction, the principal parts being a body and a hinged cover which is clamped against the work by an eccentric or cam lever engaging a suitable pin. For the convenience of the designer, samples of standard jig and fixture parts are kept in the drafting-room attached to a cabinet as illustrated in Fig. 23. Standard die-beds and other parts have also been adopted as far as possible. For the most part, however, it is necessary to devise special tools and means, owing to the experimental nature of a large part of the work.

* * *

DRILLING SPANNER HOLES IN LOCKING COLLARS

By ETHAN VIALL*

The accompanying illustrations, Figs. 1 and 2, show the ingenious way in which a Hoefer drill press, in use at the plant of the Mitchell Motor Car Co., Racine, Wis., has been fitted to automatically drill the spanner holes in locking collars, two of which are shown on the table just in front of the jig. A worm on the driving spindle meshes with a worm gear and turns the cams which work the lever operating the drilling spindle. The cam plate on the other side of the one shown in Fig. 1, carries a pin which operates the indexing mechanism.

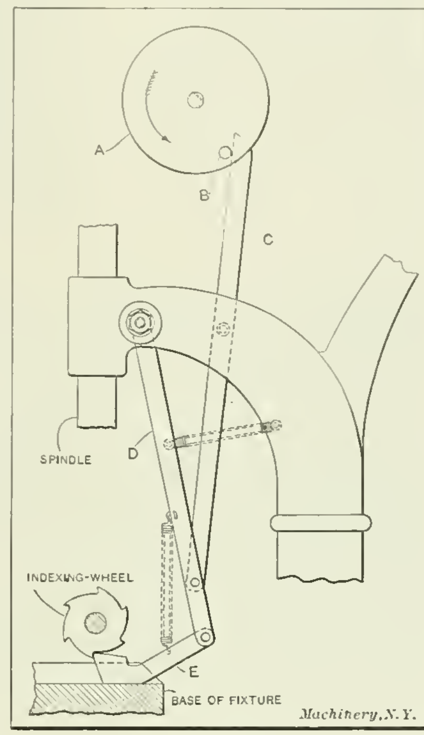


Fig. 2. Diagram showing Operation of Indexing Mechanism

The indexing mechanism is more clearly shown in Fig. 2, where *A* is the cam plate which carries the pin *B*. As the plate *A* rotates in the direction of the arrow, the pin *B* trips the lever *C*, which, in turn, operates the lever *D*, causing the dog *E* to slide back and forth, thus rotating the indexing wheel.

* * *

RAISING THE "MAINE"

An appropriation of $300,000 was made during the last session of Congress for raising the *Maine*, the United States battleship sunk in Havana Harbor, February 15, 1898. The work will be done under the direction of the army engineers and the plan for raising the wreck is to enclose it with a steel coffer dam, pump out the water, repair the hull and float the vessel by admitting the water when all repairs are made. The plan is substantially the same as that described in the January, 1905, number of MACHINERY, when a private concern proposed to raise the vessel and reimburse itself by exhibiting it as a curiosity and by selling souvenirs made from the metal of the hull. The coffer-dam plan is considered feasible. The wreck lies in 25 feet of water and in a stratum of soft mud from 5 to 8 feet deep. Beneath the mud is a stratum of hard clay, into which the interlocking steel piles will be driven.

* * *

Some experiments with aeroplane engines have recently been carried out at the National Physical Laboratory in England. It appears that the economy of the aeroplane engine as compared with that of a good automobile engine is rather low. The aeroplane engines are much lighter per horsepower, but economy has been sacrificed in order to reduce the weight, and the famous Gnome engine requires 0.89 pound of fuel per brake horsepower hour, as compared with 0.54 pound for a good automobile engine.

* Associate Editor of MACHINERY.

CUTTING FRACTIONAL SCREW THREADS*

By MARTIN H. BALL†

It is not always an easy matter to know exactly what gears should be used when cutting a fractional thread. For such work as this the writer has compiled the following tables, which should be of value to machinists in general. The numbers given in the upper row and left-hand column of these tables correspond to the numbers of teeth in the change gears of lathes having lead-screws with four, five and six threads per inch, respectively. It has been found sufficient to carry the calculations to four decimal places as this seems to be practical for all purposes.

TABLE I. RATIOS FOR CUTTING FRACTIONAL THREADS

For Lead-screwe Having 4 Threads per Inch

	28	32	40	42	48	56	72	80	88	96	105	112
28		0.8750	0.7000	0.6666	0.5833	0.5000	0.3888	0.3500	0.3181	0.2916	0.2666	0.2500
32	1.1428		0.8000	0.7619	0.6666	0.5714	0.4444	0.4000	0.3613	0.3636	0.3047	0.2857
40	1.4285	1.2500		0.9523	0.8333	0.7142	0.5555	0.5000	0.4545	0.4166	0.3809	0.3571
42	1.5000	1.3125	1.0500		0.8750	0.7500	0.5833	0.5250	0.4772	0.4375	0.4000	0.3750
48	1.7142	1.5000	1.2000	1.1428		0.8571	0.6666	0.6000	0.5454	0.5000	0.4571	0.4285
56	2.0000	1.7500	1.4000	1.3333	1.1666		0.7777	0.7000	0.6363	0.5833	0.5333	0.5000
72	2.5714	2.2500	1.8000	1.7142	1.5000	1.2857		0.9000	0.8181	0.7500	0.6857	0.6428
80	2.8571	2.5000	2.0000	1.9047	1.6666	1.4285	1.1111		0.9090	0.8333	0.7619	0.7142
88	3.1428	2.7500	2.2000	2.0952	1.8333	1.5714	1.2222	1.1000		0.9166	0.8380	0.7857
96	3.4285	3.0000	2.4000	2.2857	2.0000	1.7142	1.3333	1.2000	1.0909		0.9142	0.8571
105	3.7500	3.2812	2.6250	2.5000	2.1875	1.8750	1.4583	1.3125	1.1931	1.0937		0.9375
112	4.0000	3.5000	2.8000	2.6666	2.3333	2.0000	1.5555	1.4000	1.2727	1.1666	1.0666	

TABLE II. RATIOS FOR CUTTING FRACTIONAL THREADS

For Lead-ecrews Having 5 Threads per Inch

	20	25	30	35	40	45	46	50	55	60	65	70	75	80	90	100	110
20		0.8000	0.6666	0.5714	0.5000	0.4444	0.4347	0.4000	0.3636	0.3333	0.3076	0.2857	0.2666	0.2500	0.2222	0.2000	0.1818
25	1.2500		0.8333	0.7142	0.6250	0.5555	0.5434	0.5000	0.4545	0.4166	0.3846	0.3571	0.3333	0.3125	0.2777	0.2500	0.2272
30	1.5000	1.2000		0.8571	0.7500	0.6666	0.6521	0.6000	0.5454	0.5000	0.4615	0.4285	0.4000	0.3750	0.3333	0.3600	0.2727
35	1.7500	1.4000	1.1666		0.8750	0.7777	0.7608	0.7000	0.6363	0.5833	0.5384	0.5000	0.4666	0.4375	0.3888	0.3500	0.3181
40	2.0000	1.6000	1.3333	1.1428		0.8888	0.8695	0.8000	0.7272	0.6666	0.6153	0.5714	0.5333	0.5000	0.4444	0.4000	0.3636
45	2.2500	1.8000	1.5000	1.2857	1.1250		0.9782	0.9000	0.8181	0.7500	0.6923	0.6428	0.6000	0.5625	0.5000	0.4500	0.4090
46	2.3000	1.8400	1.5333	1.3142	1.1500	1.0222		0.9200	0.8363	0.7666	0.7076	0.6571	0.6133	0.5750	0.5111	0.4600	0.4181
50	2.5000	2.0000	1.6666	1.4285	1.2500	1.1111	1.0826		0.9090	0.8333	0.7692	0.7142	0.6666	0.6250	0.5555	0.5000	0.4545
55	2.7500	2.2000	1.8333	1.5714	1.3750	1.2222	1.1956	1.1000		0.9166	0.8461	0.7857	0.7333	0.6875	0.6111	0.5500	0.5000
60	3.0000	2.4000	2.0000	1.7142	1.5000	1.3333	1.3043	1.2000	1.0909		0.9230	0.8571	0.8000	0.7500	0.6666	0.6000	0.5454
65	3.2500	2.6000	2.1666	1.8571	1.6250	1.4444	1.4130	1.3000	1.1818	1.0833		0.9285	0.8666	0.8125	0.7222	0.6500	0.5909
70	3.5000	2.8000	2.3333	2.0000	1.7500	1.5555	1.5217	1.4000	1.2727	1.1666	1.0769		0.9333	0.8750	0.7777	0.7000	0.6363
75	3.7500	3.0000	2.5000	2.1428	1.8750	1.6666	1.6304	1.5000	1.3636	1.2500	1.1538	1.0714		0.9375	0.8333	0.7500	0.6818
80	4.0000	3.2000	2.6666	2.2857	2.0000	1.7777	1.7391	1.6000	1.4545	1.3333	1.2307	1.1428	1.0666		0.8888	0.8000	0.7272
90	4.5000	3.6000	3.0000	2.5714	2.2500	2.0000	1.9565	1.8000	1.6363	1.5000	1.3846	1.2857	1.2000	1.1250		0.9000	0.8181
100	5.0000	4.0000	3.3333	2.8571	2.5000	2.2222	2.1739	2.0000	1.8181	1.6666	1.5381	1.4285	1.3333	1.2500	1.1111		0.9090
110	5.5000	4.4000	3.6666	3.1428	2.7500	2.4444	2.3913	2.2000	2.0000	1.8333	1.6923	1.5714	1.4666	1.3750	1.2222	1.1000	

To illustrate the use of the accompanying tables, we will take a practical example: Assume that it is necessary to cut a worm having a lead equal to 0.194 inch, and that the number of threads on the lead-screw is four per inch. Then the lead of the lead-screw expressed in decimals will be 0.250 inch; therefore, the ratio of the gearing required is 194 to 250 and we find the ratio is $\frac{250}{194}$ or 1.2886. Referring to Table I, we find that 56 into 72 gives a ratio of 1.2857, which is the nearest decimal we can find in the table. But the following method of proving the above shows that the amount of error is very slight. For example: $\frac{56 \times 0.250}{72} = 0.1944 +$ which is less than 0.0004 inch too long in lead; but this is usually close enough for ordinary practice.

To give another example, we will say that it is necessary to cut a worm which is to run in mesh with an 8 diametral pitch gear, the circular pitch of which is 0.393 inch. Then the ratio is $\frac{250}{393} = 0.6361$. Referring to Table I we find that the nearest decimal is 0.6363, which calls for an 88 into a 56 gear, this giving a lead of 0.3928 +, which is less than 0.0002 inch too short.

To give another example, we will say that 48 threads per inch are required, and the ratio is found to be 12. Not finding this in Table I, it is apparent that compounding the gears will have to be resorted to. Referring to Table I, we find ratios 4 and 3, and $4 \times 3 = 12$. The ratio of 4 calls for a 28 into a 112 gear, and the ratio 3 for a 32 into a 96 gear, which are the required gears to produce a lead of 48 threads per inch. It can be seen, therefore, that the compounding of the gears is just as simple as using the single driver and driven gears.

Another method that can often be used to advantage is as follows: In a case where 24 threads per inch are required, the ratio between the lead-screw and the screw to be cut (when the number of threads in the lead screw is four per inch) is $\frac{24}{4} = 6$. Referring to Table I, we find that 32 into 96 gives a ratio of 3 and that 40 into 80 gives a ratio of 2, thus, $2 \times 3 = 6$. This latter method of using fractions instead of decimals is sometimes shorter and more convenient. Tables II and III are made up on the same principle as Table I, for lead-screws of five and six threads per inch, respectively.

TABLE III. RATIOS FOR CUTTING FRACTIONAL THREADS

For Lead-screws Having 6 Threads per Inch

	24	28	32	36	40	44	48	52	56	60	64	68	72
24		0.8571	0.7500	0.6666	0.6000	0.5454	0.5000	0.4615	0.4285	0.4000	0.3750	0.3529	0.3333
28	1.1666		0.8750	0.7777	0.7000	0.6363	0.5833	0.5384	0.5000	0.4666	0.4375	0.4117	0.3888
32	1.3333	1.1428		0.8888	0.8000	0.7272	0.6666	0.6153	0.5714	0.5333	0.5000	0.4705	0.4444
36	1.5000	1.2857	1.1250		0.9000	0.8181	0.7500	0.6923	0.6428	0.6000	0.5625	0.5294	0.5000
40	1.6666	1.4285	1.2500	1.1111		0.9090	0.8333	0.7692	0.7142	0.6666	0.6250	0.5882	0.5555
44	1.8333	1.5714	1.3750	1.2222	1.1000		0.9166	0.8461	0.7857	0.7333	0.6875	0.6470	0.6111
48	2.0000	1.7142	1.5000	1.3333	1.2000	1.0909		0.9230	0.8571	0.8000	0.7500	0.7058	0.6666
52	2.1666	1.8571	1.6250	1.4444	1.3000	1.1818	1.0833		0.9285	0.8666	0.8125	0.7647	0.7222
56	2.3333	2.0000	1.7500	1.5555	1.4000	1.2727	1.1666	1.0769		0.9333	0.8750	0.8235	0.7777
60	2.5000	2.1428	1.8750	1.6666	1.5000	1.3636	1.2500	1.1538	1.0714		0.9375	0.8823	0.8333
64	2.6666	2.2857	2.0000	1.7777	1.6000	1.4545	1.3333	1.2307	1.1428	1.0666		0.9411	0.8888
68	2.8333	2.4285	2.1250	1.8888	1.7000	1.5454	1.4166	1.3076	1.2142	1.1333	1.0625		0.9444
72	3.0000	2.5714	2.2500	2.0000	1.8000	1.6363	1.5000	1.3846	1.2857	1.2000	1.1250	1.0588	

* * *

The mathematical symbols + (plus) and — (minus) first appeared in a German work published in 1489; = (equals) in another German work in 1557; > (is greater than) and < (is less than) in the works of Harriott (1560-1621); and × (multiplied by) in a work by Oughtred (1574-1660).

* For additional information on cutting fractional screw threads, see MACHINERY, November, 1903, and MACHINERY'S Reference Series Pamphlet, No. 32, "Screw Thread Cutting."

† Address: 293 5th Ave., Watervliet, N. Y.

MACHINING SHAPER RAMS

By ETHAN VIALL*

The way shaper rams are routed through the shop of the Queen City Shaper Co., Cincinnati, Ohio, is to first rough center them by marking with compasses and a prick punch and then drill and countersink them, after which they are each placed in a lathe, as in Fig. 1, the heads turned and finished and the circular T-slot *A*, cut. For handling heavy rams, an eye-bolt, *B*, is screwed into the slot for the hoist hook. The two drivers *C* serve also as brackets to steady the ram while placing it on the lathe centers. After finishing the head, the rams are placed three at a time on a planer, the top of the slides roughed off and the top of the slots surfaced off and finished, as in Fig. 4, after which they are placed six at a time on the planer, being set into brackets as shown in Fig. 2, and the sides, bottoms and bottoms of the slots, as shown by the arrows, are roughed and finished at one setting. Again the rams are placed bottom down, three at a time, on the planer, Fig. 3, and the tops of the slides carefully finished, care being taken to so set and clamp the work as to avoid springing it. The tops of the slots having been finished in the first operation are not touched in this.

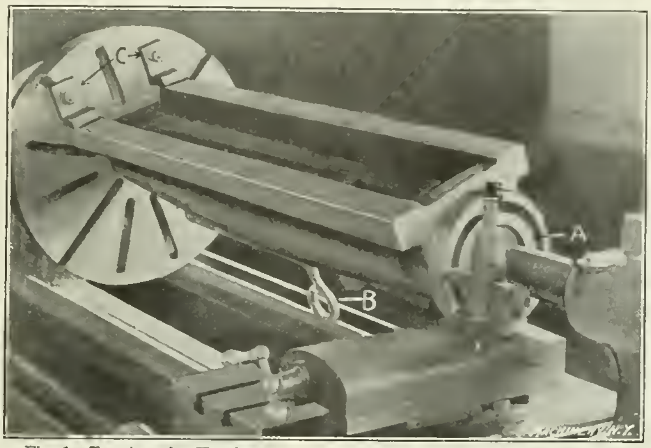


Fig. 1. Turning the Heads and Finishing the T-slots of Shaper Rams

From the planer the rams go to a Fosdick radial drill, Fig. 5, and are clamped in a special bracket, the head resting in the bottom of the pit, and the long screw holes are drilled, reamed and faced with a counterbore, on each end. Fig. 6 shows the bracket for holding the ram and the manner of setting it on the drill jig, which is lined up by and clamped to the finished slot. Next, the hole for the ram-adjusting shaft is drilled, as shown in Fig. 7, the ram being set on angle blocks. The drilling jig for this operation is lined up and clamped to the finished slot in the same way as was the jig shown in Fig. 6, and in this way the two holes always bear a definite relation to each other.

Fig. 8 shows the jigs in which the links are drilled, bored and reamed, the boring-bar and reamer being supported by bushings on both sides of the hole.

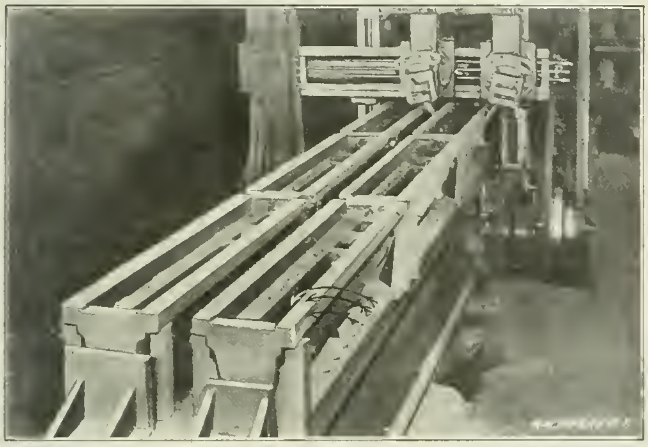


Fig. 2. Finishing the Bottom and Sides of Shaper Rams on the Planer

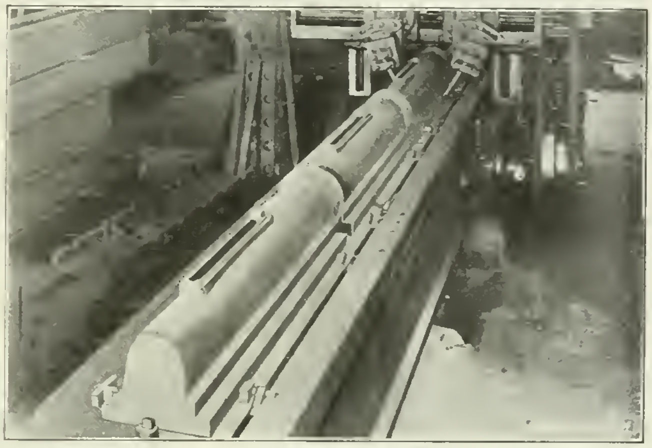


Fig. 3. Taking the Finishing Cuts on the Slides, Three at a Time

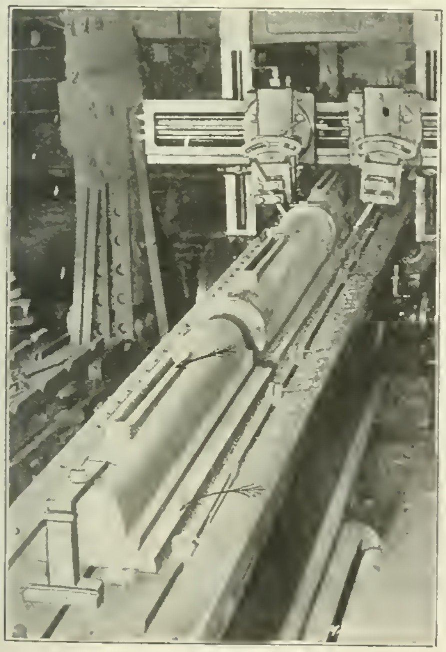


Fig. 4. Roughing the Top of the Slides and Finishing the Slots

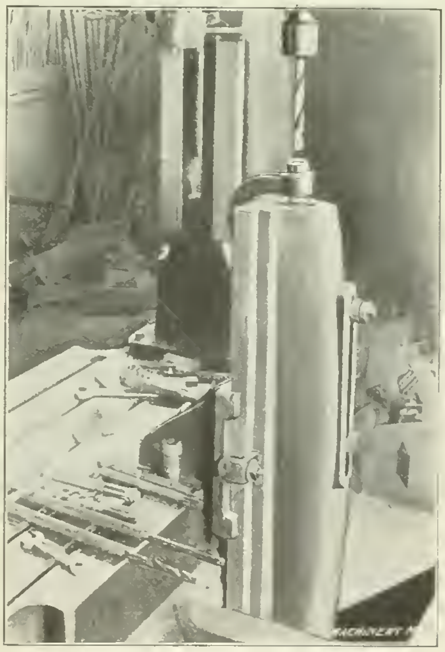


Fig. 5. Drilling, Reaming and Facing the Long Screw Holes in the Rams


Fig. 6. Bracket used in Holding the Shaper Ram on the Drill Press

The tool slides are drilled in the jig shown in Fig. 9 and then the swivel is slipped on the dovetail ways and the slide clamped to the angle-plate jig, as shown in Fig. 10, a drill bushing being used in the hole just drilled in order to line up the holes in the two parts correctly.

*Associate Editor of MACHINERY.

THAT NEW JOB

By K. P. C.

I thought at the time it was the one important event of my life, and although other things of some importance have since happened, such as losing a good job in mid-winter a thousand miles from home after spending all my money for a new winter outfit, having someone cut me out of my best girl, getting married, etc., I still consider it of some moment. It was one of the proudest times of my life—even though my pride was soon doomed to fall.

I had finished my time and was now a full-fledged machinist with a brand-new tool-box in my possession, containing most of the tools listed in a tool catalogue, and was on my way to work at a new shop which paid the best wages in that locality. I lasted just half a day.

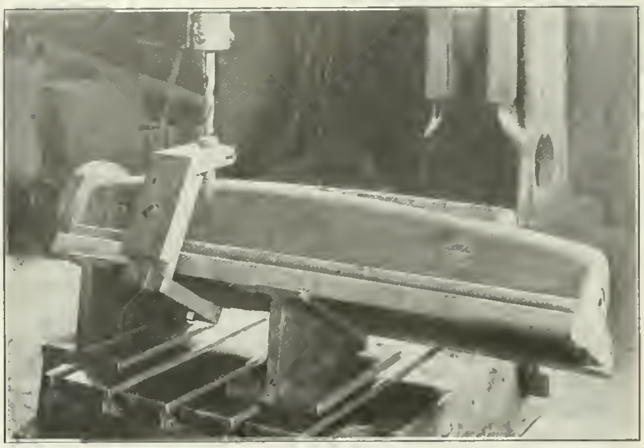


Fig. 7. Drilling the Holes for the Ram-adjusting Shaft in a Fosdick Radial Drill Press

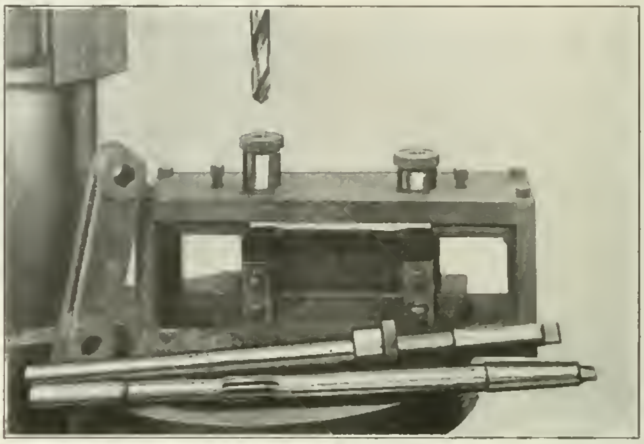


Fig. 8. Jigs used in Drilling, Reaming and Boring the Links

It was not because I was incompetent to hold that job either —it was just nervousness. In the shop where I had served my time, all we had to do was our own repair and tool work; we had from one to three extra men all the time for break-down jobs, so ordinarily we were not rushed. This class of work had given me a wide range of experience, but it was not the kind to accustom an apprentice to make time on new work, and my new job was in a shop where speed was demanded. The foreman put me on a lathe and stood watching me for five or ten minutes. That, alone, gave me a bad start, and I soon saw I was not making the time the others were. In trying to keep up with the others, I spoiled the work and lost my job.

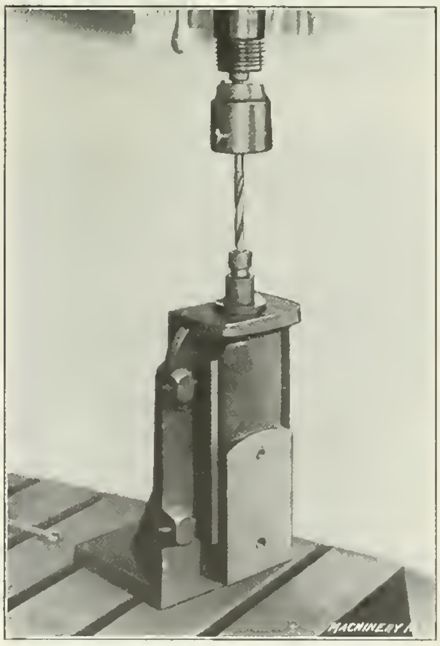


Fig. 9. Jig in which the Tool Slides are drilled

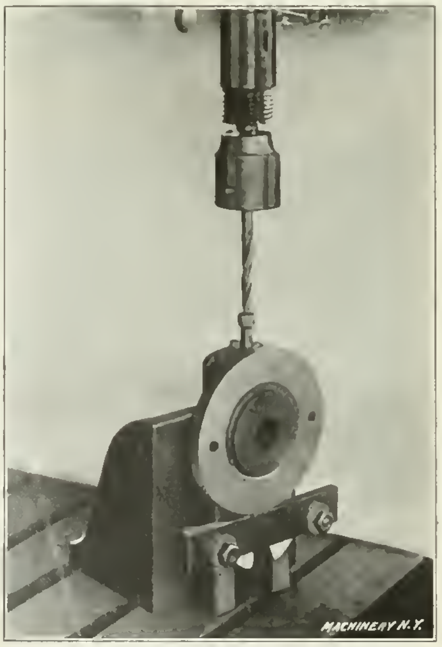


Fig. 10. Drilling the Holes in the Swivel in Correct Relation to the Hole in the Tool Slide

As I was packing up my tools an old machinist I knew came over and gave me some advice which has since proved to be first-class. "Boy," he said, "you are never expected to make the time on your first day in a strange shop that the old men do, but you are expected to do a good job, and if you do that in a reasonable amount of time you will soon be able to make the speed. Another thing, if the foreman rubbers at you like this one did this morning, don't start while he is there—oil your machine well, look for some tool, and if he is still there, ask him where the water is, and go get a drink. This will give you a chance to find yourself and to see how the other machines are running on the same class of work." When I applied for my next job I followed his advice and was successful.

Some foremen make a practice of giving a new man what they call a "test," that is, they pick out the hardest job they have and give that to him, and if he is successful with it he is a good man. I knew a locomotive pit boss who always gave new men shoes and wedges, and if they could lay them out they were machinists.

In one shop I was given an inside, double, left-hand, square thread to cut. The lathe was an old one and I had to take up some lost motion in it, figure out the gears, get tools dressed, etc., in fact there was a lot of preliminary work to do before I could start on the job. I do not remember how long I was on it, but I made good and satisfied the foreman. Now there was nothing really difficult about that job, and I was capable of doing it at the time I lost my first job, but a little nervousness would have spoiled it, as it did in the first case.

The differing requirements for work in various shops is another thing a new man has to contend with; one wants a nice finish—another doesn't care so long as the workmanship is good. Most shops have certain ideas about work that you do not agree with, but it is not good policy for a new man to criticise them. I remember one shop that used lard oil for lubricating. Although I considered this poor practice, I used it and said nothing —it was their business, not mine; and so with everything.

In brief, a new man must be guided by circumstances, do what he does right, avoid getting nervous, and not go to the other extreme of trying to tell people in his first day how to run a business which they have spent years and money building. In the words of a successful master-mechanic, "A good man does as he is told to do."

* * *

Cylinder oil may be tested by heating it and noting its color. A good cylinder oil will not change color to any noticeable degree when heated to 480 degrees F., or a temperature higher than that existing in a high-pressure engine cylinder. Low-grade oils, however, will darken when heated to this temperature.

CUTTING KEYWAYS IN AN AUTOMATIC SCREW MACHINE

By S. N. BACON

Very few mechanics and engineers are aware of the possibilities of the automatic screw machine, for different reasons, one of which is that when an odd job is tried and successfully made it is regarded as a discovery and a secret, and the fellow who dares to write about it, is in danger of being discharged; in the meantime our competitor over in the next town, has been using this same device for years and he also is very careful not to let the secret out.

In this article the writer will describe the making of the pieces shown at *A*, *B* and *C*, Fig. 1, in the automatic screw machine. The cutting of the keyway is most interesting, so it will be described first. To those who have doubts as to whether these jobs worked successfully the writer will say that the material was in all cases soft brass, and that the keyway in the piece *A*, was given a limit of 0.005 inch. This piece was made from 1-inch diameter round brass rod in a No. 2 Brown & Sharpe automatic screw machine, and it was manufactured in large quantities to be used in lathe construction. The hole was not reamed, as the drill cut a hole smooth enough for the use to which it was put. The surface speed of the drill was 157 feet per minute and the surface speed of the external diameter of the stock was the same.

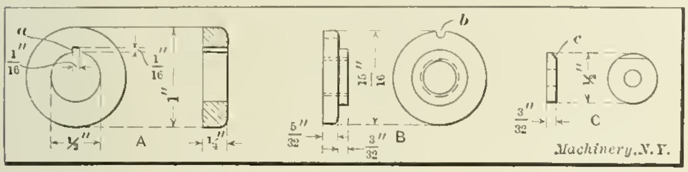


Fig. 1. Pieces which were successfully shaved in a Brown & Sharpe Automatic Screw Machine

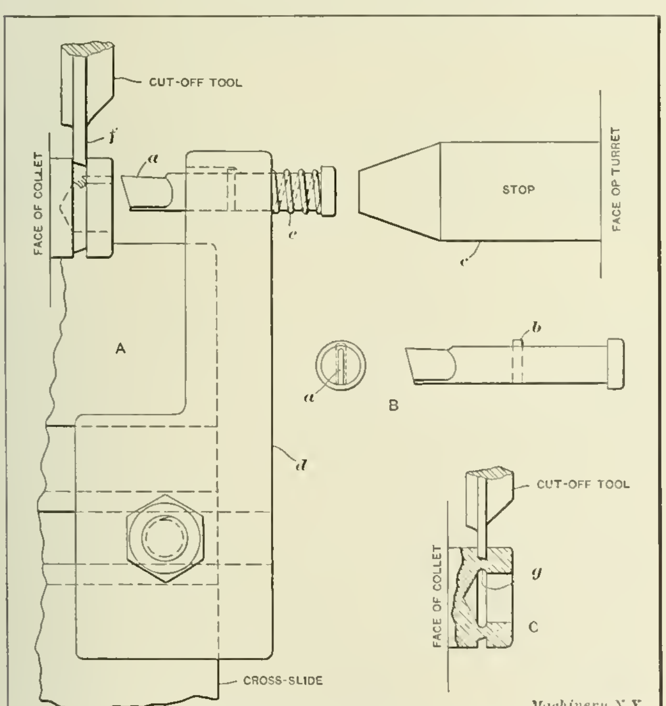


Fig. 2. Tools and Method used in Cutting the Keyway in the Piece shown at A, Fig. 1

The reason for this is that the stock is twice the diameter of the drill and the fast spindle speed, which is 1200 revolutions per minute, is twice that of the slow speed, which is 600 revolutions per minute. It should be mentioned here that a Brown & Sharpe spindle brake was used in connection with this operation and the belt-shifting attachment also, which gave the two spindle speeds 600 and 1200, respectively. This belt-shifting attachment was described in the June number of MACHINERY, so it will not be necessary to mention it further.

We will now describe the shaving tool and the operation of shaving the keyway. The tool-holder and shaving tool used for this operation are shown at *A* in Fig. 2, and a clearer view of the shaving tool itself is shown at *B*. This tool is made rectangular at the cutting edge *a* and is also given a slight top rake. A small pin *b* is inserted in it which prevents it from rotating in the holder. The tool is shown assembled in the holder at *A* and it can be seen that a small spiral spring *e* is used to keep the tool back from the work until it is operated on from the turret.

In operation the front cross-slide cam moves the cutter forward until the cutting point has reached a point where it will shave a chip 0.0205 inch thick. The stop *c*, which is held in the turret now moves forward pushing the cutter through the holder *d*, and into the work. Then the stop *c* is withdrawn and the coil spring *e* returns the cutter to position for another cut. The front-slide is now advanced until the cutter is in position to take another cut 0.021 inch thick and the same operation is repeated until the keyway 1/16 inch deep is cut. This is performed by three movements of the shaving tool. It will be noticed that the cut-off tool *f* is of sufficient width to allow the hole in the piece to be drilled deep enough so that the shaving tool will have plenty of room to pile up the chips. If this were not provided for, the chips would pile up ahead of the tool and break the point.

A method could be used as shown at *C* so that the blade of the cut-off tool would not be as thick as at *f*; in this case the hole could be recessed as shown at *g* so as to leave plenty of chip-room. The peculiar shape at the bottom of the hole is made by the point of the drill and the recessing tool. The shaving tool is very cheaply made and is sharpened by grinding on the end. If desired the pin *b* could be dispensed with by leaving a ring at this point when turning the shaving tool, and milling the ring away, except the part which would fit in the slot; but the pin, however, is more easily made and also simplifies replacing when broken. The order of operations to make this piece is as follows

TURRET OPERATIONS

(Spindle Speed, 1200 R. P. M.)

Order of Operations	Revolutions	Hundredths
Feed stock to the stop and chuck	44	0 to 4
Revolve the turret	33	4 to 7
Center 0.250 inch rise at 0.007 inch feed	44	7 to 11
Revolve the turret	33	11 to 14
Drill 0.310 inch rise at 0.0065 inch feed	44	14 to 18
Revolve the turret and shift to dead pulley, held by spindle brake	33	18 to 21
Push in shaving tool on front-slide with stop held in turret	33	23 to 26
Return and push in shaving tool 2nd cut	55	26 to 31
Return and push in shave tool 3rd cut	55	31 to 36

FRONT CROSS-SLIDE OPERATIONS

(Spindle Speed, 1200 R. P. M.)

Order of Operations	Revolutions	Hundredths
Bring forward shaving tool on front-slide so it will shave 0.0205-inch chip	22 (49.5)	21 to 27½
Advance shaving tool 0.021 inch	(55.0)	27½ to 32½
Advance shaving tool 0.021 inch	11 (38.5)	32½ to 37

REAR CROSS-SLIDE OPERATIONS

(Spindle Speed, 600 R. P. M.)

Order of Operations	Revolutions	Hundredths
Cut off 0.530 inch rise at 0.00152 inch feed	693	37 to 100
Revolve turret 3 times while cutting off	(99)	(9)

The total number of revolutions to complete one piece equals 1100; number of seconds equals 55; gross product, 654; net product, 574; gears used, 60 driver, 60 first on stud, 42 second on stud and 77 on the worm shaft.

In Fig. 3 is shown a lay-out of the cams and it will be seen that the most interesting part is from 21 to 36 hundredths on the cam circle, this part being used for shaving the keyway. At the hundredths line marked 21 is seen a dotted line

which is the rise of the front cross-slide cam, this bringing the shaving tool to its forward position 0.0205 inch past the edge of the hole. When in this position the cross-slide dwells, while the stop in the turret pushes the shaving tool which is operated by that part of the cam shown by the full line from 23 to 36 hundredths, inclusive. It is necessary to keep the shaving tool on a dwell until the stop in the turret has receded; this is shown on the cam outline.

The lock-nut shown at *B* in Fig. 1 is another interesting piece on which expense was saved by using a shaving fixture in the automatic screw machine. This piece has the groove at *b* shaved in it to be used as a catch, for tightening the nut with a spanner wrench. As this piece is similar to the one just described it will not be necessary to dwell on the method of shaving. The order of operations is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	18	3
Revolve turret	18	3
Center 0.180 inch rise at 0.006 inch feed	29	5
Revolve turret	18	3
Drill 0.300 inch rise at 0.006 inch feed	59	10
Form 0.130 inch rise at 0.001 inch feed	130	22
Revolve turret	18	3
Tap in	18	3
Tap out	18	3
Revolve turret	18	3
Stop spindle and bring forward shaving tool for 0.020 inch chip	18	3
Shave 0.200 inch	35	6
Bring forward 0.020 inch	18	3
Shave 0.200 inch	35	6
Return and bring forward 0.020 inch	18	3
Shave 0.200 inch	36	6
Clear, start spindle	18	3
Cut off 0.400 inch rise at 0.002 inch feed	200	34
	592	100

The spindle revolutions used are 789 R. P. M. backward and forward The time to make one piece is 45 seconds, the gross product in 10 hours is 800 and the net product is 700.

Another piece which is shaved in an entirely different manner is shown at *C*, Fig. 1. In this case the piece was made on a No. 0 Brown & Sharpe automatic screw machine. Consider-

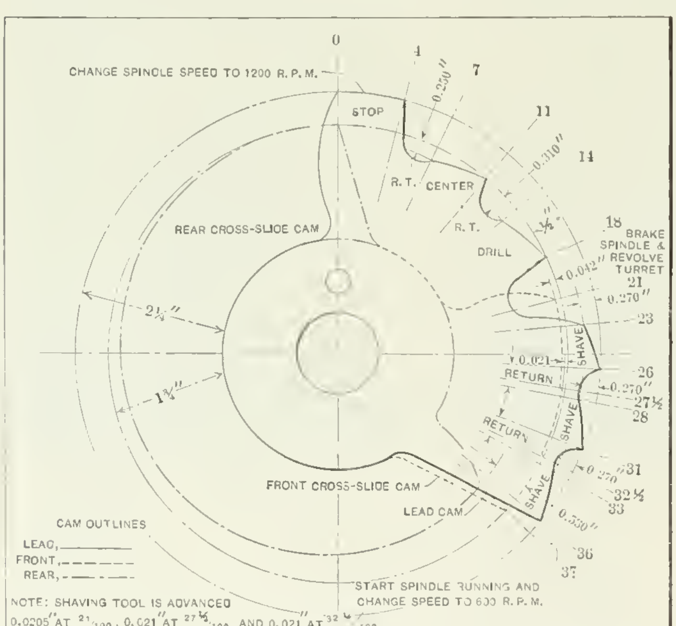


Fig. 3. Lay-out of the Cams used in Making the Piece shown at A in Fig. 1

able trouble was first experienced with this job but eventually it was worked out successfully. The material from which the piece was made is ½ inch diameter soft brass rod and the shaving operation consisted in removing the corner at *c*. The difference in the method of making this piece and those previously described is that the shaving tool and holder are held in the turret instead of on the cross-slide. The holder used for this operation is shown in Fig. 4, where *a* is the shank which fits in the turret, and inserted into it, as shown, is the shaving tool *b*. This tool is made spherical in shape and is ground on the end as shown. It also has a small pin *c* inserted in it to prevent it from turning in the holder, and is actuated by means of the small spiral spring *d*. The spindle brake, of course, is used in connection with this oper-

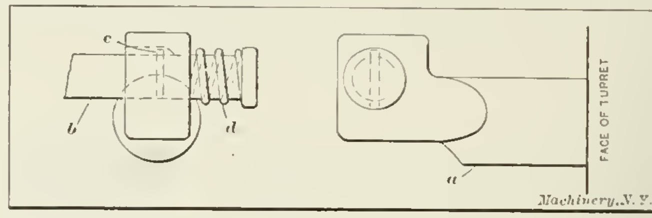


Fig. 4. Tool and Holder used in Shaving the Piece shown at C in Fig. 1

ation, but as only one spindle speed is used, it is not necessary to use the belt-shifting attachment. The tool is operated by the toolpost carried on the cross-slide. As this operation is somewhat similar to those described, it will be sufficient to give the order of operations only. They are as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	20	4½
Revolve turret	22	5½
Center 0.060-inch rise at 0.003-inch feed	20	4½
Revolve turret	22	5½
Drill 0.080-inch rise at 0.004-inch feed	20	4½
Revolve turret	22	5½
Stop spindle and bring shaving tool forward to cut 0.020 inch	15	3½
Shave 0.0250 inch	20	4½
Withdraw front-slide and advance shaving tool 0.020 inch	15	3½
Shave 0.250 inch	22	5½
Clear and start spindle	22	5½
Cut-off 0.270 inch rise at 0.002-inch feed	132	31½
Revolve turret 3 times while cutting off	66	16
	418	100

The spindle speed was 1174 R. P. M. The total time to make one piece equalled 17 seconds; gross product or number of pieces made in 10 hours, 2117; net product, 1900 pieces. The surface speed of the external diameter of the stock was 193 feet per minute, and for drilling, 48 feet per minute.

* * *

FLEXIBLE COUPLINGS

Couplings of some flexibility are often required for coupling together electrical machinery, or for coupling electric to other machinery. Two general types of flexible couplings are available—the leather link coupling and the laced belt coupling. The leather link couplings consist of two iron castings with flanges which are connected by leather links and bolts. The bolts are generally six in number and each alternate bolt is fitted tight in the flange of one casting and given considerable play in the other. The leather links then extend from each bolt to the one next to it, and provide a slight flexibility in driving. This coupling is especially adapted for shafts up to 3½ inches in diameter. The leather laced flexible coupling is adapted for shafts of larger diameter. It consists of two steel rings, one outer and one inner, in which slots are formed and through which two endless leather belts are interwoven. This coupling possesses great flexibility, and as the two rings are concentric, there are no bending strains.

* * *

Some tests have recently been made on a new alloy called duralumin, mentioned in the October number (engineering edition), brought out by Messrs. Vickers, Sons, and Maxim, Ltd. According to the *Practical Engineer*, London, the specific gravity is somewhat less than one-third of that of cast iron, and the tensile strength is equal to that of good mild steel. It is said that the alloy is not suitable for castings, but is used for sheets and plates. The ductility is fairly good in moderately thick plates, but falls off in thin sheets. The yield point is about one-half of the maximum strength in thin sheets.

THE EXPERIENCES OF A YOUNG TOOLMAKER*

By T. COVEY

"What is the matter, Jim? You look as if you had lost your last friend," said George, as Jim came up with a very long face.

"I'm in for it now," replied Jim.

"What is the trouble?"

"Mr. Corbin gave me this piece to make and I have spoiled it. He won't do a thing to me when he finds it out."

"Oh, I don't know. Mr. Corbin will be fair with you. He realizes that anyone is liable to make mistakes. What is wrong with the piece?"

"I've got this slot in it too wide. I had it all done but running a finish cut over the sides of the slot and was going to leave about two thousandths inch to finish by scraping. I had one side finished all right and the next to the last cut over the other side left the slot about five thousandths inch too narrow. I thought that by leaving the tool set as it was and running the cut up again I would have it about right. After I had gone about a half inch up from the bottom I tried this little gage that I had made, in it and it was just right, so I finished the cut; now the thing is all right at the bottom and four thousandths too wide at the top—and he told me to be particular and get it to the right width."

"That is too bad," said George, "but it can probably be fixed up all right."

"I don't see how," said Jim. "The stock is gone and that is all there is to it. What can be done with it now?"

"Well, if I had the job of fixing it up I should take a saw about an eighth inch thick and cut a slot alongside of that one and then plane up a strip enough thicker than the saw to make up the amount the large slot is too wide; then force the strip into the saw slot and solder it there, thus bending the stock between the saw slot and the large slot over towards the

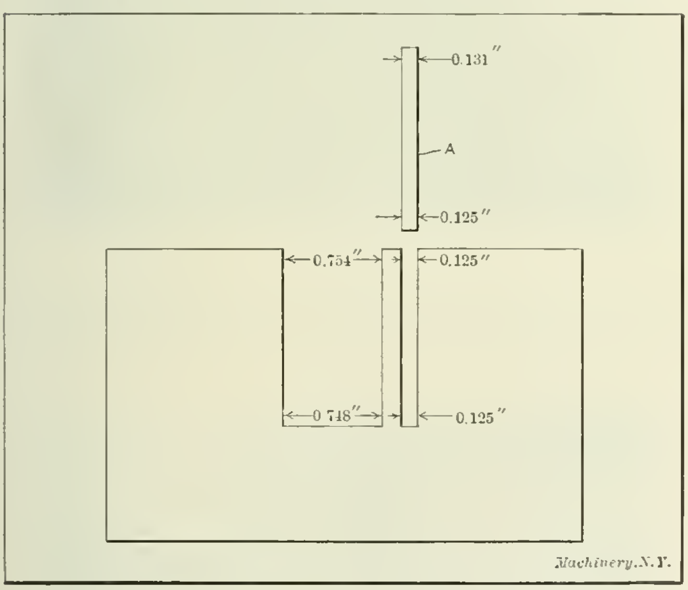


Fig. 1. The Spoiled Piece and the Way it was made Good

large slot and leave it so that it could be scraped up to the size that you want it. With a little care it could be done so that it would not show afterwards."

"I'll do that," said Jim.

"You had better show it to Mr. Corbin first and see what he says about it."

"Hard luck," said Jim as he walked away. About an hour afterward George came up to where he was puttering around at his vise and asked him what Mr. Corbin had said about it.

"I have not told him yet," said Jim. "I guess that I will finish it up and turn it in as it is."

"That is no way to do; if you leave it for him to find out, you will put yourself in a good way to get a lecture that you will remember for some time. Go tell him now and have it over with."

"I guess I will. I am in for it, and I may as well take it now as later," and he picked up the piece and, going up to Mr. Corbin's desk, said: "I have spoiled this piece, Mr. Corbin."

"How is that?" asked Mr. Corbin.

"I made this slot too wide," he replied, and went on and explained how it came about.

"Well, what will we do with it now?"

"Couldn't I take a saw and cut a narrow slot alongside of this one and put a piece in it enough thicker than the width of the saw slot to make up what I need to finish it properly?"

"I don't like patched-up jobs, but I want that pretty soon, and you could fix it much quicker than you could make an-

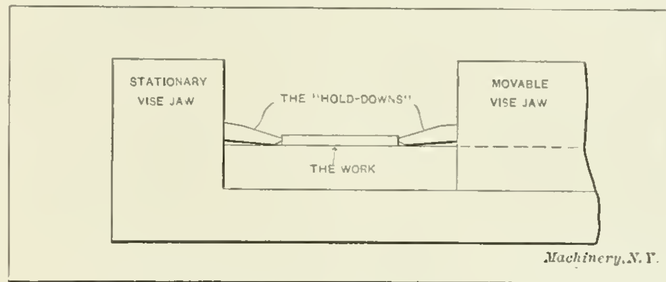


Fig. 2. Showing Use of "Spuds" or "Hold-downs" for Thin Plener Work

other. It is not going out of the toolroom anyway, so go ahead and see what you can do with it."

Jim took the piece back and told George that Mr. Corbin said that he did not like patched-up jobs, but to go ahead and fix it. "How far away from the slot should I cut in with the saw?" he asked.

"I should say about three-sixteenths inch. It is cast iron and you don't want to get too close. It is a good thing that the bottom of the slot is all right; now all you have to do is to make your piece that you put in slightly wedge-shaped and put the thin edge to the bottom; that will crowd the top over and leave the bottom as it is."

Jim got a large saw about 1/8 inch thick and cut a slot in the piece so that it looked like Fig. 1. (The patch properly dimensioned and ready to put in is shown at *A*.) Then he found a piece of cast iron that would plane up about 1 1/4 inch by 3 inches and a little thicker than 1/8 inch, which was what he wanted. He got the length and width planed up so that when put in place it would project slightly all around to allow for trimming off evenly with a file and scraper, but when he came to plane up the thickness he had considerable trouble holding it, as it was so thin, and he went over to George and asked him how he held such work.

"I have a couple of little strips here I call 'hold-downs' that I use on such work as that. All you have to do is to lay your piece on the bottom of the shaper vise and put one of these strips on each side of it and close the vise. (See Fig. 2.) They will hold it down on the bottom of the vise and firm enough so that you can plane it easily. When you take the last cut you can put paper under one edge to make that edge thinner than the other, and your piece will come out about right."

"Say, those work fine," said Jim. "Where did you get them?"

"I made them," said George. "They are fine for any work that you wish to plane parallel; and if they are hardened as those are they will last indefinitely."

"I'll have to make a pair myself," said Jim. "How will I go about it to solder that piece in place?"

"Why, get one of those small plumber's torches and heat the piece up around the slot so that it will just about melt solder, then put a little acid in the slot and with an old file thin enough to get well down to the bottom, scrape the inner surface and at the same time apply solder. In that way you can tin the inside of the slot. You should then heat the piece and tin it also; then heat both pieces until the solder will run, and press the strip in place, squeezing out the excess solder. Let the job cool, and if you have the surfaces in contact well tinned you can not drive the piece out with a sledgehammer. This method of soldering is sometimes called sweating."

Jim got the piece patched up and the slot finished to the

* For previous instalments of this series see: "Experiences of a Young Toolmaker" in the October number, and the accompanying references.

right width without any further difficulty, and when he had filed and scraped the patch down even with the piece, it was impossible to see where it was. Going over to George, he showed it to him and said. "You would never be able to tell where it was patched if you did not know. I wish now that I had not said anything to the boss about it—he need never have known it at all."

"Don't be too sure about that; it might turn out like the farmer's boy and the pumpkin seed."

"How was that?"

"Why, a farmer gave his boy some pumpkin seed and told him to go through the corn field and in every fourth hill of every fourth row push down a couple of the pumpkin seeds with his fingers, explaining that by the time the seed came up the corn would be past the need of cultivation and the pumpkins could grow undisturbed, thus raising two crops at once. The boy worked industriously for an hour or so and then began to get tired of the task; he noticed with dismay that the supply of seed given him had not diminished perceptibly, and, coming to a large stone, was struck with a bright scheme to finish the task at once and proceeded to put it in operation. He lifted up the stone and planted the remainder of the seed under it, then went and informed his father that the seed was planted. In due time the seed came up, including those under the rock, and told a very explicit story and incidentally caused—well, ask the boy what it caused. Now, if you had said nothing to Mr. Corbin, and finished your work up as it is now and turned it in to him as completed, he would have called you up in the course of a couple of days or so, showed you the piece with the patch distinctly outlined with rust caused from the acid used with the solder and asked for an explanation. You would have felt very small while giving it and smaller still when he was through talking to you. And, incidentally, you would have dropped several points in his estimation. The full confidence of your foreman is an asset that is much more valuable than one is likely to realize, and one that can be much more easily destroyed than built up."

"Yes, but as long as the piece was patched according to my suggestion, or rather yours through me, and it is just as good for fulfilling the purpose for which it was made, what difference should it make to him whether he knew about it or not?"

"As a foreman, Mr. Corbin is responsible to his superiors for the proper execution of all work done under his supervision. For this reason we all do our work according to instructions received from or through him, and for the same reason when any deviation from his instructions caused by defective material, mistakes or carelessness becomes necessary, he should at once be informed so that he may take such action as he considers proper. It is *his* province to judge whether such irregularities are of sufficient importance to prohibit the use of the piece or whether the defect can be repaired so that the piece will perform that which is required of it. If a piece of work was to be surreptitiously patched so skillfully as to pass his inspection without detection, it would be work of which he had no true knowledge of the character and for which he would still be responsible. You can readily imagine his position if such a piece should fail in service and the failure be reported to his superiors before it was to him. He would then be called to account for something of which he had no knowledge, and the very fact that such work was done in his department without his knowledge would be very much to his discredit. Now, don't you see that in justice to your foreman any irregularities in your work should be reported to him at once?"

"Yes, I can, and I also see that it would not reflect to a man's credit to impose on his foreman in that way."

"No, nor in any other way. There is no man so perfect that he never makes mistakes, and the one that is prompt and willing to admit it when he does make a mistake and stands ready to take the consequences of it, will find that he will be much more liberally and leniently dealt with than one that tries to cover up his mistakes and shoulder the responsibility on some one else. Your foreman is the medium through which you obtain advancement. Your advancement depends entirely on his report to your employers, and it is hardly to be expected that he will try to push a man ahead that is not honest and square with him."

"That's right," said Jim, "and I thank you for helping me to fix this job up and for the talk, too," and he took the work to Mr. Corbin for his inspection.

"You have done a good job of patching," said Mr. Corbin, "but don't forget that you are learning to be a mechanic and not a doctor, and that it is much better to prevent a mistake than it is to be able to patch it up well."

* * *

CLAMPING PLANER WORK AND BORING JIGS

By ETHAN VIALL*

A simple and effective method of clamping work onto a planer table is in use in the shop of the Elgin Tool Works, Elgin, Ill., and is illustrated so plainly in Fig. 1 that little description is necessary. It will be readily seen that the ten-

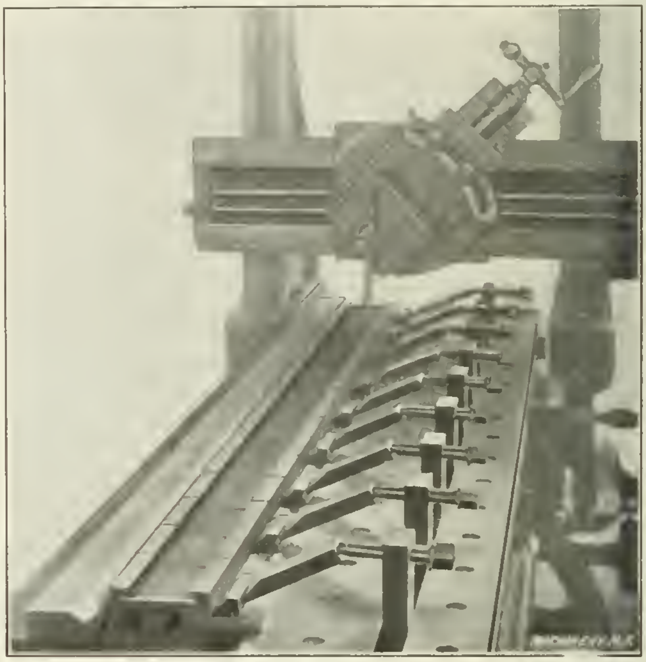


Fig. 1. Method of Clamping Work on Planer Bed at Elgin Tool Works, Elgin, Ill.

dency of the clamping screws is to bind the parts down firmly onto the bed, the strain being downward. The pieces are, of course, kept from moving lengthwise by a stop in the bed.

Holes in jig plates are accurately laid out and bored as

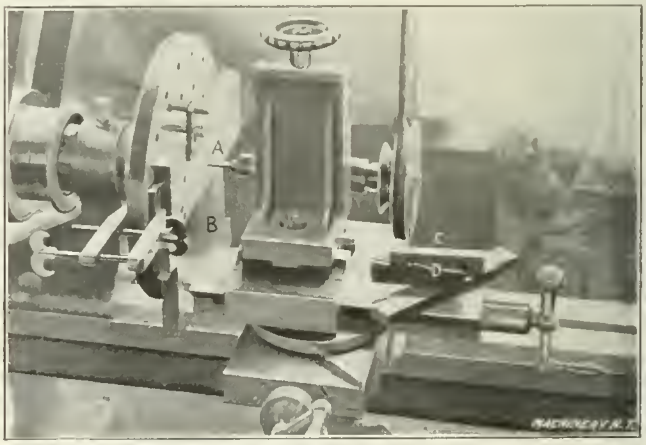


Fig. 2. Method of Laying out and Boring Jig Plates in the Elgin Tool Works

shown in Fig. 2, *A* being the jig plate to be bored and *B* an adjustable parallel block which may be set to any width within its range by using a micrometer, and adjusting and locking the two halves of the parallel in the correct position. Where required solid parallels may be used to block up, and dimensions in both directions may be obtained by using adjustable parallels on the end as well as the side of the jig

* Associate Editor of MACHINERY.

plate. Two small adjustable parallels are shown at *C*, which are locked when set in the desired position by the lock-screws *D*. The two pieces composing the parallel are held together by a T-tongue and slot, as will be seen by examining the front end of *B*.

* * *

DIAGRAM FOR FINDING CUTTERS FOR BEVEL GEARS

By V. BROCKBANK*

The accompanying diagram, Fig. 2, gives the number of cutter to be used for cutting the teeth in bevel gears with shafts at right angles. The number of cutter given is according to the system inaugurated by the Brown & Sharpe Mfg. Co. for involute gear teeth. The method of using the diagram is very simple. Locate the number of teeth in the pinion on the right-hand side, and the number of teeth in the gear at the top of the diagram. Then follow, from the points thus located, the horizontal and vertical lines, respectively, until they intersect. The figures denoting the section of the diagram within which the lines intersect, are the numbers of the cutters to be used; where two numbers are given, the lower number in each case gives the number of cutter for the gear, the higher number, the cutter for the pinion.

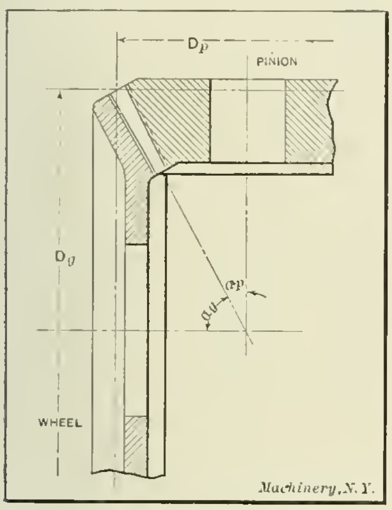


Fig. 1. Diagram showing Significance of Symbols used in Formulas

For example, assume that we are to select the cutters for a pair of bevel gears, the pinion having 24 teeth and the gear 60. Locate 24 on the right-hand side and follow the horizontal line from the point located. Also locate 60 on the top scale and follow the vertical line from this point. The two lines intersect within the area marked "1—5"; hence, a No. 1 cutter will be used for the gear, and a No. 5 cutter for the pinion.

The diagram is based on the regular bevel gear formulas, as given below:

Let D = pitch diameter,

N = number of teeth,

N' = number of teeth in equivalent spur gear for which cutter is chosen,

P = diametral pitch,

a = pitch cone angle,

When sub-letters ($_g$) and ($_p$) are used, reference is made specifically to the gear or pinion (see Fig. 1).

Then:

$$D = \frac{N}{P};\quad \tan a_p = \frac{N_p}{N_g};\quad \tan a_g = \frac{N_g}{N_p};\quad N' = \frac{N}{\cos a}$$

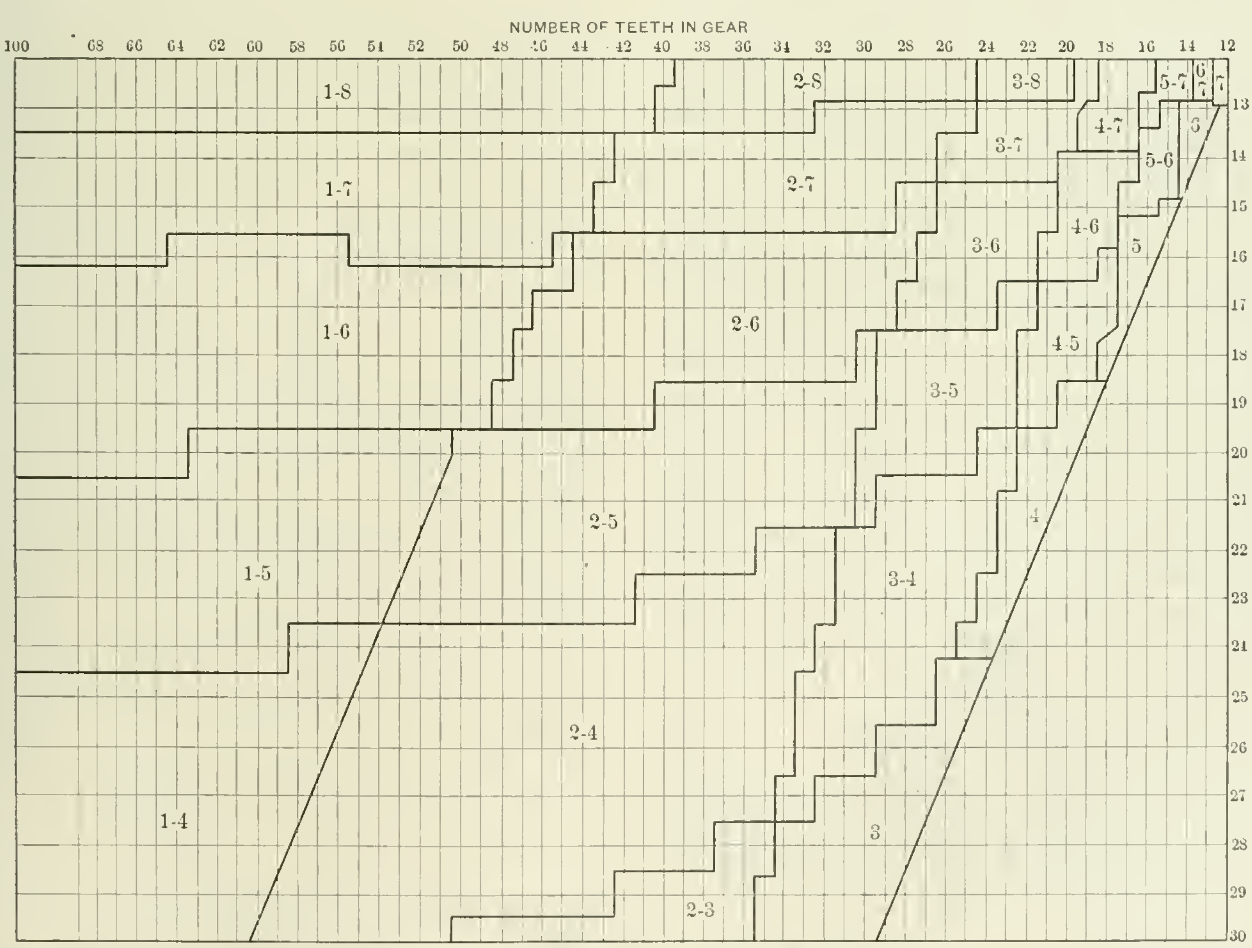
When used for spur gears,

No. 1 cutter cuts	135	teeth	to	a rack
No. 2 cutter cuts	55	teeth	to	134
No. 3 cutter cuts	35	teeth	to	54
No. 4 cutter cuts	26	teeth	to	34
No. 5 cutter cuts	21	teeth	to	25
No. 6 cutter cuts	17	teeth	to	20
No. 7 cutter cuts	14	teeth	to	16
No. 8 cutter cuts	12	teeth	to	13

When the number of teeth in the equivalent spur gear, N', is found, the numbers of cutters for cutting bevel gears are also found from the above table.

* * *

Pure platinum is too soft for many purposes, and the platinum iridium alloy used for spark-plugs, etc., is not only harder, but is more infusible than pure platinum. The alloy is made with varying percentages of iridium, containing as a rule, from 80 to 97.5 per cent of platinum and from 20 to 2.5 per cent of iridium. Commercial platinum ranges from 99.7 to 99.8 per cent pure.



WHERE TWO NUMBERS ARE GIVEN, THE LOWER IN EACH CASE IS FOR THE GEAR

Fig. 2. Diagram for Finding Cutters for Bevel Gears

* Address: 157 Albert Road, Handsworth, Birmingham, England.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Ethan Viall,
Douglas T. Hamilton,
Associate Editors

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

DECEMBER, 1910

PAID CIRCULATION FOR NOVEMBER, 1910, 26,083 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SINGLE-PURPOSE MACHINE TOOLS

In the paper on the "Design and Construction of Machine Tools from the User's Standpoint," read by Mr. John Riddell at the October meeting of the National Machine Tool Builders' Association, the desirability of a simple turning lathe for manufacturing establishments was touched upon.

In every large manufacturing plant there are scores of engine lathes used for shaft turning and similar operations, day after day. These lathes are furnished with large and small faceplates, steady-rest, lead screw, change gears, cross-feed and other features of a complete modern engine lathe. A large part of this equipment is practically useless in manufacturing shops, and perhaps is never used during the life of the machine. Mr. Riddell has seriously considered the advisability of buying simple turning lathes without the useless adjuncts referred to, but intimated that there is no single-purpose lathe on the market that fully meets his requirements.

We feel sure that lathe builders will be glad to produce all the simple turning lathes that manufacturers require, and it can hardly be laid at their doors that it is not now a common machine tool. The fact is that most manufacturers regard their machine tool equipment as an available asset, its value being measured by the number of standard machines comprised. In other words, engine lathes, planers and other common machine tools have a well recognized market value, being available for any kind of manufacturing. They hesitate, therefore, to fill up their shops with turning lathes and other special equipment which does not, under the present conditions, have as great market value. We think that machine tool users will have no difficulty at all in inducing machine tool builders to furnish standard engine lathes, minus the unnecessary parts, provided orders for sufficient numbers are given at one time.

* * *

THE DANGER OF OVER-EXPANSION

A prosperous business may be compared to a flourishing tree. A tree's roots spread from year to year, reaching new soil and gathering more and more nourishment to the parent trunk. It grows steadily, adding a new ring each year—whether the season be wet or dry. The winter's winds may assail and the summer's sun beat fiercely down upon it, but the deep, wide-spreading roots support it and reach never-failing sources of water and nourishment. When the tree is a sapling, its roots are not deeply seated, but its needs are not great. As the trunk grows, the roots keep pace, for it is an established fact that the diameter of spread of the roots of trees growing in the open is equal to the total height.

A safe business is one that has grown healthily from year to year; its ramifications like the roots of the tree, having spread in all directions. If sales fall off in one part of the country, those from other parts may be relied on to nourish the business and keep it alive. Strength and prestige should come from age in a business, and on the other hand, one that has grown by leaps and bounds is likely to lack strength for the same reasons that apply to the trees. While it flourishes under favorable conditions it lacks foothold and balance to weather hard storms. Change in public taste, a financial crisis, or other conditions likely to develop may easily cause its downfall.

Automobile manufacturing is an industry that has grown beyond all precedent. Some concerns have sprung up like mushrooms in the night, and although originally of great size, they were unable, working day and night, to meet the phenomenal demand. The result was that they were repeatedly expanded until they have assumed enormous proportions, covering acres of ground and representing millions of dollars in investments. During the past few months evidences have appeared of a slackening demand for automobiles, and the prospects for the immediate future of some of these great manufacturing concerns are not so bright as we wish they were, although we believe that the natural and conservative development of the business, especially towards the construction of commercial vehicles, will in course of time establish it on as permanent a basis as any of our industries.

Probably the greatest temptation a business man encounters is to expand his business rapidly to meet expected demands. He realizes that he must go forward or backward, that he cannot stand still. Growth being generally regarded as synonymous with progress, it is perfectly natural to expand rapidly under favorable conditions. But the conservative business man when tempted to expand rapidly will consider carefully what the prospects are of surviving a period of hard times. It is better to turn away some business than to expand to such proportions that one bad season will ruin a business that has taken years to build up. "Make haste slowly" is still a good adage even for these strenuous times.

* * *

ACCURACY AND THE "SENSE OF VALUES"

From time to time we have called attention to the lack of accuracy in engineering calculations which has been displayed in articles submitted to us by apparently well-informed young engineers. This lack of accuracy is perhaps not entirely confined to the younger men, but it seems especially to be a shortcoming of the man recently out of college. Accuracy is the first requirement of engineering, but it may be misplaced. Some engineers and mechanics in making calculations go to an extreme of accuracy in cases where absolutely accurate results either cannot be obtained, or, if obtainable, would be unnecessary for practical requirements. In such cases too great accuracy may be a sign of careful work, but also an indication of poor judgment. This statement may require to be illustrated by an example. Assume that a girder 48 feet 4 inches between supports is subjected to a load at its center. This load is assumed to be 20,000 pounds as a maximum. It is also assumed that the safe stress in the girder must not exceed 12,000 pounds per square inch. Obviously, in a case of this kind, where the whole calculation is based on assumptions given in round numbers, it is not necessary to give the bending moment as 241,666.6 foot-pounds, or the calculated stress (assuming the moment of resistance to be 232) as 10,416.66 pounds. It simply requires an unnecessary amount of time to carry out the calculation to such close limits, and it is useless for all practical purposes. It is sufficiently close to say that the bending moment is 242,000 foot-pounds and the maximum stress 10,500 pounds per square inch.

Such approximations, of course, are permissible only when certain factors entering into the problem are based on assumptions which themselves are likely to vary to considerable degree from the actual figures in the case. The judgment required for determining to what extent such approximations are permissible or desirable comes almost wholly from experience; but as a general rule it may be said that if the calculation is based on general assumptions, or on experimental values varying between wide limits, it is sufficiently accurate, and almost always preferable, to give the answer in approximate rather than exact figures. To do so is an indication of a "sense of values"; that is, an ability to decide when and where extreme accuracy is required—a faculty for distinguishing between essentials and non-essentials.

This "sense of values" applies not only to engineering calculations. It applies to the work in the business office and to the practical shop as well. To be able to properly distinguish essentials from non-essentials is one of the prime requisites in a successful engineer or in a manager. In essence, it involves an ability to recognize under all conditions that the results accomplished are of greater importance than the system or the red tape necessary for its accomplishment; that the capacity of a machine is of greater importance than its finish; that the dimensions of parts which may be said to fit "a hole in the air" need not be accurate to one-thousandth part of an inch, etc. While accuracy is the first requirement in engineering, it is apt to be misplaced if it does not go hand in hand with a proper "sense of values."

* * *

MACHINERY MAKES OUR SUPREMACY

By J. CROW TAYLOR*

At no time, probably, more than during the past two or three years have we given the agricultural part of our country credit for representing our main source of greatness. Agricultural products have been high and we picture the farmer as being a bond-holder and riding in automobiles; and we do not stop at picturing his prosperity, but assume that he is the mainstay of the world and that the American farmer not only teaches the world, but can feed the world.

The facts and figures of to-day, however, show us plainly that our supremacy is due to machinery and not to our wonderful production in agriculture. Not that our agriculture is insignificant. It is the greatest in the world, and, by the way, its greatness is itself due to the development in the use of machinery in farming and handling farm products.

The record of exports of manufactures for the United States during the first nine months of the present year as furnished by the Bureau of Statistics at Washington not only shows that machinery and manufacturing is our great stronghold, but it furnishes evidence of its increased greatness each year and the fact that it overshadows agriculture. It is estimated that the exports of manufactures for this year will be in excess of $800,000,000 in value for the first time. For the single month of September the aggregate of export of manufactures was $70,000,000, and the figures so far this year show a large gain over last year's production and everything indicates a steady and much more rapid growth in the future.

We have two items that exceed our agricultural products or rather exceed the food-stuffs proper. One of these is crude material for use in manufacture, which includes some of our natural resources and some of the products of agriculture. Then we have manufactured stock ready for consumption. These manufactured goods represent the biggest export item of all and are practically double our immense trade in food products.

So, it is really mechanics and machinery that are responsible for our greatness, and the inventor has been a greater factor for development in the United States than has the farmer. Indeed, the inventor has been a great factor in developing our farming possibilities. If we had continued to farm as they do in old countries with primitive tools and hand labor we would never have attained anything like the greatness of the present. It took the inventors to bring this out and there is a long line of them to which much credit is due. The planters, plows, cultivators, mowers, reapers, threshers, mills, and all the mechanical apparatus used in planting, producing and handling agricultural products, have made farming what it is, and these same inventors and the machinery institutions making and handling their products that have made the United States famous have made possible our great manufactures, have made it practical to turn out manufactured products in competition with poorly paid labor in all parts of the world, made competition successful, and still paid the mechanics operating the machinery more money than is paid anywhere else in the world.

So, we may grow sentimental if we will over the farm and its products and over the farmer being the backbone of the nation and the main dependence for its subsistence, but the facts and figures show that the farmer is only a secondary consideration and it is the manufacturer and machinery that comes first as a factor in the upbuilding of our nation's greatness. It is machinery and mechanics that have enabled us to dominate the world's markets and have made possible our great progress in farming. Not only that, when things are slow in the manufacturing world, when panics and depressions come there are hard times and the people suffer more perhaps than when there is a bad crop in this section or that section. Moreover, the mechanics which make possible irrigation furnish a safeguard in agriculture against famine by a national wide failure of crops. Therefore, it is to the men of genius who invent and to the men of capital and enterprise who manufacture and produce that the great share of credit is due for the upbuilding of the American nation and its supremacy in the world of industry and commerce.

*Address: Masonic Building, Louisville, Ky.

* * *

HORSEPOWER REQUIRED TO COMPRESS AIR*†

By J. WILLIAM JONES‡

In estimating the various items in compressed air computations, it is customary to employ formulas previously determined, and generally published in various hand-books. This custom not only eliminates the possibility of errors, but saves time that would otherwise be used in long calculations. For the same reason the tables in the accompanying Data Sheet Supplement will be found invaluable to those who have to deal with calculations relative to compressed air.

When air is compressed in a cylinder without the removal of any heat due to compression, the compression is termed "adiabatic." On the other hand, when the heat of compression is removed as fast as produced, the compression is known as "isothermal." Neither of the above conditions are ever met with in actual practice. The actual compression curve, however, follows the adiabatic curve closely, and we, therefore, assume that the compression is adiabatic, as any slight difference is on the safe side. Isothermal compression is an impossible ideal, and the horsepower, mean effective pressure, etc., relating to isothermal compression are employed in the making of comparisons only.

The formula for calculating the horsepower required to compress, adiabatically, a given volume of free air to a given pressure is as follows:

$$\text{H.P.} = \frac{144\,N P V n}{33000\,(n-1)}\left[\left(\frac{P_3}{P}\right)^{\frac{n-1}{Nn}} - 1\right]$$

in which

N = number of stages in which compression is accomplished,

P = atmospheric pressure in pounds per square inch,

P_3 = absolute terminal pressure in pounds per square inch = gage pressure plus atmospheric pressure.

V = volume of air in cubic feet, to be compressed per minute, at atmospheric pressure,

* With Data Sheet Supplement.

† For further information on kindred subjects, see MACHINERY, November, 1909, "Compressor Designing—The Distribution of the Load"; March, 1910, "Air Compressor Testing"; August, 1910, "High-pressure Cylinder Diameters for Air Compressors." See also MACHINERY's Data Sheet for August, 1910, "High-pressure Cylinder Diameters for Air Compressors."

‡ Address: Painted Post, N. Y.

n = exponent of the compression curve, taken as 1.41 for adiabatic compression.

Simplifying the above formula for the different stages and for a value of one cubic foot we have:

For one-stage compression:

$$H.P. = 0.015\ P\ (R^{0.29} - 1)$$

For two-stage compression:

$$H.P. = 0.030\ P\ (R^{0.145} - 1)$$

For three-stage compression:

$$H.P. = 0.045\ P\ (R^{0.097} - 1)$$

For four-stage compression:

$$H.P. = 0.060\ P\ (R^{0.0725} - 1)$$

In these formulas $R = \frac{P_3}{P}$ = number of atmospheres to be compressed.

For computing the horsepower required to compress, isothermally, a given volume of free air to a given pressure, the following formula should be employed:

$$H.P. = \frac{144 \times PV}{33000}\left(1 + \text{Nap. log. } \frac{P_3}{P}\right)$$

The Napierian logarithm is obtained by multiplying the common logarithm by the factor 2.302585. (Tables are given in Kent's Mechanical Engineer's Pocketbook, 7th edition, page 156.)

In the fourth and fifth columns of the Data Sheets for two- and three-stage compression, it will be noticed that these columns cover the correct ratio of the cylinders, and the intercooler pressure, respectively. The correct ratio of cylinders (r) is obtained by the following formula:

For two-stage compression:

$$r = \sqrt{\frac{P_3}{P}}$$

For three-stage compression:

$$r = \sqrt[3]{\frac{P_3}{P}}$$

Thus, for two-stage compression we extract the square root of the number of atmospheres to be compressed, and for three stage we extract the cube root. This proportion of cylinder volumes divides the work equally between the different stages, providing the intercooler abstracts all the heat due to compression in the preceding stage. The intercooler gage pressures, as shown in the fifth column, are obtained by multiplying the absolute intake pressure by the ratio of the cylinder volumes, and subtracting from this result the atmospheric pressure. It should be remembered that the intake pressure of the second-stage cylinder of any three-stage machine is the absolute intercooler pressure from the cooler between the first and second stages.

Let

P_1 = intercooler pressure between first and second stages,

P_2 = intercooler pressure between second and third stages.

Then, for two-stage compression:

$$P_1 = \left(P \times \sqrt{\frac{P_3}{P}}\right) - P$$

For three-stage compression:

$$P_1 = \left(P \times \sqrt[3]{\frac{P_3}{P}}\right) - P$$

$$P_2 = \left(P_1 \times \sqrt[3]{\frac{P_3}{P}}\right) - P$$

It is sometimes advantageous to know the mean effective pressure per stroke as shown on the Data Sheets. By dividing 144 by 33,000 we obtain a factor 0.00436, which divided into the horsepower will give the mean effective pressure per stroke.

* * *

It requires very little ability to find fault. That is why there are so many critics.—*Oliver Wendell Holmes.*

INCREASING THE PRODUCT OF AUTOMATIC SCREW MACHINES

By S. N. BACON

In the following the writer will describe two pieces on which the production was increased fifty per cent. The first piece contains, as the reader will notice, some valuable information in regard to the forming of work to a small diameter. By referring to screw machine treatises, tables, etc., it will be found that two-and-one half times the smallest diameter of the work is the maximum width advised for forming; that is, the width of the form tool cutter a for forming the screw at A in Fig. 1 should not exceed two-and-one-half times the diameter of the threaded body b. This means that when we have a piece too long to form, it must either be reduced by a hollow-mill or a box tool. As this subject has not been thoroughly

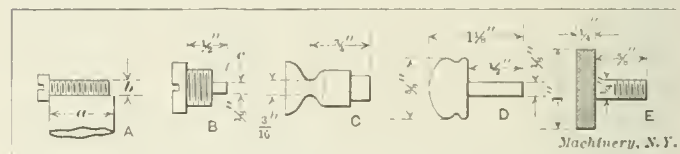


Fig. 1. Work on which the Production was increased

explained, that is, the relation of the width of the form tool to the diameter of the stock, the writer will give a few results of experiments which he has made.

First, by actual test it has been found that screws and other parts made from machine and tool steel can be formed with a form tool whose width is four times the smallest diameter of the part to be formed. Now this does not mean a piece as shown at B in Fig. 1, where the smallest diameter c is on the end of the piece, but it applies to pieces similar to those shown at A, C and D, where the smallest diameter of the work is next to the spindle. Again, it would be very easy to form with a tool of a width equal to four times the smallest diameter, if that diameter were not very small. Two examples of this class of forming are given, and the reader can safely use them as a guide for doing work of a similar character.

The first test was the forming of a 5/8-inch piece of screw stock with a tool 7/16 inch wide, down to 7/64 inch diameter.

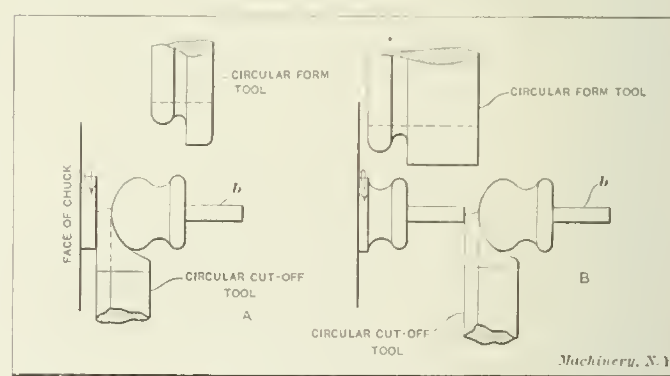


Fig. 2. Method of applying the Circular Form and Cut-off Tools to increase the Product

Here we have a width of four times the smallest diameter. It might also be mentioned that this test was performed on a No. 2 Brown & Sharpe automatic screw machine and that the surface speed of the stock averaged about from 80 to 85 feet per minute, with a feed of 0.001 inch per revolution. This forming was successfully done without any of the pieces breaking off.

The second test was made on a piece of 3/8-inch iron wire, which was formed to a diameter of 3/16 inch, the form tool in this case being 1 inch wide. This test was made on a 3/8-inch Cleveland automatic screw machine. The maximum surface speed of the stock was 90 feet per minute and it was calculated as nearly as possible that the chip averaged from 0.0004 to 0.0008 inch thick.

The writer believes that this information will help those who are designing cams, as the slow and troublesome method of using a hollow-mill and box-tool can sometimes be avoided when the designer knows that he can form a piece with the

circular form and cut-off tools. The two methods of forming the piece shown at *A* and *B* in Fig. 2 on the No. 2 B. & S. automatic screw machine, and the following order of operations show clearly the advantage that the forming method has over the box-tool or hollow-mill method of turning.

In the method shown at *A*, two roughing box-tools are used for reducing the diameter of the stem *b*, and as the stem was also required to be smooth, a finishing box-tool was used, as can be seen in the following order of operations. The feed also had to be fine, to avoid a large teat, as the cut-off tool forming such a round head would cause the piece to break off before it had been entirely cut off.

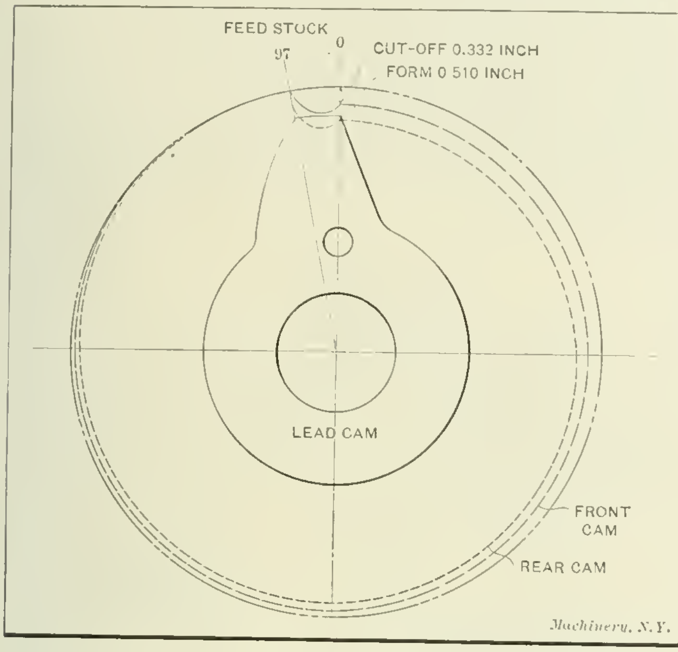


Fig. 3. Cams for Making the Piece shown in Fig. 2 by the Method shown at B

Order of Operations	Revolutions	Hundredths
Feed stock to stop,	29	2½
Revolve turret,	29	2½
First roughing box-tool 0.500-inch rise at 0.005-inch feed,	100	8½
Revolve turret,	29	2½
Second roughing box-tool 0.500-inch rise at 0.005-inch feed,	100	8½
Revolve turret,	29	2½
Finishing box-tool 0.500-inch rise at 0.005-inch feed,	100	8½
Revolve turret,	29	2½
Form, 0.510-inch rise at 0.0015-inch feed,	340	29
Cut-off, 0.332-inch rise at 0.0009-inch feed,	383	33
Revolve turret twice while cutting off,	(58)	(5)
Total number of revolutions to make one piece,	1168	100

The spindle speed used was 549 R.P.M., so that the time to make one piece was 135 seconds, gross product in 10 hours, 266 pieces.

The new method of making this piece is shown at *B* in Fig. 2. Here the form tool travels the same distance as in the method shown at *A*, but a much finer feed is used on account of the greater width of form. No time is lost by this, however, as one piece is being cut off at the same time that another piece is being formed. It might be well to mention, however, that no trouble was experienced by feeding the stem out against the stop, that is, the stem *b* did not bend or become distorted in any way.

By comparing the following order of operations with those previously given, it will be noticed that there is a considerable increase in production, and also that the work is handled more expeditiously, and a good job is the result.

Order of Operations	Revolutions	Hundredths
Feed stock to stop,	16	3
Cut-off, 0.332-inch rise at 0.0007-inch feed,	503	97
Form, 0.510-inch rise at 0.001-inch feed,	(503)	(97)
Revolve turret five times,	(80)	(15)
Total number of revolutions to make one piece,	519	100

The speed of the spindle was 519 R.P.M., giving a maximum surface speed of 84 feet per minute. The time required to make one piece was 60 seconds, giving a gross product of 600 pieces in 10 hours. This is a considerable increase over 266 pieces, which were obtained by the method shown at *A*, and the gain is not made by "hogging" out the work, because the feeds are finer and the work is better.

The cams used for the operation shown at *B* in Fig. 2 are shown in Fig. 3. Here it can be seen that the cut-off and form cams start at 0 hundredths and finish at 97 hundredths on the cam circle. The form cam is shown by the dotted lines and the cut-off by long dashes; and the lead cam by a full line.

Another piece on which the production was increased considerably is shown at *E* in Fig. 1. This is a thumb-screw made from 1-inch machine steel on a ⅞-inch Cleveland automatic screw machine, which had been changed to take 1-inch stock. This piece was first made on an old-style Cleveland automatic screw machine having a single-acting cross-slide, that is, the front and back tools were mounted on the same slide and could not be operated independently. The order of operations for making this screw by this method is as follows:

Order of Operations	Revolutions	Seconds
Feed stock to stop,	30	6
Form,	275	55
Knurl from turret,	100	20
Thread on and off,	40	8
Cut-off,	300	60
Total number of revolutions to make one piece	745	149

This order of operations gave a gross product of 240 pieces in 10 hours.

To increase the production of this piece it was transferred to a new Cleveland machine which had a double independent cross-slide, thus enabling the cut-off and form tool to be operated at the same time. A cross-slide knurling tool was also used on the cross-slide, obviating the necessity of putting it in the turret. The order of operations for this piece is as follows, and it can be seen that a considerable increase was the result of this change.

Order of Operations	Revolutions	Seconds
Feed stock to stop,	30	6
Cut-off,	300	60
Knurl, attached to cut-off tool,	....	....
Form, while cutting off,	(275)	(55)
Thread, on and off,	40	8
Total number of revolutions to make one piece	370	74

The gross product by this method was 486 pieces in 10 hours, or twice that of the previous method.

* * *

SOFT SOLDERING FLUX

By C. D. K.

In soft soldering or tinning metals, it is necessary to have the surfaces operated upon free from the metallic oxides that are usually found on them. They should be quite bright or at least chemically clean for this purpose, and they are usually scraped or polished. When they have been treated in this way it is found that it is best to apply some sort of flux, which helps the soldering in several ways, and when they are united the adhesion is much better. The bright metal is much more apt to take up fresh oxygen, especially when it is heated in the oxidizing portion of a gas or Bunsen flame, but the flux when applied, helps to protect it from fresh oxidation, and some fluxes help to remove oxidation, also. Common resin, sal ammoniac, muriatic or hydrochloric acid and chloride of zinc are used for fluxes as well as others, but the first four are generally used. Zinc chloride, or as it is sometimes called muriate of zinc, has many advantages for use in some of the soldering work which machinists and toolmakers have to do, such as soldering pieces of steel, iron, brass and copper, especially iron and steel. The remarks given herewith do not pretend to deal with the methods used in places where large numbers of pieces and large pieces are tinned, but those adapted for the smaller operations in this line of work.

The most convenient form for using the zinc chloride as a flux for such work, is in that of a solution of zinc chloride ($ZnCl^2$) in alcohol, to which a little glycerine is added, which makes it sticky and causes it to adhere more readily to the articles to be soldered. Zinc chloride can be obtained in two forms, one of which is the salt sold by wholesale druggists and chemists, and which comes in bottles in anhydrous crystals and readily dissolves in water and in alcohol, with a caustic solution. The salt is deliquescent, taking up moisture, and should therefore be kept covered up when not in use.

The other form can be prepared by dissolving metallic zinc in hydrochloric or muriatic acid. This form is apt to be corrosive as it frequently contains free acid, and the salt is therefore preferable. It is obtained by a similar process, but the acid has all been evaporated. The form made direct from acid can be used, however, without any other solvent; but the other form requires a solvent of some sort so that it can be applied to the work. Alcohol possesses two advantages which adapt it to this purpose, as it dissolves the chloride readily and when applied to the work takes fire if the work is hot enough, thus acting as a temperature indicator and helping to heat the work and keep it hot while the soldering is being done. Various proportions are given for mixing the chloride, alcohol and glycerine, but as alcohol will dissolve the chloride in various proportions these can be varied to suit individual preferences.

One formula gives the proportions as follows:

Zinc chloride	5 parts
Alcohol	4 parts
Glycerine	1 part

Another formula used successfully is as follows:

Zinc chloride	2 parts
Glycerine	3 parts
Alcohol	5 parts

These mixtures can be kept for a long time in ordinary bottles with corks, but it is preferable to use glass stoppers when they can be obtained. A brush, cloth or swab is convenient for applying the solution to the work, but whatever is used should be kept away from the flame on account of the alcohol in the mixture.

Cast-iron pieces can be successfully tinned and soldered with a flux of zinc chloride solution, but great care is necessary in all the work and the cleaning, fluxing, heating, and soldering must be well and carefully done.

Another "wrinkle" of soldering can be done by the aid of a flux, where the surfaces of the work fit together well, and this is soldering together by means of a piece of tinfoil. The surfaces must be cleaned thoroughly and closely fitted, and then bound together firmly with wire or held by clamps. The work is then heated by a lamp or a Bunsen burner or in a fire, using plenty of flux as needed, until the foil melts and joins the surfaces of the work together. Care, of course, must be taken to cool it properly and not disturb the parts until the tin has become thoroughly set and crystallized.

* * *

APPLICATION OF BALL BEARINGS TO LATHE CARRIAGE GEAR

By RACQUET

There seems to be no limit of uses to which ball bearings may be put. A few years ago the bicycle was about the only machine to use this type of anti-friction bearing to any great extent, but now it is the exception rather than the rule to find any machine that does not contain at least one ball bearing. About the most novel application that I know of is the one described herewith and I can safely say that the advantages derived were so self-evident that there was no question as to the efficiency of the arrangement. Fig. 1 is an elevation of a lathe apron showing the position of the gears for the longitudinal feed. Fig. 2 shows the method of driving the feeding arrangement from the feed-shaft, situated at the front of the lathe. It will be seen that the worm which is keyed to the feed-shaft drives the worm-wheel at the back of the apron which is keyed to the shaft *A*. The shaft *A* has forged solid with it a friction cone *B*, which engages with a corresponding friction surface in the 30-tooth by 7-pitch gear, which when in a normal position revolves loosely on the shaft. On the outer end of the shaft and keyed to it is another friction *C* which also engages with the 30-tooth by 7-pitch gear, only on the opposite side. This arrangement of double frictions was necessary because of the comparatively heavy pressure to be transmitted.

To engage the automatic feed, the knob *D* is clamped by turning it to the right on the threaded end of the shaft *A*. This, of course, clamps the shaft *A* to the gear, thus compelling the latter to revolve with the shaft. The small nut on the inside of the knob was used to prevent the knob from working off due to vibrations, and dropping on the floor.

When the lathe was erected it was found on trial that no matter how tight the knob *D* was clamped (by hand, of course) the hand-wheel could easily be turned by applying a force of

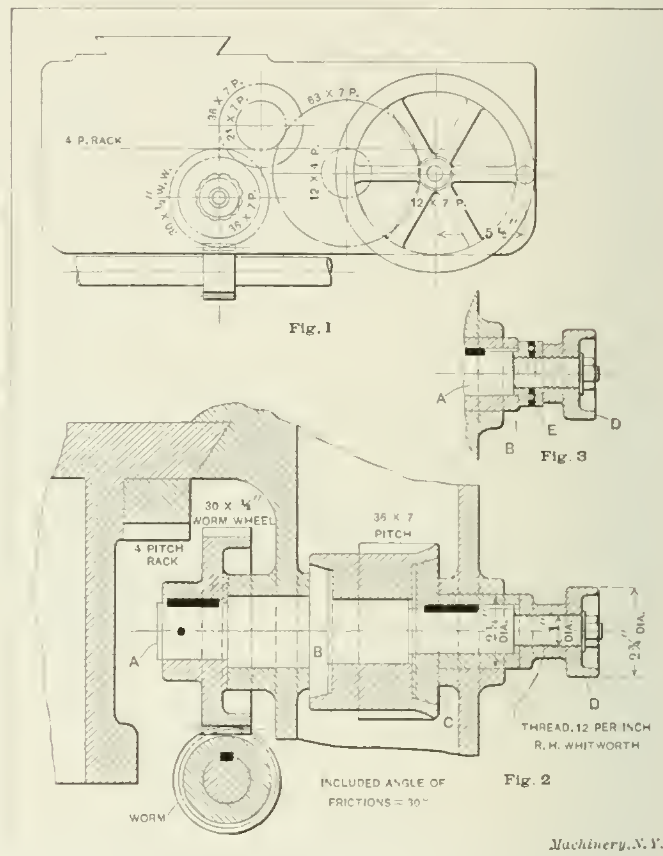


Fig. 1. Elevation of Lathe Apron showing Position of Gears for Longitudinal Feed. Fig. 2. Sectional View showing Feed Arrangement. Fig. 3. How Thrust-bearing was applied

between 40 and 50 pounds, this being equivalent to about 900 pounds cutting pressure, whereas it should have been at least twice that amount. After carefully considering the matter, I came to the conclusion that the friction between the knob *D* and the friction cone *C* was where the trouble lay, owing to the fact that the diameters of the surfaces in contact were too large in comparison to the diameter of the knob. One way of minimizing the trouble would be to reduce the diameters of the surfaces as much as possible, but this was not thought to be a good idea. I then decided to introduce ball bearings, and fortunately, as we carried several sizes of thrust-bearings in stock, it was not difficult for me to secure the size suitable for this, so it was only the question of a few minutes before I had one in position and found that it worked perfectly. By clamping the knob with only one hand it was found that a pressure of 150 pounds could be applied on the hand-wheel without the friction slipping. It will therefore be seen that by this simple expedient, the power of the friction was at least trebled, and in addition the knob was much easier to engage and disengage. Fig. 3 shows how the thrust-bearing *E* was applied, the only difference being that a shorter knob *D* was used. I might say that this lathe took a cut 3/4 inch deep, and 0.033 inch feed per revolution on a fairly tough steel bar, and we had no trouble with the friction slipping.

A PROBLEM IN DISK FRICTION*

THE POSSIBILITY OF A NEW THEORY FOR ARRIVING AT THE IDEAL COMPROMISE OR HAPPY MEAN VALUE IN MACHINE DESIGN

By JOHN S. MYERS†

In the designing of machinery it is impossible to have everything ideal; on the contrary, the designer is continually compromising between the desirable and the undesirable, and the design will be good, bad, or indifferent in proportion to the care and judgment exercised when making these compromises. Now, if it were possible to develop a theory of the compromise between those things which are desirable and those which are not, applying mathematics as a means whereby results might be obtained with some precision and logic, instead of being guessed at, hit or miss, as now seems to be the prevailing fashion, it should be of great value to the designer. In

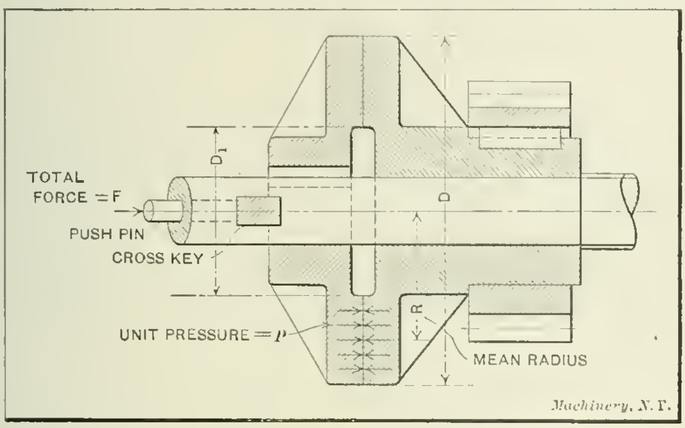


Fig. 1. Section of Disk Clutch

the present article is presented a problem in connection with a disk friction clutch which suggests the development of such a theory. The writer presents, first, his conception of the general problem in the hope that it may start others thinking along this line, with the purpose of eventually securing a scientific method of dealing with desirable and undesirable conditions, and second, a tentative solution to a specific problem in relation to disk friction.

Proposed Problem of finding the Happy Mean or Ideal Compromise in Machine Design

In the case of three variables, let y and z be functions of x, either explicit or implicit. Let x be the independent variable, *i. e.*, the one which may have any value at the will of the designer. Then y and z are two dependent variables.

Now, in most mechanical problems, there are certain states of the dependent variables (y and z) which are desirable states. What these desirable states are depends upon the nature of the specific problem under consideration; for instance, it may be desirable either to have both y and z a minimum, a maximum, or to have one a minimum and the other a maximum; but the desirable states of y and z may be determined by some consideration entirely extraneous to the direct mathematical relation existing between x, y and z.

Generally speaking, it is the exception rather than the rule that the desirable states of y and z are contemporaneous, *i. e.*, that they occur at the same value of x, and, if such be not the case, it is then impossible to have both y and z at their desirable states. This is the condition that has given birth to the oft-used expression, strike a "happy mean", which conveys the idea of approaching as nearly to the desirable states as their mutual interdependence permits. Again, viewed in the light of the impossiblity of having both quantities at their desirable states simultaneously, we may consider the process as one of choosing between necessary evils, in which case the term "ideal compromise" is appropriate and conveys the idea of departing from the desirable states as little as possible.

Assume that y and z are explicit functions of x and let the subscript ($_d$) denote the desirable state of the function to which it is appended;

Then $y = f(x)$,
$z = \phi(x)$,
y_d = desirable state of the function y,
z_d = desirable state of the function z, and
x_h = happy medium value of x, which is to be determined.

Now let C denote, in general, a coefficient of relative importance for the dependent variables and, by the addition of a subscript,

Let C_y = coefficient of importance of y, and
C_z = coefficient of importance of z.

If C_y or C_z be used as a multiplier of y_d or z_d they may be considered as *coefficients of desirability*; thus if y be twice as important as z, then $C_y = 2$, and $C_z = 1$ and we would say that it was twice as important to have $y = y_d$ as to have $z = z_d$; but, since in the general solution y and z may represent dissimilar quantities, and since each is dependent upon x by some law or laws whose mathematical expression may be any one of an infinite variety of forms, there is, then, absolutely no general numerical equality between y_d and z_d, and therefore we may not say that $y_d = z_d$, or that $C_y\, y_d = C_z\, z_d$; but there may be some definite mathematical relation between the ratio $y:y_d$ and the ratio $z:z_d$, in which either or both may be affected by a coefficient of desirability, C_y or C_z; hence the problem takes this form:

Construct an equation which shall express such a relation between $z : z_d$, $y : y_d$, C_y and C_z that its solution will give the "happy medium value" of x corresponding to an "ideal compromise" between the two unattainable, desirable states of $y = y_d$, and $z = z_d$.

A Problem in Disk Friction with Tentative Solution to the Ideal Compromise Problem

The specific problem which first suggested to the writer the possibility of a general theory covering the subject of compromise is as follows:

In a disk clutch, the outside diameter D, the coefficient of friction C, and the torque to be transmitted T are given.

(a). What should be the proportion of the inside diameter D_1 to the outside diameter D in order that the average unit pressure p may be a minimum?

(b). What should the proportion be in order that the total force F pressing the disks together may be a minimum?

(c). Can both these desirable states be obtained?

(d). If not, what is the ideal compromise or happy mean between these two values of D_1 (See Fig. 1).

The solution of the problem proper involves first a settling of the mooted question as to whether the center of tangential or frictional forces lies at the mean radius of the disk, as claimed by some, or whether it is coincident with the center of gravity of a narrow sector of the disk. This phase of the problem was treated on page 924, July, 1910, issue of MACHINERY, engineering edition, the deductions there drawn being that the center of tangential effort is, at least approximately, at the mean radius of the disk. If R equals this radius we then have:

$$R = \tfrac{1}{4}\,(D + D_1) \qquad (1)$$

Solution for Minimum Value of p

Having the radius R at which the tangential frictional forces act, we may now write an equation for the torque T, as follows:

$$T = F\,C\,R \qquad (2)$$

But

$$F = p \times \text{area of disks} = \tfrac{1}{4}\,\pi\, p\,(D^2 - D_1^2) \qquad (3)$$

Substituting in (2) the values of R and F as given by (1) and (3) we have:

$$T = \frac{1}{4}\,\pi\, p\,(D^2 - D_1^2)\, C \times \frac{1}{4}\,(D + D_1), \text{ or}$$

$$T = \frac{1}{16}\,\pi\, C\, p\,(D^3 + D^2 D_1 - D D_1^2 - D_1^3) \qquad (4)$$

from which

*See MACHINERY, July, 1910, engineering edition: "Mean Radius of the Frictional Forces of a Disk Brake."
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$$p = \frac{16\,T}{\pi\,C\,(D^3 + D^2 D_1 - D D_1^2 - D_1^3)} \qquad (5)$$

By the methods of calculus it may be shown that p will become a minimum when $D_1 = 1/3\,D$.*

Inserting this value of D_1 in (5) gives:

$$p = \frac{27\,T}{2\,\pi\,C\,D^3} \qquad (6)$$

This is the minimum average unit pressure for any given values of T, C and D.

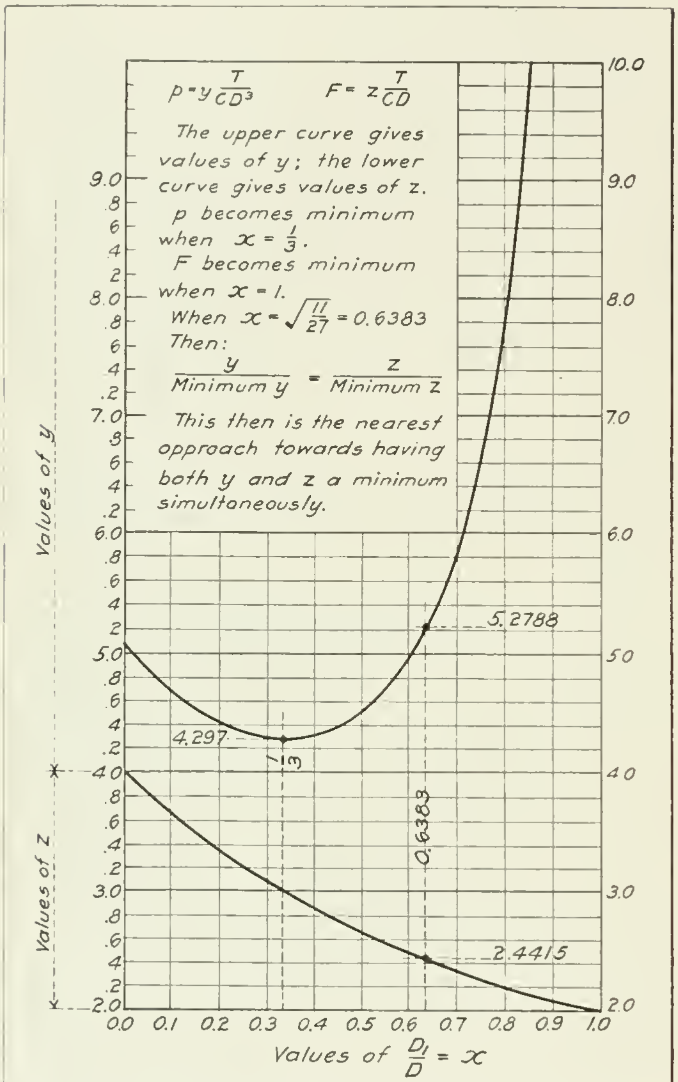

Fig. 2. Diagram showing Relative Values of y and z in Basic Equations for Disk Clutch Problem

Inserting $D_1 = 1/3\,D$ in (4) or solving (6) for T gives:

$$T = \frac{2}{27}\,\pi\,C\,p\,D^3 \qquad (7)$$

This is the torque developed by the clutch for any given values of C, p and D. If the value of p be taken at the maximum safe value, then this equation gives the maximum capacity of the clutch.

The total force pressing the plates together in order to transmit the torque is, in general:

$$F = \frac{4\,T}{(D + D_1)\,C} \qquad (8)$$

For

$$D_1 = \frac{1}{3}D, \quad F = \frac{3\,T}{DC} \qquad (8\text{ A})$$

Equation (8 A) gives the value of F for the minimum value of p.

The Ideal Compromise

Now, in the usual construction it is not only desirable to have as low a value of p as possible, in order that the wear may be reduced and that the clutch may be able to develop the highest possible torque consistent with the safe bearing capacity of the material and the conditions of lubrication, but it is also desirable to have as low a value of F as is consistent with the low value of p. Now p is minimum at $D_1 = 1/3\,D$, and F is minimum at $D_1 = D$, so that it is impossible to have both a minimum, but somewhere between these limits there is a point at which the increase over the minimum value of p will be the same percentage of that minimum as the increase over the minimum value of F is in per cent of the minimum value of F. Tentatively, we may assume, with a certain amount of justification, that this point is the "happy medium" value of D_1 when it is just as important to have p a minimum as it is to have F a minimum; in other words, this is the "ideal compromise." This condition will exist when

$$\frac{p - \text{Minimum } p}{\text{Minimum } p} = \frac{F - \text{Minimum } F}{\text{Minimum } F}$$

which reduces to

$$\frac{p}{\text{Minimum } p} = \frac{F}{\text{Minimum } F} \qquad (9)$$

The minimum value of p is given by equation (6), and the value of p for any value of D_1 is given by equation (5). The value of F for any value of D_1 is given by (8) and, since the minimum value of F occurs when $D_1 = D$, this minimum value must be:

$$F = \frac{2\,T}{DC} \qquad (10)$$

Substituting these values in (9) gives:

$$\frac{16\,T\,2\,\pi\,C\,D^3}{\pi\,C\,(D^3 + D^2 D_1 - D D_1^2 - D_1^3)\,27\,T} = \frac{4\,T\,D\,C}{(D + D_1)\,C\,2\,T}$$

$$\text{or } D_1 = D\sqrt{\frac{11}{27}} \cong 0.6383\,D \qquad (11)$$

This is the value of D_1 giving the nearest approach to having both p and F at their minimum values. This is then the "ideal compromise" between two desirable conditions which cannot both be obtained, and is a proposed solution to question (d) of the problem.

Relation of Unit Pressure to Total Pressure

To better show the relations of the variables p and F, curves may be plotted.

$$\text{Let } x = \frac{D_1}{D};\ \text{then } D_1 = x\,D \qquad (12)$$

Substituting in equation (5) we have:

$$p = \frac{T}{C\,D^3}\left[\frac{16}{\pi\,(1 + x - x^2 - x^3)}\right] \qquad (13)$$

Now let

$$y = \frac{16}{\pi\,(1 + x - x^2 - x^3)} \qquad (14)$$

Then

$$p = y\,\frac{T}{C\,D^3} \qquad (15)$$

---

*This may be deduced as follows: In equation (5) if π, C and T are constant factors, then p will become a minimum when the quantity within the parentheses in the denominator becomes a maximum. Let y be this quantity, then:

$$y = D^3 + D^2 D_1 - D D_1^2 - D_1^3,$$

which being differentiated with respect to D_1 gives:

$$d\,y = D^2 d\,D_1 - 2\,D\,D_1\,d\,D_1 - 3\,D_1^2\,d\,D_1$$

$$\text{Then } \frac{d\,y}{d\,D_1} = D^2 - 2\,D\,D_1 - 3\,D_1^2$$

Equating this first differential coefficient equal to zero gives:

$$D_1^2 + \tfrac{2}{3}\,D\,D_1 = \tfrac{1}{3}\,D^2$$

Adding $\tfrac{1}{9}\,D^2$ to complete the square gives:

$$D_1^2 + \tfrac{2}{3}\,D\,D_1 + \tfrac{1}{9}\,D^2 = \tfrac{4}{9}\,D^2$$

Extracting the square root gives:

$$D_1 + \tfrac{1}{3}\,D = \pm\tfrac{2}{3}\,D$$

from which

$$D_1 = \tfrac{1}{3}\,D \text{ or } D_1 = -D$$

This second expression, being an imaginary value, need not be considered: hence the value $D_1 = \tfrac{1}{3}\,D$ is the only value to investigate to determine whether it corresponds to a maximum or minimum value of y, and, since a curve is plotted later on in the article, further investigation is unnecessary here.

Substituting in equation (8) the value of D_1 as given in equation (12), we have:

$$F = \frac{T}{CD}\left(\frac{4}{1+x}\right) \qquad (16)$$

Let

$$z = \frac{4}{1+x} \qquad (17)$$

Then

$$F = z\frac{T}{CD} \qquad (18)$$

Calculating values of y and z by formulas (14) and (17) gives the values shown in the accompanying table.

Plotting the values given in the table gives the diagram shown as Fig. 2, on which the minimum values of y and z, as well as the compromise value of x, are plainly indicated.

The foregoing formulas can readily be applied to multiple disk clutches, such as the Weston clutch, by letting

$$T = \frac{\text{total torque}}{\text{number of rubbing surfaces}} \qquad (19)$$

Conclusion

The conclusions to be drawn in relation to the disk problem are that the ratio of inside to outside diameter should be at least one-third, which corresponds to a minimum mean average unit bearing pressure on the disks, and where it is desirable to keep the total force pressing the disks together as low as possible, this ratio should be increased. When $\frac{D_1}{D}$ equals 0.64, approximately, we have the ideal compromise between the two unattainable states of minimum unit pressure and minimum total pressure, based upon the assumption that these two states are equally desirable.

CALCULATED VALUES OF FACTORS y AND z FOR USE IN EQUATIONS (15) AND (18)

$x = \frac{D_1}{D}$	$y = \frac{16}{\pi(1+x-x^2-x^3)}$	$z = \frac{4}{1+x}$	$x = \frac{D_1}{D}$	$y = \frac{16}{\pi(1+x-x^2-x^3)}$	$z = \frac{4}{1+x}$
0.00	5.093	4.000	0.6383	5.279	2.442
0.10	4.677	3.636	0.7000	5.874	2.353
0.20	4.421	3.333	0.8000	7.859	2.222
0.30	4.305	3.077	0.8500	9.924	2.162
$\frac{1}{3}$	4.297	3.000	0.9000	14.108	2.105
0.40	4.331	2.857	0.9500	26.791	2.051
0.50	4.527	2.667	1.0000	∞	2.000
0.60	4.974	2.500	......	......	.....

The conclusion to be drawn in relation to the general subject of compromise between desirable and undesirable values of variables in design is that a rational method or general theory might be developed applicable to any problem capable of formulation. The solution to the specific problem given is not general. It fails as soon as any of the desirables become zero or infinity, and is, therefore, not rational and probably not absolutely theoretically correct, even for the particular case it is here applied to. It is, bowever, better than pure guesswork, inasmuch as a certain amount of logic is used in justification of the method pursued.*

*To those who may attempt a solution of this interesting problem the writer desires to call attention to some points liable to develop in arriving at a solution:

(a) C_y and C_z are, in a sense, functions of the form of the equation expressing the relation between x, y, and z, *i.e.*, in a certain problem it may seem desirable to give C_y double the value of C_z, but the form of the equation controlling the mutual interdependence of x, y, and z may make this impossible, or give an undesirable value of C.

(b) While, by hypothesis, x is an independent variable which may have any value whatever at the will of the designer, it is obvious that $x = x_h$ is the one value to be desired, but, in attempting to find this value of x, it must be remembered that x may have some desirable value entirely inherent in itself, *i.e.*, by the very nature of the specific quantity which x represents, and entirely independent of its mathematical relation to y and z, there may be some desirable value of x such as $x_d = x$ min. $x_d = x$ max. etc. When x possesses any such inherent characteristics, it would probably be well to have a special case covering it in the general solution.

(c) It would seem that neither of the coefficients of desirability could ever be infinite in relation to the other, as this would mean that the other desirable state was not really a state to be desired, but a state of no importance.

WORM GEARING EMPLOYED FOR FREIGHT ELEVATORS

By A. P. ELTOFT*

The writer was recently called into consultation concerning worm gearing as applied to freight elevators. The inquirers state that they employ a worm gear having 108 teeth, ¾-inch pitch, 2 1/2-inch face, and a worm 5 3/16 inches diameter, single thread, direct connected to an electric motor running 850 R.P.M., and are having some difficulties with regard to the worm's heating and the current taken by the motor being too great. The drum is 24 inches diameter, and the load on the drum is 4000 pounds, which corresponds to 3720 pounds on the worm gear teeth. These manufacturers use a hob the exact diameter of the worm and allow for clearance in erection. This is bad practice, as the two surfaces on gear and worm brought into contact by this method do not correspond to each other and a good contact can not be expected. A hob should be used that cuts the clearance for the worm, thus permitting the worm axis to coincide in position with that of the hob when the wheel was cut.

Another improvement upon this gearing would be to reduce the diameter of the worm, provided this is possible. With the dimensions given, the angle of thread is 2 degrees 39 minutes and the efficiency of the worm gearing for a coefficient of friction = 0.05 would be 0.48 (see MACHINERY, September, 1910, page 43, engineering edition), while if the diameter of the worm be reduced to say 3¾ inches the angle of thread would be increased to 3 degrees 39 minutes and the efficiency to 0.58, or an increase in efficiency of 21 per cent.

It will be seen from the above that a decrease in worm diameter not only reduces the speed of rubbing surfaces, but also increases the efficiency of the machine. In general the worm should be made just as small as the circumstances will allow in order to increase the angle of thread and thereby the efficiency, while maintaining the same pitch and the same number of threads on the worm.

There are three factors which may determine the minimum size of worm that can be used, which are as follows:

First, the diameter of the shaft on which the worm has to be keyed if not made in one piece with this shaft limits the size of the worm. Second, if the gear is to be self-locking the angle of the thread cannot be increased above a certain degree; with the pitch settled on this will determine the diameter of the worm, provided it is single threaded. Third, if the face of the gear is determined, it is not desirable to go below a certain diameter of worm on account of the consequent large face angle.

Concerning the load which can safely be carried on worm gearing, it is determined by one of three considerations, which are: the strength of the material, the danger of abrasion and the danger of overheating.

The first consideration seldom comes into play because a gear proportioned to prevent abrasion and excessive heating will generally have excessive strength. For very slow-running worms and for worms used intermittently with short runs and long intervals, the heating effect does not enter and the determining factor will be danger of abrasion from too high a pressure per unit of contact surface. The contact between worm and worm gear is mathematically a line, but the physical properties of the opposed surfaces and the lubricant between them expand this ideal line into an actual area, and as the radii of curvature increase directly with the pitch, it is natural to consider this surface as directly proportional to the product of pitch and face. The proper allowable load per unit must necessarily be determined by experience, and 1000 pounds to 1200 pounds seems to be about the safe limit of load per $p \times f$ (pitch $\times$ face) considering that there ought to be here, as well as in all other designs, a certain margin or factor of safety, as we might say, to prevent having the machine put out of commission by an occasional overload or other accidental excessive pressure. If all the load, as is usual for spur gears, is considered to be taken by one tooth, the stresses pro-

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duced in the material for these loads are about the safe stresses for cast iron.

The third consideration, the danger of overheating, is perhaps the most important, and the most trouble with worm gearing is from this source. When more heat is developed than is carried off from the gear housing, the temperature of the oil will increase, but with the higher temperature the oil becomes less viscous and its adhesion to the rubbing surfaces becomes less. The coefficient of friction increases with consequent more rapid increase in temperature. Thus the critical conditions are constantly augmented by one another until the oil film between the surfaces is squeezed out altogether and abrasion occurs. The only safe way to avoid this is, of course, to so design the gearing that the temperature is kept below a certain limit. For continuous service the proper loads may be based on Bach's and Roser's experiments (see MACHINERY, September, 1910). It may be well here to call attention to the fact that the loss of heat from a body is approximately directly proportional to its surface, and consequently a large gear housing is at an advantage. The housing should have stuffing-boxes for the worm shaft, and be well filled with a viscous oil so that the heat created at the point of contact may be distributed quickly to the upper parts of the housing.

For intermittent duty, like that imposed on a freight elevator, the question of allowable load becomes more complicated. The load that can safely be carried on a gear for this class of work will depend entirely on the circumstances, and a value can only be arrived at if these are known, or after certain assumptions as to the maximum time of continuous service, time of intervals, etc. have been made. The total heat developed can then be compared to that for continuous service and a correspondingly higher load allowed, provided, however, that this does not exceed the maximum load allowed without regard to heating.

Consider, for instance, a worm for driving a freight elevator with a load on 24-inch drum of 4000 pounds, worm direct on motor shaft running 850 R.P.M. If in this instance it is considered safe to assume that the maximum average load for a certain unit of time will never exceed 2000 pounds and the time required for loading and unloading the elevator is at least equal to the time of actual running, then the work performed by the worm gearing will be one-fourth of that for continuous service with full load, assuming the coefficient of friction the same for all loads. The heat developed will also be one-fourth of that developed with full load. A gearing designed for continuous service with 1000 pounds load on drum will therefore meet the requirements. For a worm of 3¾ inches diameter running at 850 R.P.M. we have a velocity of 824 feet per minute. For this velocity, a load per unit of pitch times face of 180 pounds is allowable for a difference in temperature of 50 degrees F. (see MACHINERY, September, 1910). The gear will have to have 108 teeth to give the necessary reduction to 50 feet per minute elevating. As this number of teeth is exceptionally large, we can expect a good contact with less danger of abrasion, and a higher temperature difference, say 70 degrees, is warranted. The allowable load is approximately proportional to the temperature difference, and we can, therefore, allow $180 \times 70/50 = 252$ pounds per unit of pitch times face. On account of large diameter of worm gear, the worm and its housings will be comparatively long with consequent large radiating surface, and a temperature difference of 70 degrees will probably not be reached at all.

A worm 4 inches diameter, 1 inch pitch, with gear 34.4 inches diameter, 2¾ inch face, will then carry $252 \times 1 \times 2\frac{3}{4} = 693$ pounds, which corresponds to a load on drum $= 693 \times \frac{34.4}{24} = 993$ pounds, or practically 1000 pounds. The intermittent load on gears will be $4000 \times \frac{24}{34.4} = 2791$ pounds, or 1015 pounds per $(p \times f)$, which in this case is within the limit.

In the case referred to in the first part of this article the load on gear teeth was 3720 pounds for a ¾-inch pitch, 2½-inch face gear, which corresponds to load per unit of $p \times f$ equal to 1984 pounds. This is undoubtedly too heavy a load even for intermittent service, and a gearing with any such load running at high speed is likely to give trouble.

Upon being advised that the gears were too small for the service required of them, the manufacturers object, saying that they are building elevators in competition with other concerns and a material increase in these gears would put them out of business, and state that they have sometimes operated a load of 6000 pounds with a 10 H.P. motor very easily, but on one or two cases with conditions practically the same they have found it very difficult to start the elevator at all except by using a heavy current. Now 6000 pounds at 50 feet per minute represents $\frac{6000 \times 50}{33{,}000} = 9.1$ H.P. The efficiency of a worm gear with an angle of thread 2 degrees, 40 minutes was found above to be 0.48 for a coefficient of friction of 0.05. This is the efficiency of the worm gearing itself and does not allow for friction in gear or worm-shaft bearings, for end-thrust bearing, for bending of cables or friction in guides. When all this is taken into consideration the horsepower required for running conditions will be at least 22. The horsepower for starting will be still higher and a corresponding electric current consumption in the motor must necessarily result, which indeed must be called high for a 10 H.P. motor.

If defective designs like these are found necessary to obtain business in competition with others, it is certainly a deplorable state of affairs. Customers should be educated to demand machines designed for a reasonably long life and not working under stresses perilously near the point of breakdown.

* * *

SINGLE-PHASE ELECTRIC TRACTION IN FRANCE

The electrification of existing steam railways is being pursued with activity in France. One of the latest electrifications is that which the Midi Railway of France will make in connection with the Montrejeau-Pau portion of the Toulouse-Bayonne Line. The portion to be electrified has a length of some 70 miles; the country is very hilly and the line has a number of steep gradients, one of 3½ per cent being about seven miles in length. This is the largest scale upon which electrification of existing lines has been attempted in France, and the results will be watched throughout Europe with no little interest. Later the electrification is to be extended to the entire Toulouse-Bayonne Line, a distance of 200 miles.

The Midi Railway Co. has ordered from the French Westinghouse Co., the works of which are at Havre, the equipments for thirty double bogie electric motor coaches for the passenger service and one complete electric locomotive for the freight service of this line. The locomotive and motor car equipments will be built by the Italian Westinghouse Co. at the Havre Works, while the mechanical parts of the locomotive will be built by the Italian Westinghouse Works. The design and construction is based on the results obtained in connection with the successful electrification by the Italian Westinghouse Co. of the Giovi tunnel section of the Italian State Railways on the dense traffic line between Genoa and Milan.

Each of the thirty motor coaches (seating about 50 passengers each) will be equipped with four 125-H.P. Westinghouse single-phase motors, 16 2/3 cycles, 285-volts, and with Westinghouse multiple control. These motor coaches will be able to haul trains weighing 100 metric tons—including the motor itself—at a speed of 45 miles per hour on level track. The weight of a motor coach in running order will be about 56 metric tons.

The Midi locomotives will be provided with five axles, three of which will be driven by the motors through jack shafts and connecting-rods. The locomotive will be equipped with two 600-H.P. single-phase motors. The locomotive will weigh 80 metric tons and will be able to haul trains weighing 400 metric tons, inclusive of the locomotive. With a haulage of 280 metric tons the speed will be 25 miles per hour, and with 100 metric tons about 38 miles per hour. The current will be supplied to the motors by means of a 12,000-volt overhead catenary line. The pantagraph type of trolley will be used.

DRAWING-ROOM EQUIPMENT AND ARRANGEMENT

By F. B HAYS* and B. B. COOLEY†

The accompanying illustrations, Figs. 1 and 2, show the equipment and arrangement of a thoroughly modern drawing-room. The main room is made large in order that there will be sufficient space for the equipment without the danger of overcrowding. At the same time the room should be well heated and ventilated, and should face the north in order to secure the steadier light which is always obtained from that direction. It is a well-known fact that the light secured from this direction does not cast the conflicting shadows due to the different positions of the sun during the day, that the light obtained from any of the other three directions does. The whole north wall of the building should be given up to window space, so that plenty of light can be obtained. It is always desirable for right-handed persons to have the light coming from the left, and with this fact in view it is well to arrange the drawing tables so that when the draftsman is at work he faces the east.

At the east end of the main room will be found files and cases running the full width of the room, in which drawings, placed in separate rows, thus making them easily accessible and easy to find.

The supply case *D* consists of two sets of drawers in which supplies, such as tracing cloth, paper, ink, pencils, erasers, etc., are stored. The top of the supply case is constructed of such a height that it also answers the purpose of a table, which will be found very convenient when consulting any of the drawings or prints in the files. On the south side of the room is found another set of files similar to the one just described.

The sample cases *E*, in Fig. 1, are arranged at the west end of the room. These cases consist of several drawers and two or three small cabinets, and are intended as a place to store defective castings, patterns, new parts, etc., which are used for reference by the draftsmen from time to time.

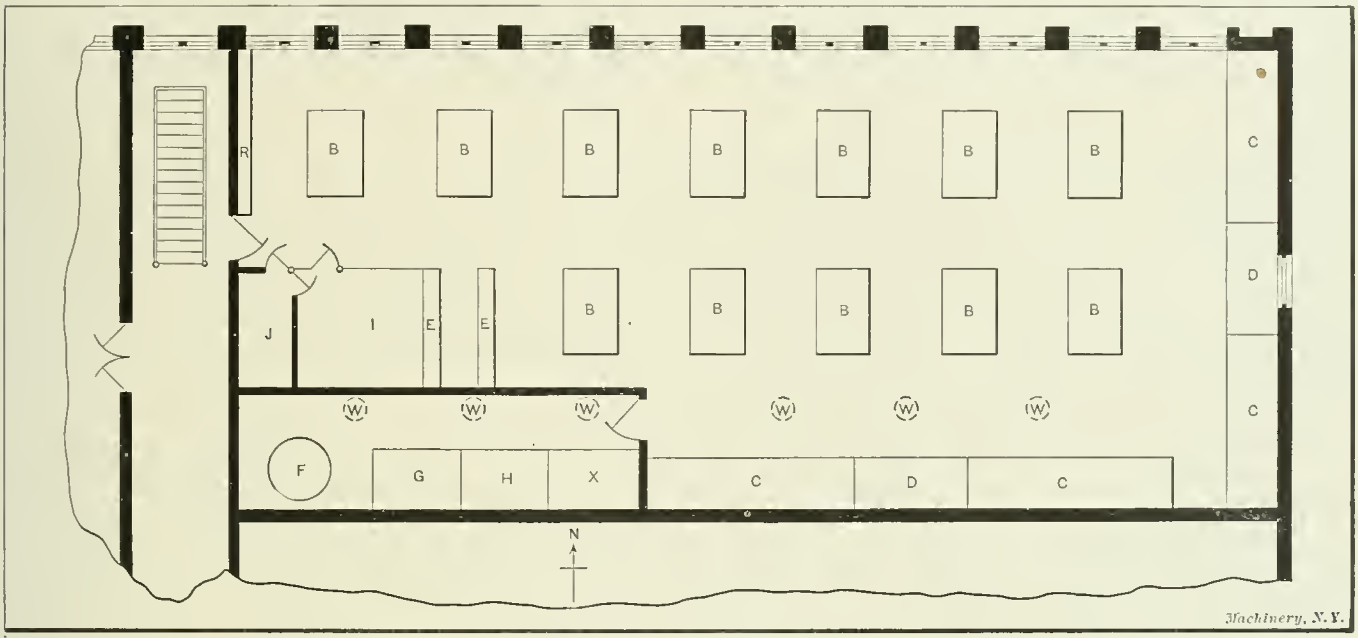

Fig. 1. Plan of a Modern Drawing-room

One of the principal features of the modern drawing-room is the portion set apart for the blueprinting work. This room should be of light-proof construction and should be equipped with all of the modern improvements which have been invented for the process of blueprinting, such as blueprinting machines, steam driers, washing pans, etc. In Fig. 1, the location of the blueprinting machine is at *F*, the steam drier at *G* and the washing pans at *H*.

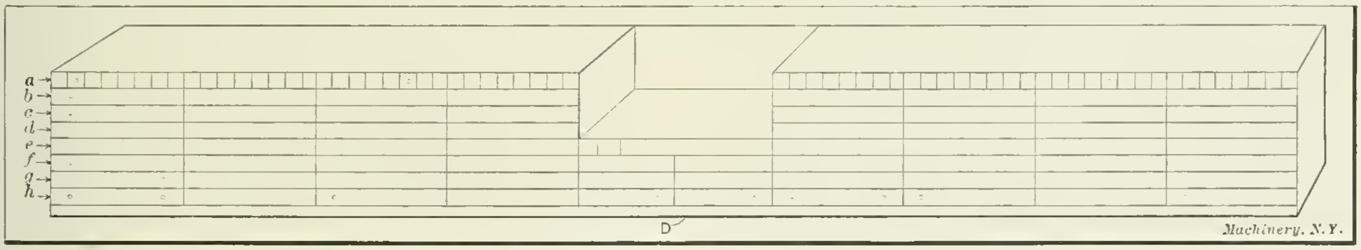

Fig. 2. Arrangement of Files and Supply Cases

tracings, pencil sketches and supplies are kept. The files are arranged on each side of the supply cases and extend toward the center for about two-fifths of the width of the room. The supply cases are arranged between the files and are about half their size. The file cases consist of seven sets of files, as shown in Fig. 2, at *b*, *c*, *d*, *e*, *f*, *g* and *h*, respectively. A card index, *a*, which is very valuable to a drafting-room, is arranged at the top of the case. The file *b* is reserved for blueprints of parts, and assemblies of standard products of the plant, file *c* is for tracings, file *d* for original drawings, file *e* for duplicate sketches, and file *f* is for foreign blueprints, that is, blueprints which have been obtained from other companies. The file *g* is for obsolete drawings and prints that are retained for reference. There are eight rows of these files and the drawings of the different years are

The chief draftsman's or engineer's private office is located directly in front of the blueprint room. It is advisable for the head of the department to have a room separated from the drawing-room, where he can discuss his business problems with his employes in private. All of these rooms should be large and well ventilated. A lavatory *J* is located in the west end of the main room next to the engineer's office, but partitioned off from it. The roof should be equipped with a number of ventilators *W*, in order that a good circulation of air can be obtained. The use of skylights has been dispensed with on account of the fact that in a drawing-room equipped with them the draftsman is naturally standing in his own light, and a great deal of his work has to be done in the shadow, which is not only hard on the draftsman's eyes, but detrimental to the work, as no draftsman can do first-class work without proper light.

The illustrations shown here are a combination of the lay-

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out and equipment of several of the drafting-rooms in use at the present time in several of the most modern plants in this country.

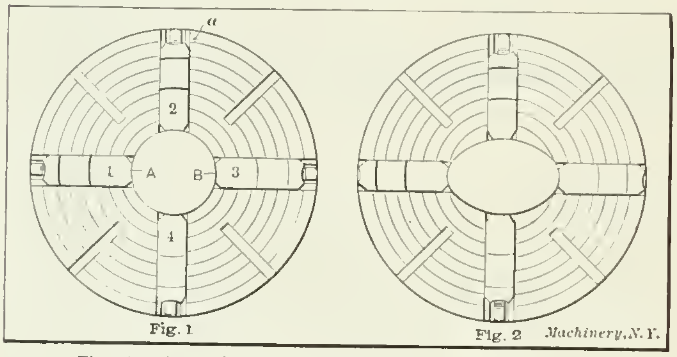
* * *

TRUING UP WORK IN THE LATHE

By CHARLES DOESCHER*

Truing up work in the lathe, when using a chuck or faceplate, is of such frequent occurrence that very little is said with reference to it in the various mechanical papers; in fact it is an operation that is looked upon as being so simple that very little attention is paid to it; however, the method employed by the average mechanic for truing up work can be simplified, therefore making it possible to do this work more easily and quickly. From personal observation, the writer has come to the conclusion that the so-called "chalk method" of truing up work in the lathe is the one most widely used by the general run of mechanics. This method is about as follows:

We will assume that a piece of round bar stock four inches in diameter, and three inches long is to be trued up in a four-jawed independent chuck. After the piece is secured in the chuck, one jaw is loosened, and another tightened until the work runs fairly true to the eye. A tool is then placed in the toolpost and set about parallel with the work, after which the belt is shifted to enable the lathe to run at its fastest speed. A piece of chalk, held in the hand and supported by the tool, is next brought to bear lightly against the fast revolving work. After the lathe is stopped, the jaws of



Figs. 1 and 2. Illustrating Method of Truing up Work in an Independent Chuck

the chuck are adjusted according to the story that the chalk mark tells. The lathe is then started again and the marking operation repeated until the piece runs true; oftentimes it happens that before the work runs sufficiently true, the operator has to take a piece of waste and wipe out the old chalk marks, which are so numerous as to be confusing.

A more efficient method of truing up the piece in question is as follows:

Place the work in the chuck and bring the jaws to bear upon it in such a manner that the ends of the jaws will be an equal distance from one of the circular grooves *a*, as shown in Fig. 1. (These grooves are provided on the faces of chucks, in order to facilitate the operation of truing up work.) An off-set tool—preferably a round-nose—is now placed in the toolpost and set to the height of the centers. The point of the tool is brought to bear lightly against the work near jaw number 1, and at a point *A* which is directly central with the jaw itself. The lathe carriage is next moved just enough away from the chuck so that the tool will not come in contact with the work; the lathe spindle is then given one-half a turn by hand, so that the side *B* opposite jaw number 3 will be at an even height with the tool. The lathe carriage is next moved forward until the tool is again opposite the work. If the tool bears hard against the work, jaw number 1 is loosened and jaw number 3 is tightened; on the other hand if there is an open space between the tool and the work, number 3 is loosened and number 1 is tightened. This operation is repeated until the tool bears equally at *A* and *B*. Jaws 1 and 3 should not be tightened too much, in order to allow for truing up between jaws 2 and 4 after the manner described in the foregoing. When the work is true, all four jaws are tightened evenly and the piece will be found to run as true as it is possible to make rough stock run. The advantage of this method is that every move counts; there is no unnecessary running of the lathe at full speed, nor is there any time lost while waiting for it to stop. One can see at a glance where the work is out, and just how much it is out, so that adjustments can be made accordingly.

This same method can be applied when truing up a piece of octagon stock in a four-jawed independent chuck, or an odd-shaped forging, such as is shown in Fig. 2. When using a three-jawed independent chuck, the same method can be applied by adjusting all three jaws so that the tool bears equally upon the work at a point central with each jaw.

It often happens that a piece of work is of such a shape that it can best be strapped on the faceplate when the latter is off the lathe. If the piece is square in shape and is to be drilled outside, it pays to set it before "tightening up" so that the distance from the outside of the faceplate to the center of all four sides measures the same. For example, if the faceplate is 18 inches in diameter and the work is 12 inches square, the distance from the outside of the faceplate to the center of each of the four sides should be 3 inches. By setting work in this way, a great deal of time is saved on a number of pieces, as it does not require nearly as much adjusting to get the part in the required position, as when it is strapped on the faceplate by "guess." Similarly, in truing up a center-punch mark, it pays to see that it is set central with the faceplate, by measuring, before swinging the work in the lathe.

When strapping work on a faceplate which is on the spindle, do not jam the back center into a center-punch mark in order to hold the work while it is being strapped on, but place a collet or nut blank between the work and the center. In this way the point of the center will be kept in good working condition, and the center-punch mark will not become burred or torn, which would make it practically useless as far as accurate truing of the work is concerned.

After the work is strapped in place, time can often be saved, before using a center test indicator, by bringing the point of the back center as near to the work as possible without touching it, and tapping the work so that the center-punch mark runs approximately true. In tightening up the straps, preparatory to "truing up" with an indicator, do not clamp them too tightly, nor screw one bolt tighter than another, as a piece of work that is fastened too tightly cannot be readily adjusted, and there is also a chance of springing the faceplate. When one bolt is tighter than another, one is often fooled, when using an indicator, as it is almost impossible to get the work in a true position; it shifts back and forth to its former positions as it is tapped, owing to the uneven tension exerted by the bolts.

If the work is eccentrically strapped on the faceplate, weights should be attached in such a position as to counterbalance the weight of the work; otherwise, in most cases, the bored-out hole would not be round. In drilling, boring or reaming, care should be taken to see that no part of the work, straps or bolts will come in contact with the carriage when the lathe is started, as the work might be shifted from its proper position.

In concluding this article it may be well to add that a test indicator should always be used for truing up work that is perfectly round, as the indicator enables it to be trued quickly and accurately, and also gives one the satisfied feeling of knowing that a job that runs true according to a reliable indicator can be depended upon at all times.

* * *

The Ordnance Department of the United States Government follows the practice of placing the inch marks on its drawings over the decimal point in the case of numbers containing fractional parts of an inch expressed as decimals. For example, 10⅛ inches if expressed in decimals on a drawing would be 10."125. The custom seems strange to those acquainted only with the common practice of engineering concerns, but it obviously has an advantage in that there is no mistaking the position of the decimal point.

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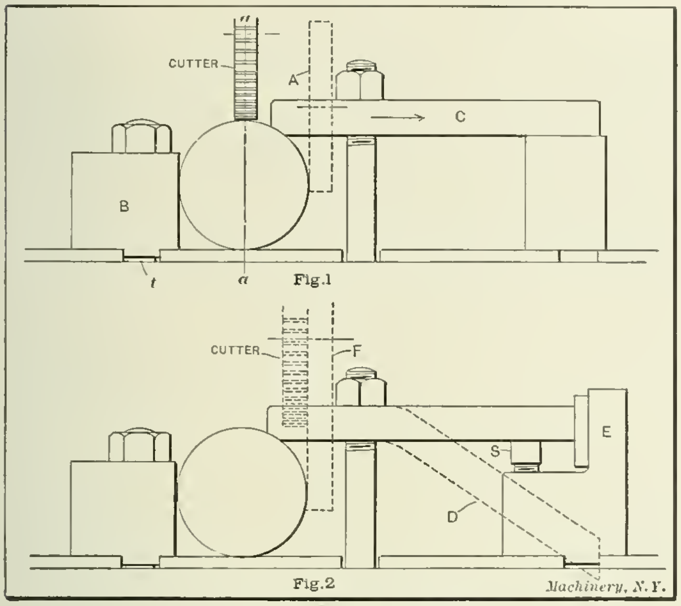
MACHINE SHOP PRACTICE*

MILLING A KEYWAY IN A SHAFT

The example of milling practice which is the subject of the current Shop Operation Sheet is not unlike many other simple machining operations in that it requires as much care and attention as some work which is more complex.

The first important step in connection with this operation —which is the milling of a keyseat in a shaft—is in clamping the work to the machine platen. The particular method illustrated on the sheet referred to is similar to the one indicated in Fig. 1, there being liner blocks *B* and clamps *C*, which hold the shaft in place. The blocks are brought into alignment by tongue-pieces *t* which fit a T-slot in the table, and the work is held both against the blocks and downward by the oblique pressure from the clamps. As the clamps are



Views Illustrating Methods of Holding Cylindrical Work and Centering Cutter for Keyseating

tightened, they tend to shift backward as shown by the arrow. For this reason clamps having rather close fitting bolt holes should be used. A special packing block, similar to the one shown in Fig. 2, is sometimes used to keep the clamps in place. This block has an extension *E* against which the clamps abut, and also an adjustable screw *S* for varying the height. A tongue-piece which fits a slot in the table, holds the block in position. By the use of a clamp bent as indicated by the dotted lines *D*, any backward movement when tightening can also be avoided, as the end of this clamp rests against the side of the T-slot. The clamps, regardless of the type used, should be placed opposite the liner blocks, as otherwise the shaft might be sprung out of true.

This method of holding a cylindrical piece, while suitable under ordinary conditions, would not be economical if a large quantity of shafts were to be keyseated, as a special fixture in which a number could be held and machined at one time would make a greater production possible.

The next important step in this operation is the centering of the cutter; that is, setting it so that the sides of the cutter are equidistant from a vertical center line *a*—*a*, Fig. 1, passing through the center of the shaft. One method of accomplishing this is as follows: Set the outer side of the cutter in the same vertical plane as the side of the shaft by holding a scale *F* (Fig. 2) against the outer faces of the milling teeth, and adjust the work until the scale just touches it, as shown; then move the work out a distance equal to the diameter of the shaft minus one-half the width of the cutter. If the cutter runs true and care is taken to hold the scale against the outer ends of the teeth, fairly accurate results can be obtained by this method.

When the size of the shaft will permit, the cutter can be used directly for centering, by raising the work and adjusting it until the side of the cutter barely comes in contact with it, as indicated by the dotted lines at *A* in Fig. 1. The work is then lowered and moved out a distance equal to the diameter of the shaft plus one-half the cutter width.

Still another method of centering the cutter with a cylindrical piece is as follows: Feed the shaft back and forth beneath the cutter until a spot, having a width slightly greater than the width of the keyway, is milled; then with the cutter revolving, set it central with the milled spot. (An illustrated description of this method of centering a cutter appeared in the October, 1909, number of MACHINERY.) The object of having the cutter in motion while adjusting it is to obtain an accurate setting, even though the sides of the cutter run somewhat out of true.

* With Shop Operation Sheet Supplement.

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ALTERATION OF PATTERNS

By C. S. BOURNE*

In almost every shop where various kinds of machinery are manufactured and an endless variety of patterns is used, the conviction often arises in the mind of the machinist who assembles and fits the parts that the proverbial "stitch in time" would, in innumerable instances, have "saved nine" money leaks for the company.

Let us suppose that a shop turns out, from year to year, a variety of machines, but not a great quantity of any one kind. An order comes for a machine that has not been made in the shop for the last year or two. The old patterns are brought from the pattern-room, numbered and sent to the foundry, with the supposition that they are all right. In due time the castings arrive, and, after cleaning, the workman begins his labor of fitting the parts, but has not gone far before he finds that an unusual amount of chipping is necessary to make things "come right." He spends, perhaps, from one-half to a full hour in extra labor, and wonders why that pattern was not corrected at the time the last machine was built. Perhaps the foreman was not informed at the time that the pattern was wrong; perhaps he was informed and it slipped his mind, so the patternmaker was not told about it; perhaps the patternmaker was told, but was very busy just then, and the matter was forgotten.

If it was only one casting that was concerned, the matter might not seem of great importance—but it may be otherwise; a considerable number may be needed, and the extra labor would then be multiplied. Different castings on the same machine may be defective to a greater or less extent, making the sum total of extra labor a serious matter. Now, what is the obvious remedy for this undesirable state of things? My suggestion would be that a general rule be adopted in the shop to the effect that any and every man discovering an error in a pattern should make a note on a card at the time, stating briefly the change to be made, and wiring the card to the pattern. It is then up to the patternmaker to make the necessary change before it goes to its shelf in the pattern-room—not to be used again, maybe, for a year, when it will be found correct. The "stitch in time" has done it.

* * *

High buildings continue to multiply in New York City, where structures twenty stories high long ago ceased to be of unusual interest and importance. The latest candidate for height honors is the Woolworth Building which will be erected at the corner of Broadway and Park Place during the coming winter and spring. From the sidewalk to the top will be forty-five stories, the total height being 625 feet or 13 feet more than the Singer tower, and 75 feet less than the Metropolitan tower. The new building will rest on a rock foundation secured by sinking thirty-eight caissons through the sand 130 feet to bed rock. The total height from the base of the foundation, therefore, will be 755 feet. The building will cost about $5,000,000 and, including the land, the total investment will be something over $7,000,000.

* * *

A international exhibition relating to the iron and machine industries will be held at Budapest in the summer of 1911.

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DRAWING DEEP CYLINDRICAL SHELLS

By E. P. DAVIS*

It is not very often that a machinist or diemaker is called upon to make a shell of a considerable length, and especially one that is greater in length than the stroke of the press. Therefore, the description given herein will, no doubt, be of interest to many readers of MACHINERY. The shell shown at *E* in Fig. 1 is similar to that used for holding acetylene gas in an automobile. This shell is 6 inches outside diameter and 19 inches long, and is made from No. 16 (0.0625 inch thick) United States standard gage, hot-rolled steel.

Before proceeding, it is necessary to determine the size of the blank. This is a simple matter if a sample shell can be obtained, as the most accurate way is to cut a circular blank of the desired metal equal in weight to the sample, and then, by adding a small amount to the blank for trimming in the several operations, we have the blank required. If it is not

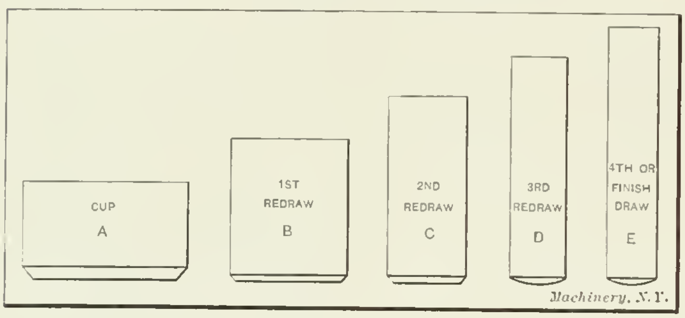


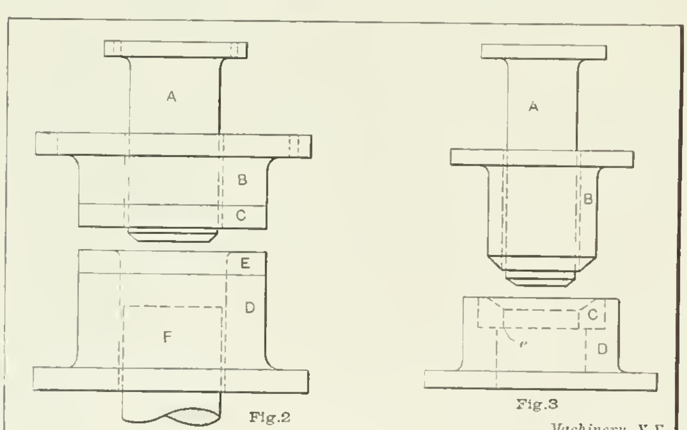
Fig. 1. Illustration showing the Length of the Shell after the Various Drawing Operations

possible to obtain a sample, the diameter of the blank can be determined approximately by the following formula:

$$D = \sqrt{d^2 + 4\,d\,h} \qquad (1)$$

where *D* equals diameter of blank, *d* equals outside diameter of shell, and *h* equals length of shell. In this case the diameter as found by the formula is 22 3/16 inches. By increasing the diameter to 23 inches it will give us sufficient margin for trimming in the several operations.

As it was found not to be economical to cut so large a blank in the first or cupping operation, the steel was ordered from



Figs. 2 and 3. Two of the Dies and Punches used in Drawing the Shell

a mill, cut into squares of 24 inches. Then these squares were taken to a circular power shear where they were trimmed to the desired diameter.

The first press operation is the drawing of the blank into a cup as shown at *A*, Fig. 1. The outside diameter of this cup is determined approximately by the formula

$$\frac{D}{1.6} = \frac{23}{1.6} = 14.375 \text{ inches,} \qquad (2)$$

but for this case we will say 14½ inches.

The dies used in making this first drawing operation are shown in Fig. 2, where *A* is the drawing punch made from cast iron and bolted to the countershaft plunger, *B* is the blank-holder also of cast-iron, but it has a steel ring *C* fastened to its base, the former being bolted to the toggle actuated slide, the action of which will be described later. *D* is the drawing die made of cast iron with a steel ring *E* fastened to its top face. The die *D* is, of course, clamped to the bed of the press. *F* is the knock-out which is operated from the toggle shaft located on the side of the press.

In operation the blank is placed on the surface of the plate *E*; then the blank-holder *B* descends, holding the blank to the top face of the die with a sufficient pressure to allow the punch *A* to force the blank into the die without buckling it. As the crankshaft of the press passes the center and is on its upward stroke, the blank-holder *B* also retreats, allowing the knock-out *F* to rise and lift the shell out of the die, when the operator can remove it and place another blank in position. The depth of the shell minus a slight amount due to the stretch of the material for each drawing operation can be found by the following formula:

$$L = \frac{B - S}{C} \qquad (3)$$

where *L* equals the approximate length of the shell, *B* equals the area of the blank, *S* equals the area of the outside diameter of the shell, and *C* equals the outside circumference of the shell. From a table of circumferences and areas of circles found in most handbooks, we find that a circle 23 inches in diameter has an area of 415.476 square inches.

As the outside diameter of the cup in the first operation is 14½ inches, by applying this formula we find that

$$L = \frac{415.476 - 165.13}{45.553} = 5.47$$

or the length is approximately 5½ inches. So that the first

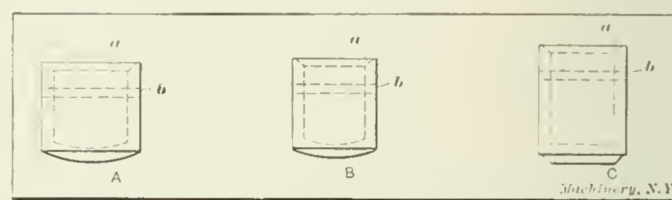


Fig. 4 Auxiliary Punches used in the Third and Fourth Redrawing Operations

drawing operation produces a cup which is 14½ inches in outside diameter by 5½ inches long. After this drawing operation the shell is annealed, and while yet warm is violently shaken and rubbed. It is then placed in a pickling bath which removes the scale. After this it is ready for the second operation or first redrawing operation. The reduction of the shell in this and the successive operations is determined by practical experience more than anything else, as it is a very difficult proposition to know just exactly how much the metal will stretch under the varying conditions.

Allowing for the first redraw a reduction of 2¾ inches in diameter reduces the cup to 11¾ inches in diameter, and applying formula (3), we find that the shell would be 11¾ inches in diameter and approximately 8 inches long. This second drawing operation is performed in the die shown in Fig. 3, where *A* is a cast-iron punch, *B* is a holder which fits loosely inside of the cup, and *D* is a cast-iron die with a steel ring *C* inserted in it. The bottom edge of *B* and the top inside edge of *C* are chamfered to correspond to the angle on the bottom of the shell. The shell is then placed on the die *D*, when the holder *B* descends and enters the shell, holding it between the bevel on *B* and *C* with a pressure sufficient to allow it to be drawn through the die by the punch *A* without buckling. As the crank of the press passes the center and is on its upward stroke, the top of the shell catches on the edge *c* and is stripped from the punch *A*, falling below the press, where it can be easily removed.

Sufficient metal is trimmed from the shell after each operation to straighten the edge, thus facilitating the following drawing operations. It is also annealed after each drawing operation except the finishing, when it is then trimmed to the desired length.

In the third drawing operation or the second redraw, the

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shell is reduced 2½ inches in diameter, which gives a shell 9¼ inches in diameter and approximately 12 inches long. This operation is performed in a die similar to that shown in Fig. 3, only that it is smaller, of course, to bring the cup to the desired diameter. The fourth drawing operation, or third redraw, allowing 1¾ inch for reduction, reduces the shell to 7½ inches diameter and increases the length to approximately 15¾ inches. The limit of the punch press used was 12½ inches and as the fourth drawing operation produced a shell 15¾ inches in length, an auxiliary punch had to be used as shown at *A* in Fig. 4. This punch is made 4 inches long and is used in the following manner: The cup is placed in position on the die and the punch allowed to descend, and as the stroke is only 12½ inches this does not force the shell completely through the die. The punch is then allowed to ascend again, and the small auxiliary punch shown at *A*, Fig. 4, is dropped into the shell, so that as the punch descends again, it forces the shell through the die. This drawing operation makes the shell 15¾ inches long. The finish drawing operation or fourth redraw, with an allowance of 1½ inch reduction in diameter, makes the shell 6 inches in diameter by 20½ inches long. This is similar to the operation previous to it, but instead of one auxiliary punch being used, two are used as it is not possible to get a punch of sufficient length into the shell. The two auxiliary punches used in this drawing operation are shown at *B* and *C*, Fig. 4. These auxiliary punches are beveled at *a* as shown to conform to the bottom of the punches. A small hole *b* is drilled through these auxiliary punches so that a bent wire can be used for lifting them out of the shell.

* * *

SETTING SCREW MACHINE STOPS

By G. MURRAY

In the October number of MACHINERY an article appeared by "Designer" on setting screw machine stops, in which two methods of setting stops were illustrated. While the writer does not wish to criticise the method shown in Fig. 1, he does consider that Fig. 2 is a rather awkward and inconvenient method, especially when the stock is small in diameter. This would require either an extremely narrow scale, or else necessitate the removal of the chuck, the latter of which is generally very inconvenient. What the writer considers a better method of setting stops is described in the following:

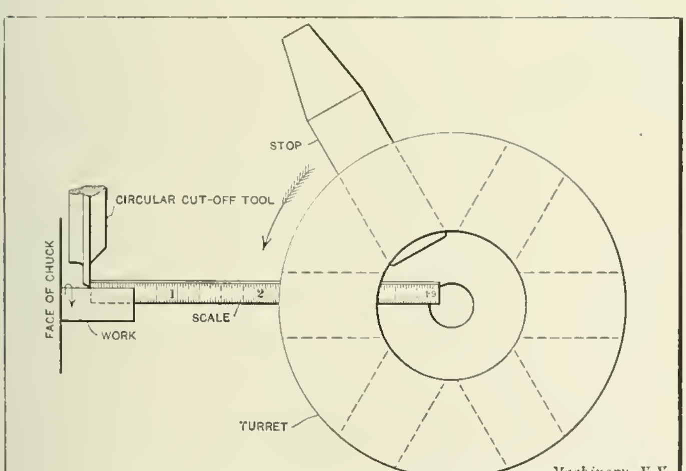


Fig. 1. Method of Setting a Screw Machine Stop

A chuck of the desired diameter is first inserted in the machine and the cap screwed on, then the stock is inserted, and the circular cut-off tool set exactly in the center, and also adjusted so that the tool will produce a square face on the work. After the circular cut-off tool has been set correctly, the chuck is opened by lifting the tripping lever, and the stock fed out the desired length by hand, the length of which can be easily measured by the method shown in Fig. 1.

This is accomplished by inserting a four-inch or a six-inch flexible scale, depending on the size of the machine, into an empty hole in the turret, and bringing one end of it up against the inside face of the circular cut-off tool, as shown. The cut-off tool is brought up against the work by means of the handle used to operate the cross-slide. It is then a very easy matter to set the stock to the desired length. When the desired length has been obtained, the chuck is closed and the turret swung down, so that the stop comes in line with the stock. When the stop is in this position the roll should be on the quick rise of the cam, so that by advancing the cam, the roll will rise up on to the lobe for the stop, thus forcing the stop back into the turret the desired amount, where it can be locked with the lock-screw provided for that purpose.

The method of setting the stop in a turret lathe or hand screw machine would be somewhat similar to that just described; but in this case the slide carrying the turret would be advanced a slight amount, leaving the stop to be forced into the turret about from 1/16 to 1/8 inch, so that a closer setting can be obtained with less trouble.

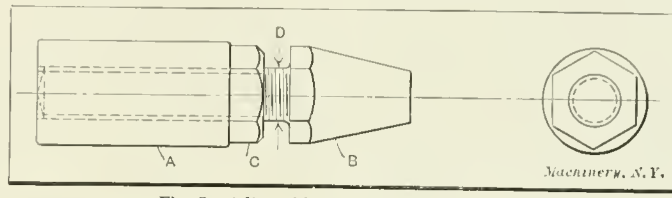


Fig. 2. Adjustable Stop for Screw Machines

When it is necessary to have the length of the piece within a limit of 0.01 inch or less the stop shown in Fig. 1 gives considerable trouble, because the only way it can be set is by tapping it in or out, which is a rather difficult matter at the best.

A stop which gives better results and obviates the difficulty encountered with the former is shown in Fig. 2. The parts *A*, *B* and *C* of this stop are made from machine steel and casehardened. The body *A* is tapped out for a 20-pitch screw and the diameter is made in accordance with the size of the machine in which the stop is used. The following diameters will be found suitable for the sizes of B. & S. automatic screw machines, as specified: For the No. 00, $D = 5/16$ inch; for the No. 0, $D = 3/8$ inch, and for the No. 2, $D = 1/2$ inch.

For the number 00 the pitch of the thread could be 32 threads per inch, which would mean that one revolution would give a distance of 0.03125 inch. The stop proper, *B*, is made of hexagonal stock, to fit the standard wrenches supplied with the machines. The nut *C* is also made of the same shape and diameter of stock as the part *B*. By having the stop hexagonal in shape, as shown, it would be an easy matter to set it to within 0.005 inch by means of these faces, as the relation of them to the nut can be noted, if the nut is held with a wrench while the part *B* is being rotated.

If suitable means could be provided for clamping and overcoming the thrust of the stock against the stop while feeding out, the ideal stop would be one which could be graduated to read in thousandths of an inch, but as it would be a difficult proposition to make a stop adjustable and also have it clamped effectively, this seems to be out of the question.

* * *

An interesting German method for cutting trees is mentioned in the (London) *Times Engineering Supplement*. The trees are cut by the friction of a steel wire about 0.040 inch in diameter which, as demonstrated by a practical test, is able to cut through a tree of about 20 inches diameter in less than 6 minutes. The wire, which is moved back and forth by means of a device driven by an electric motor, is heated by the friction against the wood to such an extent that it burns through the timber, the cut thus being both smoother and cleaner than when effected by a saw. The motor actuating the wire is installed outside of the range of the tree when it falls.

* * *

Many a machinery salesman only wishes he could get orders for machines as easily as many a foreman and machine operator thinks he can. Many a machine operator wishes he had as easy a time of it as he imagines the average machinery salesman has. It is simply a case of one fellow envying the other because he doesn't know the other's trials and tribulations.—*The Wood-Worker.*

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

GRINDING ADDING MACHINE SIDE FRAMES

The articles on the Ellis Adding typewriting machine by R. E. Flanders have undoubtedly been interesting to a great many readers of MACHINERY, especially those who are directly connected with adding machine and typewriter manufacture. The intricate and delicate mechanisms required in their construction must be made so accurately that the thought of the impracticability of the tools "standing up," is an ever-present one. The term "interchangeable manufacture" must be lived up to, and the tools used cannot be made too accurate or too efficient.

The various methods of machining the side frames of this machine, described in the September number of MACHINERY, are especially interesting to the writer, as they bring to his notice the methods used in manufacturing machines of other makes. In the description of the method used in machining the side frames, it was stated that the vertical grinder is used. Of this machine tool, very little has been written by contributors, but it is to be hoped that, in time, interesting articles describing various fixtures and appliances used in connection with this machine, will be forthcoming. The ideas imparted will be greatly appreciated by users who have experimented in many ways to obtain accurate work.

The writer having had numerous problems to deal with in connection with this grinder, will endeavor to illustrate the method used in machining work similar to the Ellis adding typewriting machine.

According to Mr. Flanders, a disk grinder is used on one side of the frames to obtain one flat side, flat enough for the magnetic chuck to hold it properly. The writer fails to see the advantage gained by this method. In the first place, it is a difficult matter to obtain a flat surface by the above method, and in the second place if it is not ground perfectly true, by placing this finished side on the chuck, the casting will spring when the current is applied, and when released will assume its original position or nearly so.

The method used by the writer in machining the side frames is illustrated in Figs. 1, 2, and 3. Figs. 1 and 2 are the fixtures used, both being placed on the magnetic chuck in the manner shown in the illustration. The idea in so doing is to obtain a frame finished on both sides at one setting or grinding. Fig. 1 is called the sizing fixture and Figs. 2 and 3, the fixture for grinding one side frame only, two fixtures being used one for the left-hand side and the other for the right.

Referring to Fig. 2, it will be noticed that the work is resting on three positive points, *A*, and supported by the spring pins *B*. One would naturally think that the magnetic chuck would have force enough to draw the remaining bosses toward it, so as to distort the frame, but it does not, owing to the fact that the work is placed far enough away, so that it has no effect on it whatsoever. All the chuck does in this case is to hold the fixture. The cross-sectional views show how the spring pin is made. The pin *C* has a hole at one end in which the spring wire *D* is placed. The wire is located in the saw slots in the fixture and is secured by screw *E*. The method of locking is shown in the cross-section of the end elevation, *F* being the locking bolt, and *G* the locking screw which operates it.

In operation, before placing the side frame in the fixture, all the spring pins are depressed and locked. Then the casting is placed on the positive points and a weight is placed on it, bearing only on the points directly over the positive

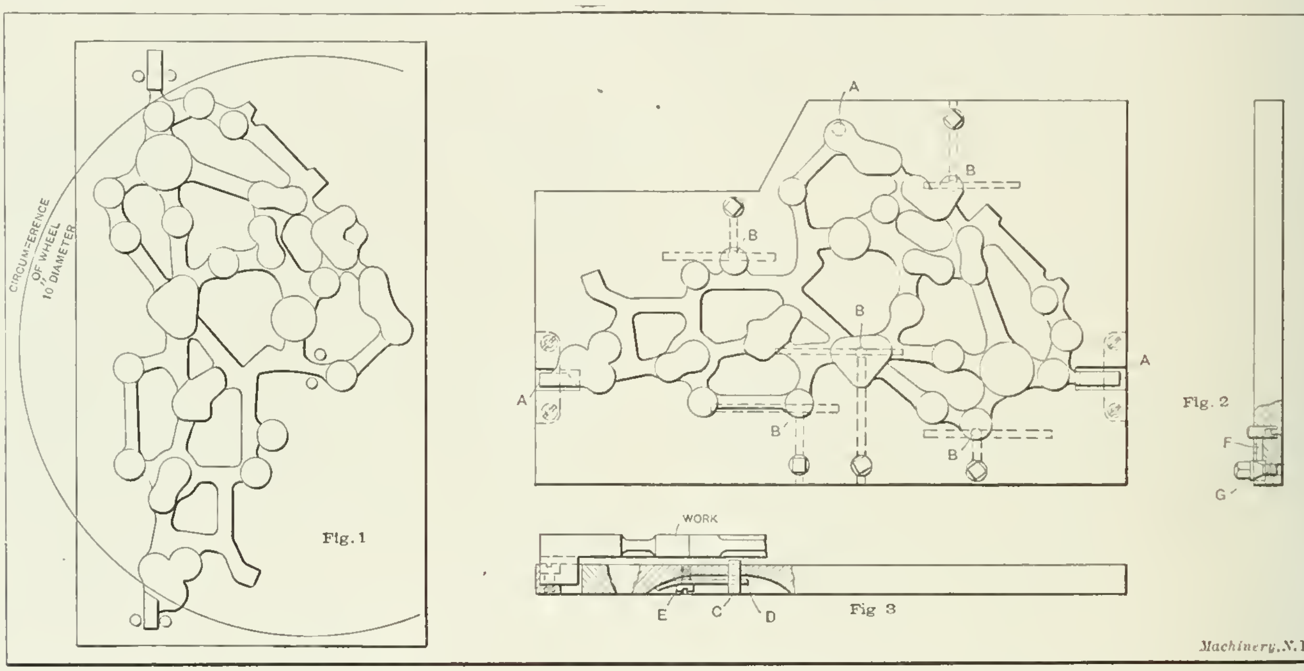


Fig. 1. The Fixture used in Finishing Both the Right- and Left-hand Frames to the Desired Thickness

Figs. 2 and 3. Fixture used in Finishing One Side of One Side Frame only, One Fixture of this Kind being used for Each Side Frame

locations. The next move is to release each spring pin separately and lock it. This is done to insure against springing the work, which would surely occur if all the pins were released at once. The slots in the sides of the fixture in which the two lugs of the casting rest, prevent the work from sliding off.

The current is now turned on and this side is ground, about 0.025 inch being removed. Having ground this side, the frame is placed in the sizing fixture, Fig. 1 with the finished side down, and located by the pins shown. Then another casting is placed in the other fixture in the manner previously explained. The wheel is now brought as far as the circle shown in the sketch, or as far as the lugs will permit, and the piece finished on this side, at the same time that the one side is finished in the other fixture. A small piece of casting (coppered) is placed on the finishing fixture for a gage, to show when the proper thickness is reached. As the wheel wears slightly, the operator can feed down to the previous setting without danger of cutting away too much material; then as soon as the wheel starts to cut the copper from the gage, he will know the proper size has been obtained.

The above method of machining flat surfaces has proved so successful, that in numerous cases, the patterns have been changed to allow less stock for finishing, and the grinder used in the place of the milling machine. In grinding, less stock

is removed, and there is consequently less liability to distort the casting, while in milling, a sufficient amount must be left on the casting to insure the tools standing up, and to allow them to get under the scale properly.

The matter of selecting proper wheels is a difficult one. Some are too hard, some too soft—so soft in fact that they wear out very soon—while others are so hard that they load up quickly and heat the work rapidly. The writer has found that when a wheel is too hard and glazes, better progress will be made by recessing or under cutting it so as to leave a cutting surface of about ¼ inch, and it will not require redressing so often.

The writer would like to hear how other users of the vertical grinding machine are solving problems in accurate machine work of this character. A. C. LINDHOLM

New Haven, Conn.

METHOD OF MAKING DUPLICATE SKETCHES

The drafting department is very often called upon to make a pencil sketch of special work for a rush job, and is expected to have it completed in the shortest possible time. In many cases, these sketches are for work that is to be done outside of the factory, or are for the use of the sales department at some agency—sometimes several hundred miles away.

As everyone knows, mistakes are easily made in mechanical work as in everything else, and someone is expected to bear the blame. The drafting or designing department will, in nine cases out of ten, be the department which will receive, sooner or later, the credit for the mistake, and consequently, should have some means for keeping accurate records of rough sketches, data, etc., as well as for tracings and blueprints.

The writer has devised a system of sketch sheets for this purpose. By means of these sheets accurate duplicates of the original sketch are kept, and may be filed away for future reference. They consist of sheets of a cheap grade of bond paper, cut to the size most adaptable to the work of the factory using them, and are printed and lined as shown in Fig. 1. These sheets can be placed on the drawing board with carbon paper placed between them, so that each sheet will be an accurate record of the original drawing. As many as four copies may be made in this manner. Where it is not desirable to make blueprints, or where no means are at hand for doing so, this method will usually be found very useful.

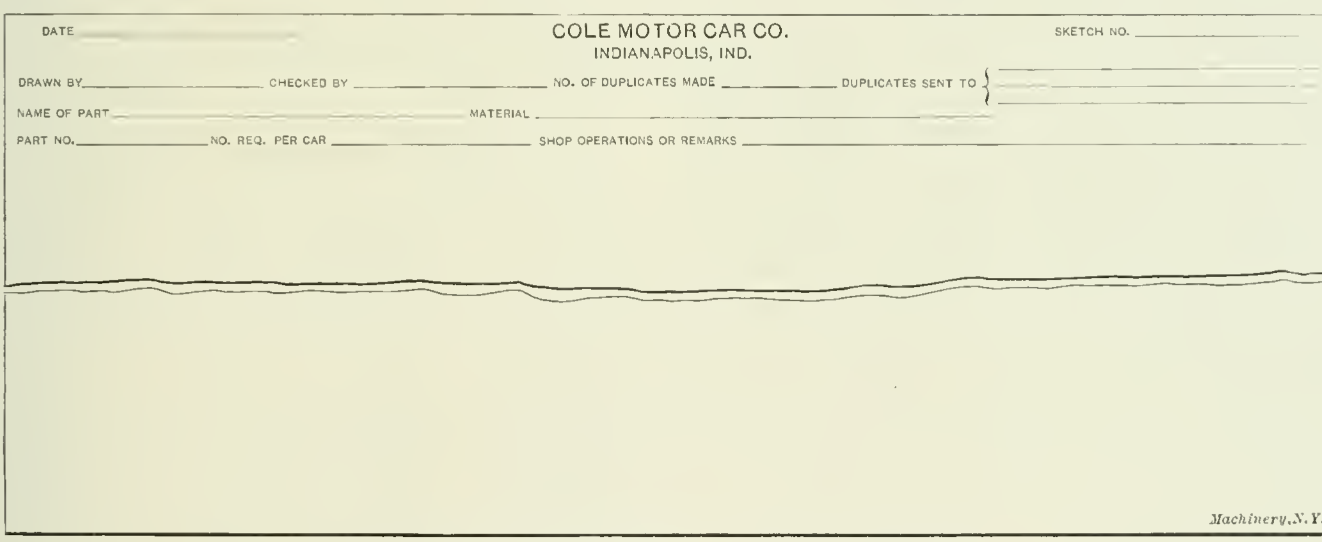


Fig. 1. Sheet used in Making Duplicate Sketches, Size 18 by 12 inches

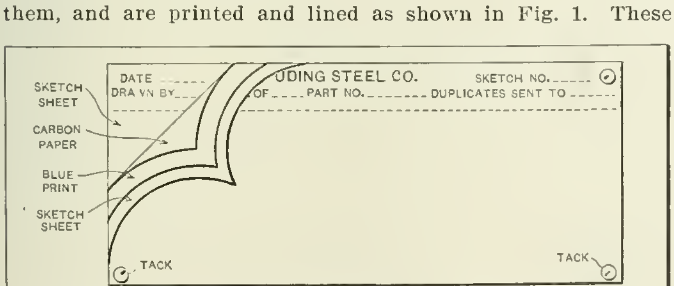


Fig. 2. Method of Making Duplicates of a Blueprint where Changes are to be made

In tracing over an old drawing, where changes are to be made, bond paper is also recommended. To do this, a sketch sheet is placed on the board, then a sheet of carbon paper is placed over it, next to the blueprint to be changed, and lastly another sheet of bond paper as shown in Fig. 2; this will give two copies of the changes made. F. B. HAYS

Indianapolis, Ind.

A FEW SUGGESTIONS TO DRAFTSMEN

Although it may seem to be too simple a matter to write about, it is, within the writer's observation, a fact that few draftsmen tack tracing cloth to a drawing-board according to any logical method. If the following procedure is adopted, the cloth may easily and quickly be placed, without wrinkling. Put the first tack in the middle of the top margin of the cloth. Then smooth the cloth with the palm of the hand downward to the middle of its bottom margin, and fasten it there with a tack. This makes the cloth taut vertically through the middle. Now, smooth out from the center to the middle of one of the side margins, fasten with a tack at this point, and repeat for the other side. The cloth is now tacked at the middle of each of its edges. Finally, smooth out the cloth from the center to each corner and tack there. In this procedure the cloth is always smoothed from the center outward; consequently no wrinkle or fullness is left.

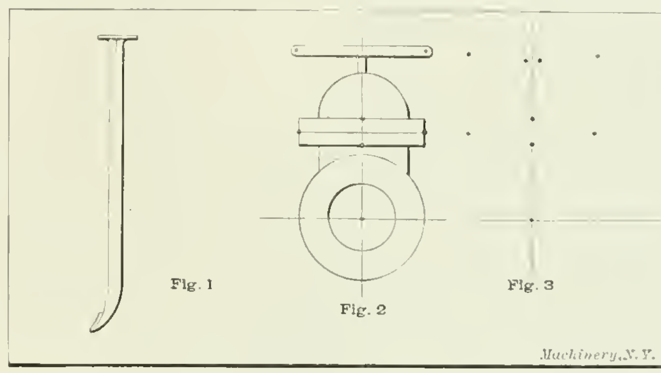


Fig. 1. A Convenient Lifter for Small Tacks — Fig. 2. Drawing to be reproduced — Fig. 3. Method of Duplicating Drawing

Thumb-tacks are objectionable on account of their interference with the T-square and triangle. It is a good plan to use, instead of these, plain cut tacks of the smallest size obtainable. These may be driven into the drawing-board with a small tack hammer kept for the purpose. If the cloth is stretched on the drawing-board according to the foregoing directions, as many additional cut tacks may be used as the size of the drawing warrants and no difficulty will be found in working over them with a T-square. Having once fastened the sheet, it will be unnecessary to remove it until the

drawing is finished. If the cloth should swell in damp weather, it will, when dry, return to its register with the paper drawing, because the cut tacks make a very secure fastening—vastly better than the thumb-tacks. For removing the tacks, a tool similar to that shown in Fig. 1 may be used. This is a tenpenny nail with its end hammered to a chisel point and shaped as shown.

It is a poor plan to trim drawings made on tracing cloth with shears or a knife. It is difficult to follow a straight line with shears, and a knife, if used with a straightedge, is likely to cut either it or the drawing-board. Take a large darning needle (which may, if desired, be furnished with a wooden handle into which the eye end of the needle is inserted) and run the point of it along the line upon which the tracing is to be trimmed, guiding it with the T-square edge. This will cut the cloth on a nice, straight edge, and will not mar the drawing-board if Manilla paper separates it from the cloth.

I have found the following described device to be of great convenience in making drawings in which small details are repeated. An illustration will best serve to explain it. It is desired to make the drawing of a gate valve, such as is shown in Fig. 2, a number of times. It is first drawn upon a small piece of tracing cloth and a number of points, such as corners, circle centers, etc., are marked with a prick point as indicated, these points being selected so as to enable one to repeat the drawing by their aid. This "jig" is laid upon that part of the drawing which it is desired to repeat and holes pricked through at the marked points. Fig. 3 shows the results from which it is easy to duplicate Fig. 2. By using such a jig, repeated details may be omitted from the pencil drawing, the points being pricked on the tracing and the drawing inked in without penciling. JULIAN C. SMALLWOOD

Syracuse, N. Y.

LAYING OUT BLANKING DIES TO SAVE METAL

In the October number of MACHINERY there was an article describing a die with an automatic stop for blanking washers, where the holes in the metal strips shown in the illustration appear to have been laid out at an angle of 45 degrees. This the writer considers a waste of stock, and although he is not criticising the stop or other parts of the design, he would like to draw the reader's attention to the correct way of laying out blanking dies for washers or work of a similar character.

Fig. 1 shows a strip of metal in which the holes have been laid out at an angle of 45 degrees, while Fig. 2 shows another

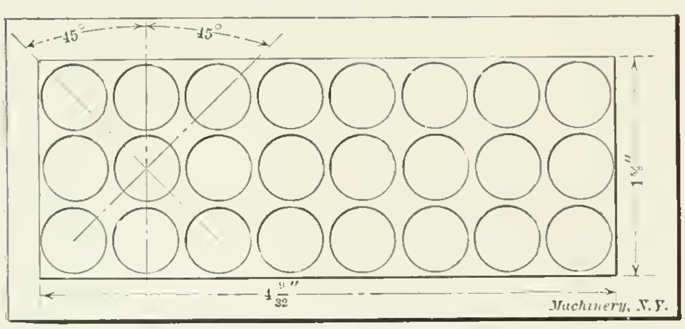


Fig. 1. Condition of the Metal Strip after Blanking in a Die laid out at an Angle of 45 Degrees

strip of metal in which holes of the same diameter as shown in Fig. 1 are laid out at an angle of 30 degrees. By comparing these two strips of metal it can be seen that in Fig. 1 twenty-four washers can be cut from a strip which is 4 9/32 inches long by 1⅝ inch wide; while the strip shown in Fig. 2, which is 4 9/32 inches long by 1 15/32 inch wide, will give twenty-three washers, and also two half washers. In reality the latter strip would give twenty-four washers, as the usual strip of metal is considerably longer than that shown, and, of course, in a long strip no half washers would be cut, except at each end.

To more clearly illustrate the difference in the two methods of laying out a die, we will calculate the area of the two strips, and see the amount of saving in stock which would be gained in making 1000 washers when the dies were laid out at an angle of 45 and 30 degrees respectively. When the die is laid out at an angle of 45 degrees, and the strip is as shown in Fig. 1, the number of square inches of material required to make 1000 washers would be $4\ 9/32 \times 1⅝ \times 1000 \div 24 = 289.87$ square inches. When the blanking die is laid out at an angle of 30 degrees, and the strip is as shown in Fig. 2, the number of square inches required for 1000 washers would be $4\ 9/32 \times 1\ 15/32 \times 1000 \div 24 = 261.71$ square inches. Then the amount of metal saved by laying out the die at an angle of 30 degrees instead of 45 would be $289.87 - 261.71 = 28.16$ square inches. This, as can be seen, is a considerable saving of metal, and where a large number of blanks is required the saving would, of course, be more noticeable.

By way of further explanation the writer will say that the holes in all classes of dies for cutting any size or any amount

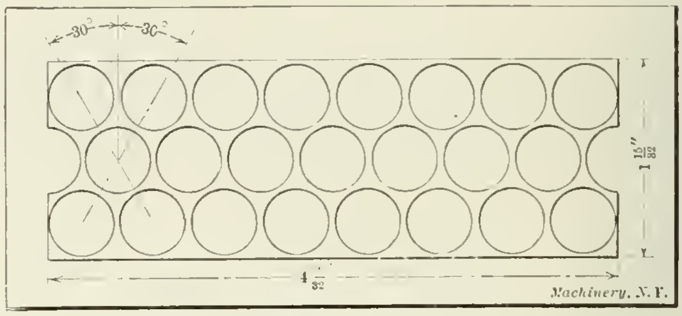


Fig. 2. Condition of the Metal Strip after Blanking in a Die laid out at an Angle of 30 Degrees

of round blanks at one time, should be laid out at an angle of 30 degrees with each other in order to get the greatest number of blanks from the least amount of metal. Of course, in all cases it is necessary that the narrow bridge between each hole should be equal to the thickness of the metal; and that the distance from the center of one hole to the center of the other be equal to the diameter of the hole plus the width of the bridge of metal between the holes.

Waterbury, Conn. CHAS. DOESCHER

HOMEMADE AUTOMOBILE MAKING

Automobile building is not confined alone to the regular manufacturers but the craze has taken hold of a number of individuals—machinists and others—who have worked in an automobile factory and who all think they have a fair knowledge of how to build an automobile. The majority of them have not the wherewithal to purchase an automobile, so the only thing left for them to do is to make a few patterns, get a few castings, spend a few evenings on the machining of these castings, do a little wood-working, and after the expenditure of a few dollars they have the machine under way.

A man may be a high-grade machinist and toolmaker and may have spent years in the toolroom of an automobile factory, and thoroughly understand the construction of patterns and the molding of them; nevertheless these qualifications do not make him competent to undertake the building of an automobile. Again we have the so-called "handy man" who after operating a cylinder-boring machine or an automatic screw machine, etc., in an automobile factory, thinks that he has experience enough to start building an automobile for himself, incorporating in his construction improvements which will open the eyes of the "regulars."

The writer, who put in about five years in the pattern and foundry departments of a large automobile factory in Detroit, and also has devoted several evenings a week to "charity" pattern making, on parts for homemade automobiles, feels that his experience warrants him to give a bit of advice to those contemplating making a homemade automobile. Go ahead, provided, however, that you have the patience, time, tools and "money to burn" and that reverses and disappointments land on you, as water on a duck's back.

The design and proportions of the cylinder are very important, and if you wish to copy another standard make of cylinder, this is well and good. Next comes the pattern and core-boxes for the cylinder, and these must be correct. By

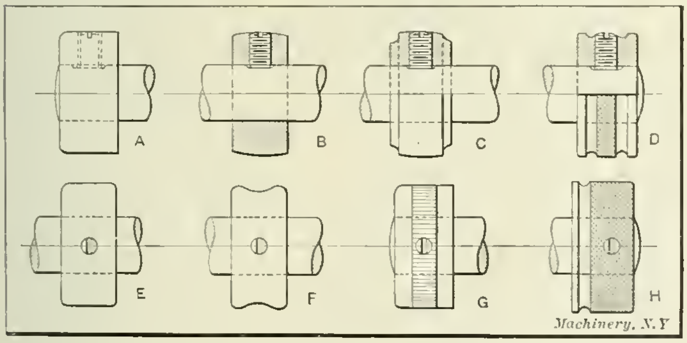
"correct" the writer does not mean that the pattern and core-boxes should have a high-grade piano finish. They must be practical for the molding and core-making; and the placing of the cores in the mold is also an important point. The making of the pattern for an automobile engine cylinder, and the successful casting of it require the services of a first-class mechanic, so do not expect the foundry to turn out a good cylinder casting from inferior patterns and core boxes; you are very fortunate if the foundry proprietor accepts the job of casting your cylinders at all.

The writer thinks he is correct in saying that no foundryman who has had any previous experience in automobile engine work will accept a job of this kind unless business is slack or a special price is made which will warrant him to take chances on turning out a perfect cylinder casting, so that his profits will more than cover the casting losses. Some readers may say: "If the foundry foreman understands his trade, he should know how to make a perfect cylinder." The very fact that he does understand his business is the reason why he will not accept gas engine cylinder work, unless the customer is willing to guarantee against any financial losses. The writer knows of two firms in Milwaukee who will not accept gas engine cylinder work (automobile cylinders) at any price. Five machinists, friends of the writer's, are building automobile engines and he has personally followed up the work on the cylinders. The first man received and partially machined six cylinders before getting even a fair one. The second man received seven cylinders and the third, eleven cylinders. This latter man got a good cylinder after waiting and working seven weeks. This should be a lesson to any young or inexperienced mechanic who attempts building an automobile, and the writer will conclude by saying not to attempt building an automobile unless you purchase the machine parts, and are willing to spend time, patience and money in assembling.

EXPERIENCE

COLLARS FOR SMALL MACHINE WORK

The collars shown in the accompanying illustration will be found very useful for small machinery. They are made from cold-rolled steel in an automatic screw machine where they can be finished complete except for the drilling of the hole for the set-screw. Of course, this hole could also be drilled



Stop and Adjusting Collars for Small Machine Work

by means of a cross-drilling attachment, but it would be necessary to tap the hole for the set-screw elsewhere, so that very little would be gained by drilling the hole in the screw machine. The collars *A*, *B*, *C* and *D* are used to retain movable parts and are fastened to the shafts by the set-screws shown, the shafts having small flats filed on them. Sometimes flats are not provided on shafts for the set-screws, but this is not good practice. The collars *E*, *F*, *G* and *H* are what are commonly called stop collars. These are used for limiting the movement of shafts, such as a belt shifter, etc.

These collars are of simple design and can be made much cheaper in the automatic screw machine than by making them of cast iron as is sometimes the custom.

Buffalo, N. Y. LAWRENCE H. GEORGER

RECESSING TOOL-HOLDER FOR SCREW MACHINES

The accompanying illustration shows a recessing tool-holder for screw machines which is of very simple design and can be cheaply made. Fig. 1 shows end and side views of this recessing tool-holder. The shank is made to fit the hole in the turret, and is of machine steel, casehardened. A detailed view of this shank is shown at *A* in Fig. 2, and a detail of the cap or cover at *B*. Two lugs *C* and *D*, shown in detail in Fig. 3, are fastened onto the head *B* with screws; one lug holds the screw *a*, which acts as a stop, and the other

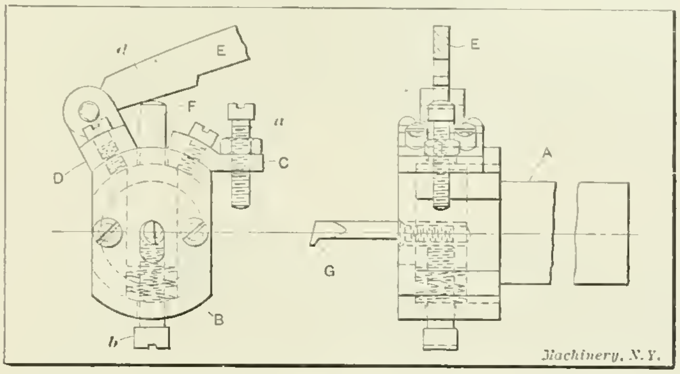


Fig. 1. A Recessing Tool-holder of Simple Design for Screw Machines

holds the handle *E*. A detail of the recessing tool and the tool holder are shown at *G* and *F* in Fig. 3. The recessing tool *G* is held in the tool-holder *F* by the screw *b*. A spiral spring shown in Fig. 1 bears against the shoulder c of the tool-holder, keeping it out against the cap *B*, as shown.

For hand screw machines this tool is operated as follows:

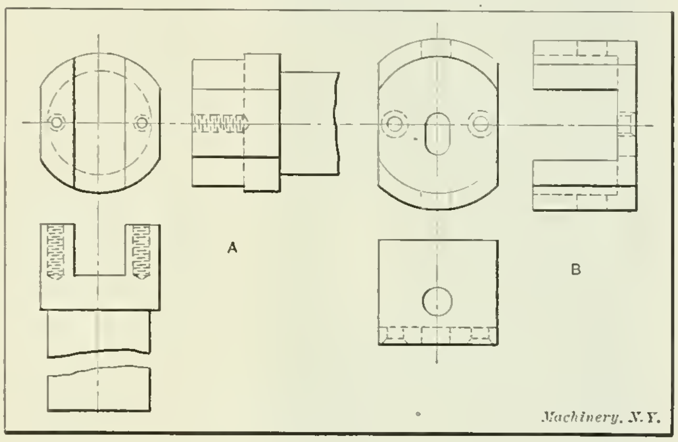


Fig. 2. Detail Views of the Shank and Cap

The recessing tool *G*, which is concentric with the hole in the work, is advanced in the hole the desired distance; then the handle *C* is depressed, being stopped by the screw *A* when the desired depth is reached. The turret can then be advanced horizontally until the desired amount of recessing is completed.

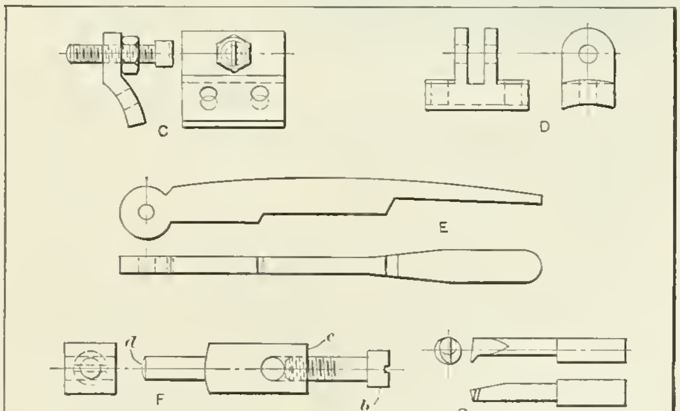


Fig. 3. Detail Views of the Brackets, Handle, Tool-holder and Recessing Tool

For automatic screw machines the parts *C*, *D* and *E* are removed, and a cam block is attached to the cross-slide tool-holder. This cam overlaps the tool-holder and is in such a position that it presses against the end *d* of the recessing tool-holder *F*. The cam held on the circular toolpost is made of the shape that it is desired to produce in the work.

One advantage of this tool is that the rise on the cross-slide cam equals the distance that the tool is to be moved, thus avoiding the calculations which are necessary when a swing tool is used for recessing JETHART

MAKING BLADES FOR INSERTED-TOOTH MILLING CUTTERS

The making of the blade shown in Fig. 1 was at one time considered a difficult proposition. These blades were made from "Intra" steel, and it was necessary to reduce the part A so that it would fit in the slots cut in the milling-cutter body.

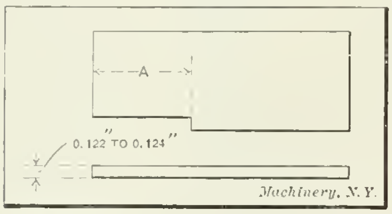


Fig. 1. Blade for Inserted-tooth Milling Cutter

The limits on the thickness were from 0.122 to 0.124 inch. The blades were at first ground in a suitable fixture on a machine of the swinging-arm type, and as the pieces varied somewhat in thickness, heavier cuts were required to be taken on some of the pieces, so that these varied considerably from the others, on which light cuts were taken. This method was discarded and the following method was adopted. A special fixture which had been used for another purpose was fastened to a Lincoln miller, as shown in Fig. 2. This fixture consisted of a casting carrying a worm-wheel and chuck, and a shaft with a worm and pulley attached to it. The pieces to be milled were held in this chuck by set screws as shown at A in the illustration. The chuck was driven by a pulley through a worm and worm-wheel, the pulley being driven directly from the 1¼ inch countershaft. This arrangement gave the desired feed. The ratio of the worm and worm-wheel was 1 to 40.

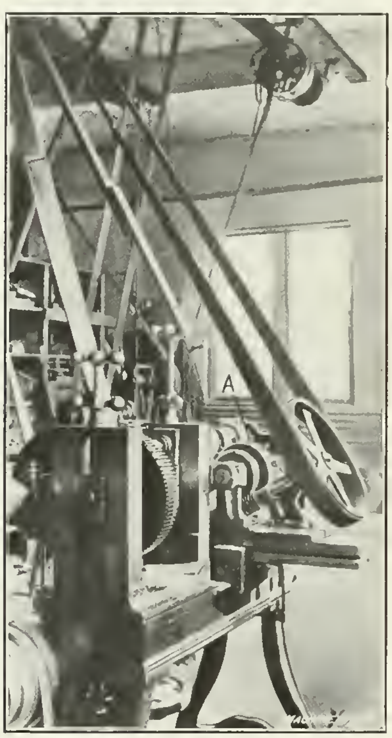


Fig. 2. Lincoln Miller equipped with Special Device for Milling the Blades

This fixture rotated slowly enough, so that the operator could keep filling it up and removing the blades as they were milled. The milling was done by straddle mills of the ordinary type. This method was found to be very efficient and none of the blades varied more than 0.0005 inch in thickness. DONALD A. HAMPSON

Middletown, N. Y.

DRILLING HOLES IN DIFFICULT POSITIONS

It frequently happens, especially in repair work, that a hole has to be drilled in a piece which breaks through, or in other words, is not supported at all points of its circumference. An example of this is shown in Fig. 1 where it is necessary to drill a hole for a ⅜-inch screw in a rib ¼ inch wide. The difficulty is very easily overcome by clamping two strips A, as shown, on each side of the web; the strips help to support the drill and guide it true.

Another example somewhat similar to that shown in Fig. 1, but where the hole only breaks through on one side of the piece, is shown in Fig. 2. Here one strip A is clamped on the side of the work, and the hole C can then easily be drilled.

An example differing slightly from those just described is shown in Fig. 3. Here it is necessary to countersink screw holes M in a cover which is to fit over a chamber, the inside of which is indicated by the dotted lines J. It can easily be seen that to make these countersunk holes with an ordinary countersink which is not supported would be a difficult proposition, as, having no support, the countersink would run to

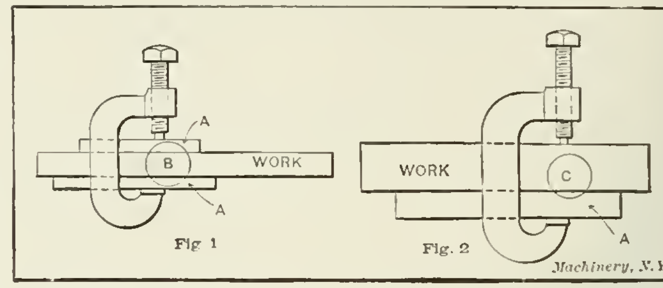


Fig. 1. Method of Drilling a Hole which breaks through on Both Sides Fig. 2. Method of Drilling a Hole which breaks through on One Side

the outside. To overcome this difficulty two strips A are held on the sides of the cover by a clamp as shown, so that the holes can be countersunk without any further trouble. When the screws are put in place, of course, they will project over the edge of the cover, but they can be easily filed off flush which will make a neat enough job for some purposes.

When it is necessary to make an elongated hole in a piece of work, as shown in Fig. 4, the usual method is to drill two holes the required distance apart and then chip or file out the intervening web. Now when the distance L is one-third greater than the distance K, or the diameter of the drill re-

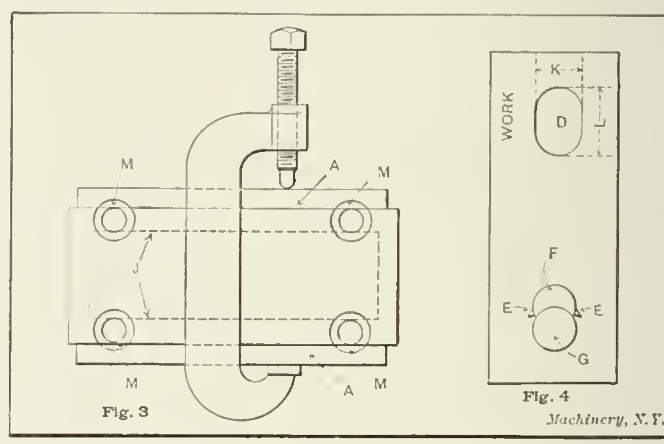


Fig. 3. Countersinking a Hole which breaks through on One Side Fig. 4. Drilling Two Holes which run into Each Other

quired, some means will have to be provided for drilling the second hole. To accomplish this, the hole F is first drilled and two small notches, E, are filed in it as shown. Then a piece of stock which is a tight fit is driven into the hole F and riveted over, so that the riveted portion of the stock will form small projections which fit into the notches E and prevent the plug from turning. After this is done the hole G

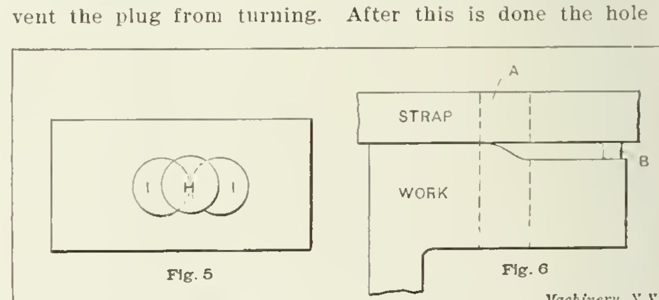


Fig. 5. Drilling Three Holes in the Same Manner as in Fig. 4 Fig. 6. Drilling a Hole which starts on a Radius

can easily be drilled and the plug removed, so that it is only necessary to cut away the small ribs to complete the elongated hole D.

Fig. 5 shows another example, which is similar to that shown in Fig. 4, except that the slot is to be twice as long as the diameter of the drill. To accomplish this, the two holes I are first drilled and then plugged as was mentioned regard-

ing Fig. 4. It is then an easy matter to drill the hole *H*, which leaves very little material to be filed or chiselled out to complete the slot.

Every machinist who has had much experience with drilling holes in cast iron knows that blow holes are frequently encountered. The writer had an experience like this at one time and overcame it in the following manner. All the chips which had been collected in the hole from drilling were removed and some of the hardest babbitt he could find was melted and poured into the hole, so that the blow hole in the casting was completely filled. The drill was again run in and the hole completed with satisfactory results.

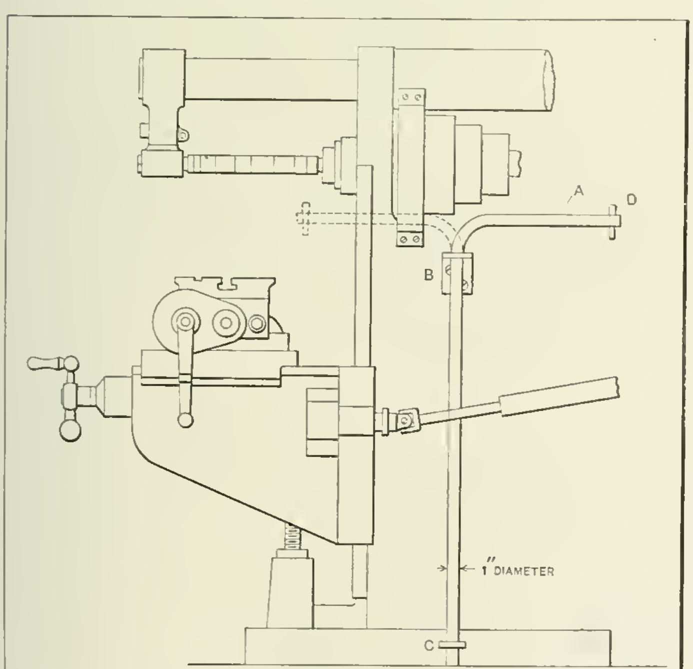
An example of a very difficult job is shown in Fig. 6. Here it is necessary to drill a hole where the point of the drill starts on a radius, so that it is practically impossible to keep the drill in a perpendicular direction. There are two or three methods by which this could be done, one of them being, to chip a flat surface in the work so that the drill point could get a good start; by using a small drill it would then be possible to make the larger drill follow the hole previously made.

Another example, which is shown in Fig. 6, is to clamp a strap onto the work which has a hole *A* of the required diameter in it, and drill through it. The strap is packed up on its outer extremity by a small plug *B*, so that it will be held perfectly parallel. By using the hole in this strap as a guide, the hole in the work can be easily drilled. Of course it will be necessary to start the drill very slowly.

Newark, N. J. H. E. Woon

DEVICE FOR REMOVING AND REPLACING THE DIVIDING HEAD OF A MILLING MACHINE

To those who have occasion to use a universal milling machine often, the frequent changing of the dividing head is usually a difficult task, owing to its weight and also to the delicacy of its mechanism which may very easily be seriously damaged by a fall. On the larger size of milling machine it requires two men to successfully handle the dividing head. To eliminate this extra labor and risk of a disastrous fall, the attachment shown in the accompanying illustration was made, and was found to be very efficient.



A Simple Device for Removing and Replacing the Dividing Head of a Milling Machine

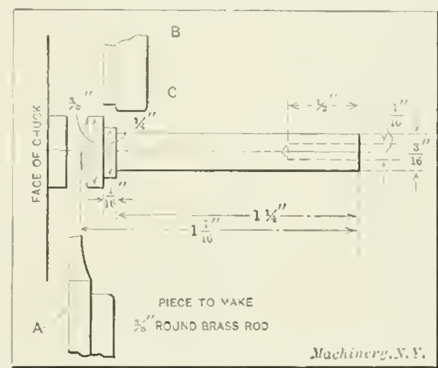
This attachment is composed mainly of a rod and two brackets. Attached to the rear of the machine by two 3/8 by 1-inch countersunk-head screws which are tapped into the column is a bracket *B* made from 5/16 by 2-inch mild steel. A lug *C* is also tapped into the base of the machine, this lug being a piece of 1/2 by 2-inch mild steel, with one end turned down to 1/2 inch diameter and threaded 3/4 inch long. Holes 1 1/64 inch diameter are drilled in the brackets *B* and *C*, in which is inserted a crane bar *A* made from 1-inch diameter cold-rolled steel, bent to the form shown.

In one end of this crane bar *A*, a 1/4-inch hole is drilled for the pin *D*. This pin prevents the dividing head from slipping off the bar when it is being removed or replaced. The dotted lines in the illustration show the position of the crane bar when removing the head and placing it on the machine table. In operation the milling machine table is lowered or raised until the hole in the dividing head coincides with the crane bar. The head is then slipped on the end of the bar and the table moved over until the head is safely on the frame, when the pin *D* is inserted. The table is then lowered until the crane is free to move around to the position shown by the full lines. Corwin Lamoreaux

Aurora, Ill.

MAKING A LARGE STUD ON THE NO. 00 B. & S. AUTOMATIC SCREW MACHINE

A small factory desired to manufacture the brass stud shown in the accompanying illustration. Their screw machine department consisted of three No. 00 B. & S. automatic screw machines, two being old and one new. This stud, it will be noticed, is made of 3/8-inch round stock and is turned to a length of 1 1/4 inch. Both of these dimensions were beyond the limit of the old machines, but the new machine took a 5-inch lead cam instead of 4 1/2 inches. This allowed us to turn the long portion. The new machine also can be geared to make a piece as low as ninety-one seconds. The 3/8-inch stock was handled by boring out an ordinary feed tube to clear the stock and soldering the feed finger in the end of it. The maximum distance between the turret and the end of the spindle on the old-style machine is 2 3/4 inches. This has been increased to 3 inches on the new machine, which allows more room for box-tools, etc., on long pieces.



View showing Application of Circular Tools used in making Large Stud

In the illustration, *A* is the cut-off tool and *B* the form tool. The corner of this latter tool is rounded off as shown at *C*, which leaves a smooth finish where the box-tool and the form tool meet.

The order of operations for this piece are as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	41	3
Revolve turret	41	3
Center, 0.040-inch throw, at 0.001-inch feed	41	3
Revolve turret	41	3
Drill, 0.510-inch throw, at 0.001-inch feed	510	37
Revolve turret	41	3
Ream, 0.510-inch throw, at 0.005-inch feed	102	8
(Form, 0.100-inch throw, at 0.001-inch feed)	(102)	(8)
Revolve turret	41	3
Box-tool (roughing), 1.250-inch throw, at 0.008-inch feed	156	12
Revolve turret	41	3
Box-tool (finishing), 1.250-inch throw, at 0.00606-inch feed	206	15
Cut-off, 0.208-inch throw, at 0.002-inch feed	104	8
(Revolve turret)	(41)	(3)
Total number of revolutions for one piece	1365	100

This lay-out, using a spindle speed of 2048 revolutions per minute, gives a gross production of nine hundred pieces in ten hours, or forty seconds for one piece. I might mention here that the gears on the new-style No. 00 B. & S. machine for pieces made in less than thirty seconds are compound, the same as on the No. 2 B. & S. machine. The gears for the

above job are 20 teeth on driver, 30 teeth first gear on stud, 40 teeth second gear on stud, and 60 teeth gear on worm shaft.

The maximum surface speed of the stock on this job is 201 feet per minute, and the maximum surface speed while drilling and reaming is 33 feet per minute. A faster speed could have been used for these two operations, but we save time by forming while drilling. This would not be possible with a faster speed. The form tool is used to finish the shoulder to the exact length.

It is possible to make long pieces on the old machine by box-tooling, etc., close to the spindle, then feeding out and forming, but the pieces will not be accurate because two diameters have been turned at different chuckings.

AJAX

IMPROVED ANGLE-PLATE FOR LATHE WORK

It is not an unusual occurrence in the use of the ordinary type of angle-plate in the lathe to have the corners strike the ways of the lathe when pieces of large or irregular shape

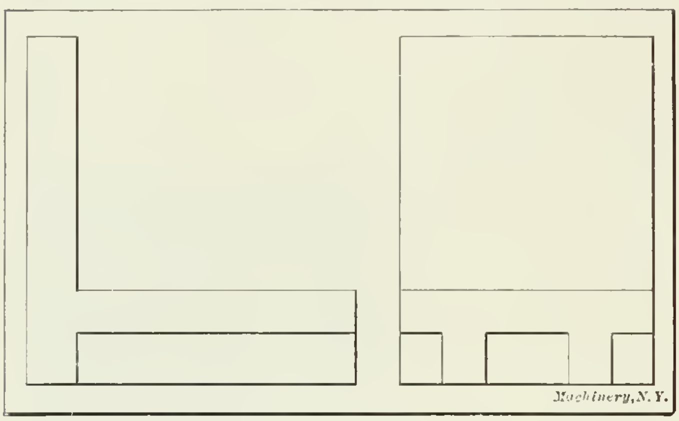


Fig. 1. Improved Angle-plate for Lathe Work

are strapped to it. This trouble may be obviated by the use of an angle-plate of the shape shown in Fig. 1. The advantages obtained by this angle-plate are as follows: The work can be strapped to the plate before the plate is fastened to the faceplate of the lathe. This will be found very convenient when work of difficult or irregular shapes is to be machined. Having the angle-plate made in this manner balances the faceplate and thus obviates the necessity of strapping balance weights to it. It is also a very convenient plate for bench work, as it has all its surfaces finished and square with each other, which makes it very useful in laying out work. At *A* and *B* in Fig. 2 is shown the advantage of this plate over the ordinary type of angle-plate. At *A* is shown the new plate, and the face on which the work is to be held is five inches from the center so that the extreme corner of the angle-plate clears the ways of the lathe. At *B* in Fig. 2 is shown the

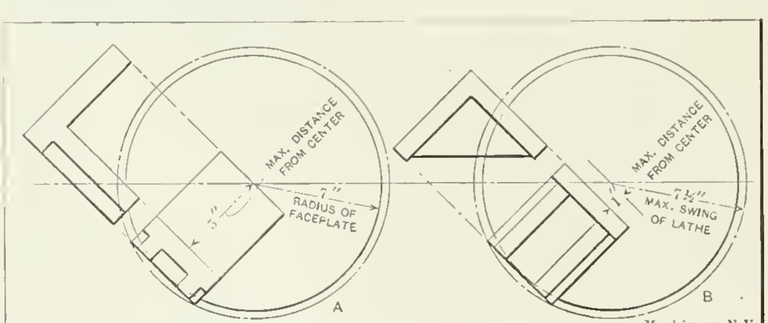


Fig. 2. Showing Advantage of the Angle-plate shown in Fig. 1, over the Ordinary Type of Angle-plate

angle-plate of the ordinary type on the faceplate, and it is seen that for the angle-plate to clear the ways of the lathe, the maximum distance which it can be set from the center is only one inch. This shows clearly the advantage of this plate for lathe work. It should be noted that the bottom of this angle-plate should be made thicker than the ordinary type so as to secure proper rigidity.

C. R. BARTON

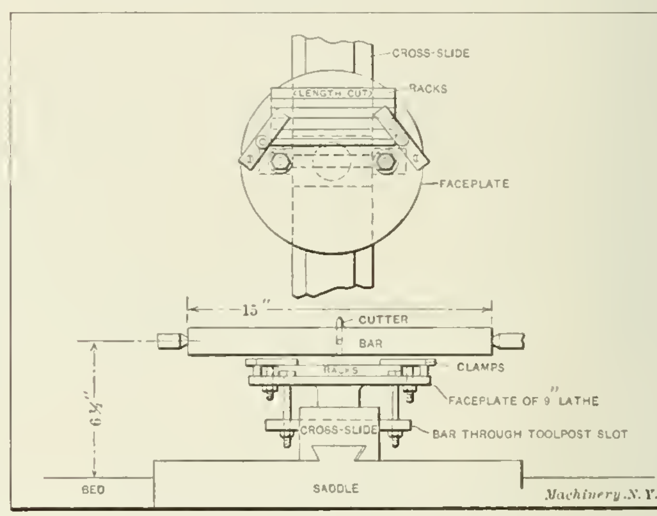
Elizabeth, N. J.

CUTTING RACKS IN A LATHE

In small jobbing shops it is sometimes necessary to do work which is quite a problem on account of the meager equipment. This was the case with six racks which we had to cut. These were made from 1/2-inch square brass 6 inches long. The teeth were to be cut to within 1 inch of each end, making the total length of cutting 4 inches. The diametral pitch was 28 so that the circular pitch was 0.1122 inch, the depth of the teeth was 0.077 inch, and the thickness of the cutting tool at the point 0.0375 inch. To cut the teeth in the rack the six pieces of brass were soldered together to form a unit. This made a block 6 by 3 by 1/2 inch.

The only two machines available to perform the job on were a 9- and a 13 inch Barnes lathe. So the faceplate of the smaller lathe was bolted onto the top face of the tool-slide of the larger lathe, as shown in the accompanying illustration. This was accomplished by putting a bar through the slot in the toolpost slide, and then strapping the faceplate onto the slide, by two clamping bolts as shown. The racks were fastened onto the faceplate by means of two clamps.

The bar which was used to hold the cutter was made of a piece of 1 1/4-inch shafting with a 3/8-inch hole near the center to hold the cutter, which was fastened by a headless set-screw. The cutter was made from a piece of 3/8-inch drill rod, turned up as close to the bar as possible. It was turned



Method used in Cutting Rack in 13-inch Barnes Lathe

to an included angle of 29 degrees and made 0.0375 inch wide at the point. The extending of the cutter from the bar to give the correct depth of cut also provided for relief.

The lead-screw of the lathe had a lead of 1/8 inch, so that by using a 20-tooth gear on it, and moving it 18 teeth for each spacing, the saddle was moved $\frac{18}{20}$ of 0.125, which is 0.1125 inch, thus giving an error for each tooth of 0.0003 inch which was close enough for the job.

After the racks were cut they were detached by heating them to melt the solder, when they were found to be all that could be desired.

JACK FINLAY

Hartford, Conn.

ABUSE OF THE THREE-JAW UNIVERSAL CHUCK

The three-jaw universal chuck properly fitted to a lathe spindle is one of the most economical appliances in the machine shop. "Yes, if it's new," some will say when they have read thus far. The makers of these chucks do not make an extension for the handle of the wrench about 12 inches or so long or one would be included when you purchase a chuck. The scroll is made to stand so much pressure and no more, and at the same time retain its accuracy. What good is a chuck of this kind if it is not accurate within a certain degree? Usually a shop has a chuck for a little while that will pass, but when a "fat head" comes along who doesn't care and, having it in charge for a period of "one job," puts a pipe on it for a larger leverage,

he strains the chuck at that point. If the job requires so much of a hold that it necessitates the aid of a pipe, that job requires a larger chuck. If the foremen of the shops would forbid the use of pipes on all universal chucks installed, they would be more in demand. They are made to run true and will if properly cared for. JOHN HOMEWOOD

Chicago, Ill.

A MULTIPLE MILLING FIXTURE

Castings similar to the one shown in Fig. 1 are used on almost all classes of machine work. The one shown here is the tail-end lead-screw support for a 14-inch engine lathe. The face marked *f* on this casting is required to be finished, and to do this the multiple fixture shown in Fig. 2 was designed.

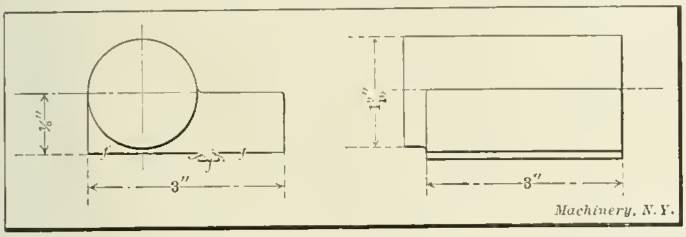


Fig. 1. Casting to be milled

From a study of Fig. 1, it can be seen that this piece is very difficult to hold, as it has no bosses, lugs or cored holes by which to clamp it, thus making it a very awkward proposition. On the work of this description it is also necessary to provide means so that the work can be set quickly and accurately, and also held so that it can withstand the cut especially at the start.

The fixture *A*, shown in Fig. 2, is of very simple design and is made of cast iron. The bosses *B* and *C* are cast integral with it. The bosses *B* have V-grooves cut in them, in which the spherical part of the castings rests. The bosses *C* are drilled to fit the cup-shaped supports *D*, which are made from second grade steel, the face being hardened, and the shank being left soft. The faces of these supports are cut out at an angle of 45 degrees, the upper half of the face being partly cut away to clear the milling cutters. A hole for a taper pin *a* is drilled, partly in the bosses *C* and partly in the stops or supports *D* to prevent the supports *D* from turning, as it is obvious, when tightening the clamping screw *E*, that a certain twisting movement will be given to the support *D*. All the other parts of this fixture are clearly shown, so that it will not be necessary to describe them further. It may be well to mention, however, that a hardened tool-gage *M* is clamped to the left end of this fixture for setting the milling cutters.

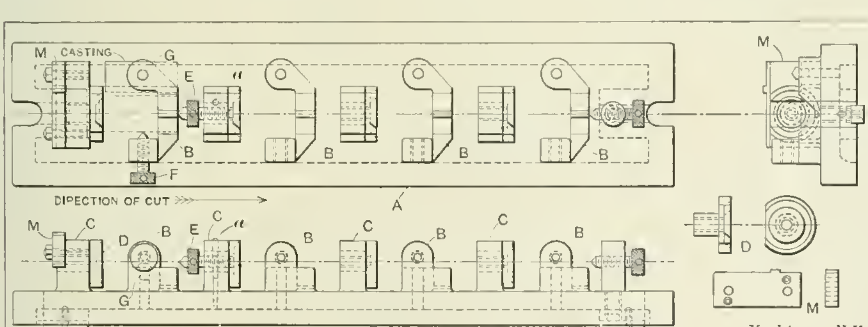


Fig. 2. Fixture used in Milling the Casting shown in Fig. 1

In operating this fixture the casting is set in the V-grooves cut in the bosses *B*, and forced into the cup-shaped hole in the stop *D* by screw *E*. While tightening this screw the casting should be held down with the hand to prevent it from rising. After this screw has been tightened the screw *F* is tightened, which is located above the center and holds the casting down on the cone-pointed pin *G*. Sufficient pressure is given to all these screws so that their points are embedded in the casting, and thus hold it very firmly. By forcing the boss of the casting into the stop or support *D*, it is centered and securely held, preventing it from rising at the starting of cut.

After four castings are set in the fixture and the cutters have been set to the master-plate *M*, the machine is started, and after finishing the first casting the table is moved across the intervening space between it and the next by hand. Then the feed is again thrown in and the second casting completed. While the second casting is being completed, the first one can be taken out and replaced and when the fourth casting is finished the table is lowered and run back. Then while finishing the first casting, the fourth one can be taken out and replaced, thus making the operation practically a continuous one. On an average, about eleven minutes is required to finish four of these castings. WILLIAM H. VOCKELL

Cincinnati, Ohio.

A NOVEL SPRING WINDER

The accompanying illustration, Fig. 1, shows a cheap and efficient spring winder for making spiral springs, which has been in use by a large automobile concern for some time and has proved to be very satisfactory.

The device consists of a casting having a flange *D* which may be fastened to the work bench by a clamping bolt *E* and two lugs *C* provided with V shaped slots in their narrow ends to receive different sizes of mandrels. The two eye-bolts *B* hold the mandrel in position; the holes in these eye bolts should be of the same diameter as the size of the largest mandrel that it is desired to use. The crank *F* has a triangular

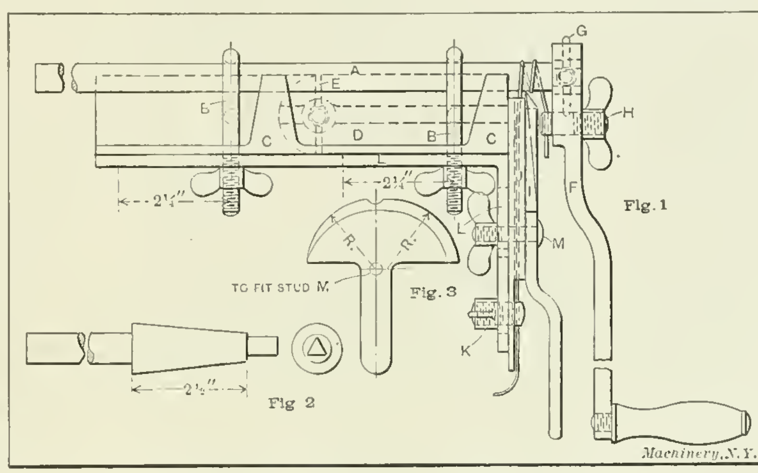


Fig. 1. Plan View of Spring Winder. Fig. 2. Arbor used for Winding Conical Springs. Fig. 3. Spacer used for Winding Conical Springs

hole of a size sufficient to take in the largest mandrel, and a thumbscrew *G* to clamp it fast to the mandrel, also a bolt with a wingnut *H*, the bolt having a hole in the end to receive the largest wire that is to be wound. The guide *J* for the wire has a hole through its entire length of the same diameter as the hole in the bolt *H*. The spacer *I* is made of a thickness equal to the greatest pitch of spring that it is desired to wind. The edge which presses against the arbor *A* is beveled as shown, thus giving a guiding surface from nothing to the full thickness of the spacer at the center.

The guide *J* and the spacer *I* are both mounted, as shown, on the bracket *L*, being held in position by a bolt *M* with a wing-nut. The hole for this bolt is elongated in *L* to allow adjustment of the guide and spacer for different sized mandrels. A bolt with a wing-nut similar to the one at *H* is shown at *K*, the hole for which is also elongated in *L*. This bolt provides means for securing the desired amount of tension on the wire while winding.

In operation the wire is passed through the hole in the bolt *K* and the hole in the guide *J*, then bent around the arbor *A* and inserted in the hole in the bolt *H* and there secured. The spacer is then adjusted for the desired pitch by rotating it on the pivot until the distance from the hole in *J* to the guiding edge of the spacer is equal to the pitch wanted. *J* and *I* are then adjusted so that the edge of the spacer just clears the mandrel and it is then clamped fast. *K* is adjusted for

the required tension and then it is only necessary to turn the crank to get the desired spring.

Conical springs may also be wound with this device by making a special mandrel as shown in Fig. 2 of the same taper as the required springs. The small end of this tapered portion should be next to the crank. To provide for the proper contact of the spacer with the mandrel while winding conical springs, the lower edge of the spacer is made radial from a point at one side of the pivot, as shown in Fig. 3. The distance that this point is off from the center should be equal to one-half the difference between the large and small diameters of the mandrel. The bracket *L* is slotted for the eye-bolts sufficiently to allow the guide and spacer to be extended an amount equal to the length of the conical spring desired. The fixture here shown will wind a spring 2¼ inches long.

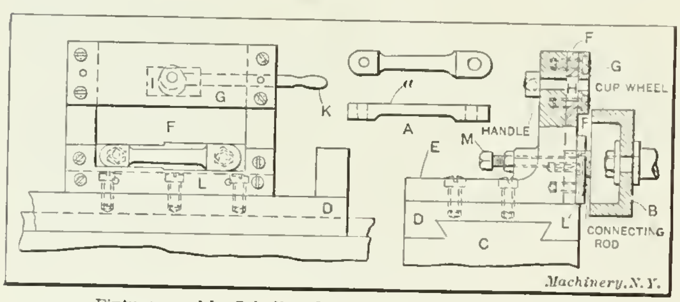
In operation for conical springs the bracket *L* is pulled out 2¼ inches, and the spacer adjusted so that its lower edge or largest diameter comes in contact with the mandrel at the small end. The bolt on which the spacer rotates is then adjusted so that the spacer may be rotated, the wire is placed the same as for spiral springs and the crank turned with one hand while the spacer is kept in contact with the mandrel with the other, which is done by simply exerting a slight upward pressure on the handle.

C. G.

A USE FOR "CUP" GRINDING WHEELS

The accompanying illustration shows a novel method of grinding the face of connecting-rods by means of a cup-wheel. *A* is the connecting-rod, which is faced off on the flat side *a*. and *B* is the grinding wheel, shown in section.

The fixture consists of a bed *C* with ways on which is mounted the slide *D* provided with suitable gibs. The slide *D* has an angle-iron *E* secured to it by screws as shown. The vertical face of the angle-iron is grooved to receive the slide *F* which is held in by the plate *G*, screwed onto the vertical face of the angle-iron. The slide is moved up and down by means of an eccentric *H* which works in a recess *I* in the slide, and is operated by a handle *K*. A crank is shown in position ready to be ground, and is clamped in between the bottom of the slide *F* and a plate *L* which is fastened below it to the angle-iron *E*. Set-screws *M* act as stops on the unfinished



Fixture used in Grinding Connecting-rod with Cup-wheel

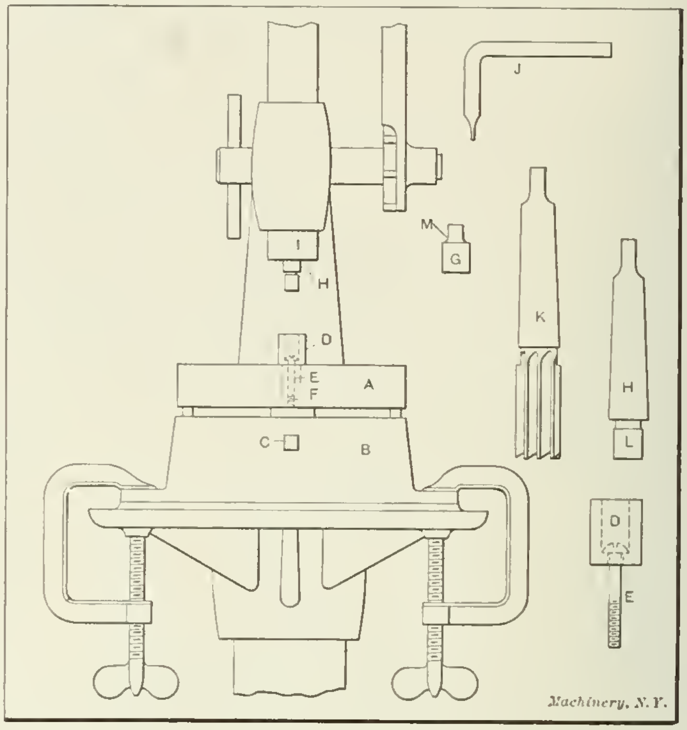
side of the connecting-rod and are adjusted as desired. A screw and hand-wheel, which are not shown, serve to feed the work to the cup-wheel. The connecting-rods after being ground are so hot that it is necessary to remove them from the fixture with a pair of tongs. After being cooled a hole is drilled in each end as shown, and they are then faced off on the side opposite to *a* in the ordinary way.

C. D. K.

LOCATING PUNCHES IN THE PUNCH-HOLDER

The accompanying illustration shows a simple method of locating round, piercing punches in the punch-holder, which has proved very satisfactory to us since it has been in use. The holes for the punches can be located, drilled and reamed very quickly, and if reasonable care is taken in setting, the work will be sufficiently accurate for ordinary conditions. This method is used when punches are secured in the punch-holder by set-screws.

Referring to the illustration, *A* is the punch-holder and *B* is a holder made of cast iron, carefully machined top and bottom, and bored to fit the shank of the punch-holder, which is fastened in it by the set-screw *C*, the punch-holder resting on parallels. *D* is a locating button hardened and ground, having a ½-inch hole in the upper part and a ¼-inch hole in the lower part. The ½-inch hole should be ground straight and true and with its axis at right angles to the bottom of the button. *H* is a pilot made of tool steel hardened and ground, with a Morse taper shank to fit the spindle of the drill press and has a portion *L* which is made a good sliding fit in button *D*. *G* is a plug made to fit snugly in the button *D* and has a portion *M*, which is the same size as the body of the punch; it is also made to fit snugly in the templet. These plugs are made in a large variety of standard sizes and form a per-



A Simple Method of Locating Piercing Punches in the Punch-holder

manent part of the outfit. The reamer or end-mill *K* is made with a Morse taper shank and is ground so that it will ream a hole which shall be a drive fit for the shank of the punch.

To lay out the holes in the punch-holder for the punches, proceed in the following manner: Lay out the various holes from the templet which was used in laying out the die, and drill holes 1/32 inch smaller in diameter than the shank of the punch, to the depth that the punch is to be set in the punch-holder. Then the small hole shown at *F* is drilled and tapped for a 10 by 32 button-head machine screw. The first punch hole is now reamed with the reamer *K* and the punch is driven in place. The button *D* is then held in place with a screw *E* over the next hole in the punch-holder, the plug *G* placed in the button *D*, and with the templet in place on the first punch, the button *D* is located for the second hole and securely held in place by the screw *E*. The pilot *H* is now placed in the spindle *I* of the drill press and the punch-holder located on the table, so that pilot *H* enters the button *D*. The holder is then held in place by the C-clamps shown, the button *D* removed by means of the bent screw-driver *J*, which is made from ¼-inch round steel, the pilot *H* removed and the reamer *K* placed in the spindle *M* of the drill press, when the hole can be reamed to size; the same procedure is followed for all the punches.

In using this method it is, of course, necessary to see that the spindle of the drill press is carefully adjusted, and that the table lines up properly with it. This same method could also be used on the milling machine.

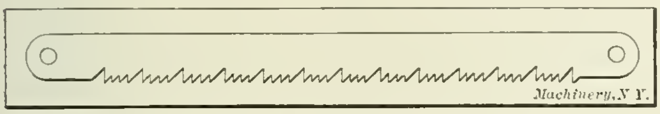
Aurora, Ill. E. J. G. PHILLIPS

UTILIZING OLD HACK-SAW BLADES

It may seem trifling to talk about saving a hack-saw blade, but when a large number are used the cost soon mounts up; and in some cases when we get into a tight corner, we like to

make a hack-saw blade last as long as possible. It has impressed the writer many times that there should be some way to lengthen the life of the common hack-saw blade, so that when the sharp cutting points are removed from the teeth it will not have to be discarded. The teeth may sometimes appear to be in fairly good shape, but a trial of their cutting properties will soon show that they have reached the end of their usefulness. To illustrate my point, permit me to cite an instance. One day while using a saw in just the condition mentioned, and being without another at the time to take its place, the thought came to my mind that it might be possible for me to improve its cutting. The idea was this. I took the saw to an emery wheel held it against the corner and ground a number of coarse teeth along its length a little deeper than the regular teeth, as shown in the accompanying illustration. This seemed to give satisfactory results and bit into the metal in fairly good style.

Another instance also comes to my mind of a makeshift which I have practiced with a tempered hack-saw blade (the



Method of Increasing the Life of Hack-saw Blades

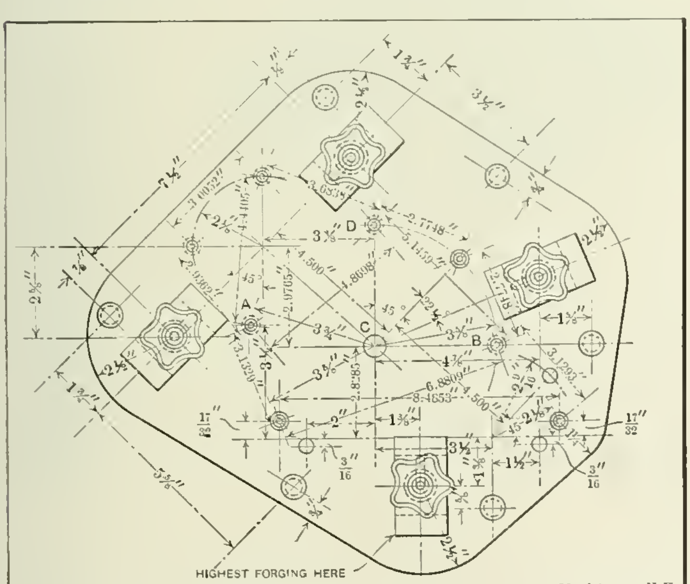
harder, the better). Break off the old saw or use a piece already broken off in service, and use this for a glass cutter. For this purpose the corner should be ground off slightly and to a knife edge. If this is done it will be found to cut glass satisfactorily until it is dull, when it can be quickly sharpened as before.

Another use to which I frequently put worn-out hack-saw blades, is for small washers. To do this anneal them by heating the ends to a cherry red and bury them in ashes. When cool and soft, cut off the ends with a chisel, grind and file around the hole and you have a small washer for many purposes. Of course, this is not suggested as an economical way to make washers, but as a trick to supply a want which is sometimes urgent. C. S. Bourne

Lowell, Mass.

PRACTICAL METHOD OF DIMENSIONING JIGS AND FIXTURES

As regards the article entitled "Improved Method of Dimensioning Jigs and Fixtures," by "Jig and Tool Designer,"



Practical Method of Dimensioning Drawings for Jigs and Fixtures

which appeared in the October number of Machinery, it is my opinion that Fig. 2 shows a more correct method of dimensioning than Fig. 1, but even that lacks many of the dimensions required by the toolmaker for spacing the holes accurately.

By using the dimensions shown in the accompanying illustration, the holes in this jig can be bored very accurately in the lathe or on the milling machine, and can be easily checked as to their relative distances from each other. I have found by experience, and I think many toolmakers will agree with me, that laying off accurate distances with the use of the micrometer dial on the milling machine is almost an impossibility, owing, no doubt, to the fact that the screw to which the micrometer dial is attached soon becomes worn, and therefore useless for setting the milling machine to very accurate distances.

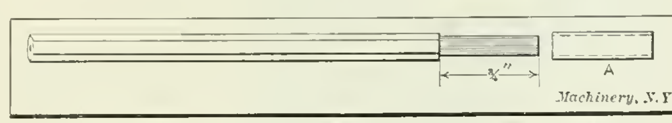
Let us assume that the holes for the bushing are to be bored in the lathe, in which case they would be located by buttons. With the dimensions given in the illustration, the toolmaker can readily locate the hole *D*, while with the dimensions given in Fig. 1, or the so-called "correct method," I fail to see how a toolmaker could locate hole *D*, unless the cross dimensions referred to above were given to him.

Again, suppose these bushing holes are to be bored on a milling machine. In this case the toolmaker would first lay them out to the dimensions given as closely as possible and then drill the holes about 1/16 inch smaller than the finished size, after which he would proceed to strap the fixture in an upright position on the milling machine, and bore the hole *C* to some convenient diameter. He then would bore the hole *B* to the correct dimension, after which he would bore the hole *A*. The next step would be to lower the milling machine table and bore the hole *D* slightly smaller than the finished size. By inserting plugs in all of the holes he would proceed to check up the hole *D* with a micrometer caliper or vernier, and find its correct location, or relative position to the other holes. When the exact center is found he would finish bore the hole. The remaining holes would also be located and bored in a similar manner. Edw. Merz

Buffalo, N. Y.

PREVENTING A PENCIL POINT FROM BREAKING

The accompanying illustration shows a simple way to prevent, or lessen the chance of breaking the point of a pencil when it falls. One end of the pencil is cut circular as shown



Simple Method of Preventing a Pencil Point from Breaking

to the size of the internal diameter of a small piece of steel tubing, *A*, about 3/4-inch long. The tubing is then forced into the prepared end, making the pencil heavier at this end than at the other. Naturally the heavy end hits the floor first, thus eliminating the chance of breaking the point.

Manchester, England. W. Thompson

THE PROCRASTINATOR

There lived a man with imagination,
Who planned to startle all creation.
Each day he talked us all near dead
And this is what the braggart said:
"When I'm an old, discarded tool,
With naught to do but sit and fool,
When my dear friends have passed away,
And auburn locks are streaked with gray,
I time will find and inclination
To start a wondrous cerebration.
You say: 'Hot air!'—but no one knows;
Before I turn my stiffening toes
Towards the sky and die content,
I may, on blissful labor bent,
Dig up some truths ne'er heard before,
Invent and patent schemes galore.
The things I long have had in mind
You on the market then will find.
My gearless, beltless, shaftless drives,
Appliances to save men's lives;
My wheelless, frameless, noiseless tools,
And cardless systems, brains for fools.
Yes, I'll make them all look sick
When I find time to turn my trick!"
Thus raved he till the whistle blew;
At home he dreamed that dreams come true;
He boasted, waited, schemed and cussed:
His thinking-box grew thick with rust.
He now is old. Vain, thoughts of fame!
And who, pray, can the duffer blame?
A scheme is N. G., not worked out;
It does not pay to simply shout.
To wait brings never fortune big;
The only recipe is—DIG.

Philadelphia, Pa. John S. Myers

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address The latter are for our own convenience and will not be published.

"PITCHING THE PIVOTS" IN WEIGH LEVERS

M. S. T.—What is the object of "pitching the pivots" in large weigh scale levers?

A.—"Pitching the pivots" in a weigh lever is setting the load pivot so that its edge will be slightly above the other two pivots. The object is to overcome the effect of deflection of the lever so that when the scale is fully loaded the pivot edges will be in line. Sometimes additional allowance is made for wear so that the pivots may be sharpened without drawing them out of line. Too much pitch makes the balance unstable, and difficulty will be found in setting the poise at a point where the beam will remain horizontal, the tendency being to indicate "up" or "down" weight.

MOUNTING BLUEPRINTS

J. B. & Co.—We would like some information concerning the mounting of blueprints for use in a machine shop. At present when we have made the blueprints we mount them on galvanized iron sheets, which we accomplish by the use of pure white gum shellac varnish. When the prints are thoroughly set to the face of the tins we clinch the edges of the sheets over and give the prints a couple of coats of white shellac varnish. We have a few objections to this method and would ask if you could suggest something better. Our objections are: 1. The cost of the galvanized sheets. 2. The trouble necessary to get the prints to adhere firmly. 3. The inconvenience of making alterations on the prints. 4. The difficulty in removing the blueprint when it is no longer of use. 5. When we use the sheets a second time we find the portion of the sheet lapped over on the first occasion, will not stand further bending without breaking off and leaving ragged edges.

A.—Strawboard of appropriate thickness is largely used for mounting blueprints for use in the shop. Suggestions from readers in reply to the above will be appreciated.

CUTTING AN ABNORMAL BEVEL GEAR

E. T. L.—I have a pair of bevel gears such as shown at *A* and *B* in Fig. 1. The teeth are 2-inch circular pitch. Gear *A* has 37 teeth and pinion *B*, 14 teeth. This gearing transmits 25 HP with the pinion running at about 400 R. P. M. I desire to run another pinion, *C*, with gear *A* on a shaft set at an angle of 79 degrees, as shown. The peculiarity of the case is that

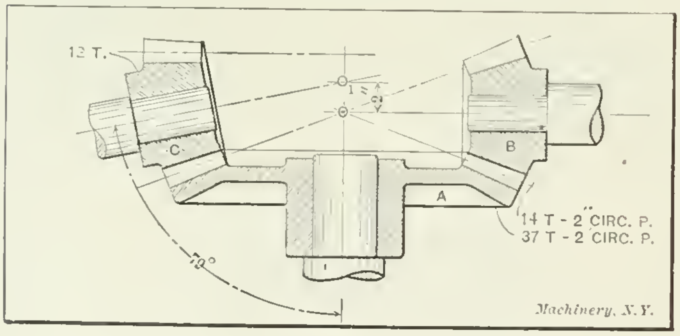


Fig. 1

the center line of the shaft on which pinion *C* is mounted, does not pass through apex *O* of gears *A* and *B*, but through a new apex, O_1, 2 inches further out. Can such a pinion as *C* be cut? It is required to transmit 5 HP to *B*.

Answered by Ralph E. Flanders, Springfield, Vt.

A.—It is theoretically possible to cut the kind of a gear shown at *C* in Fig. 1, if the teeth are generated on a bevel gear planer, and if the center line of the pinion shaft is not too far away from the apex of the gear. The conditions under which such gears operate are shown in Fig. 2. At *A* and *B* on the right of the engraving are shown the normal pitch cones of the gear and of the normal pinion. At the left of the engraving are shown the abnormal pitch cones of the gear and of the abnormal pinion. It will be seen that large gear *A* has two different pitch cones, one for the normal and the other for the abnormal gear. Gears of involute form, or of the corresponding form applied to bevel gearing, have this possibility of changing the location of the pitch line without affecting the running of the tooth. The difficulty in your case is that you demand an extreme condition. It will be seen at the left of Fig. 2 that the pitch line of pinion *C* at the small end of the tooth is entirely inside the tooth, and so is entirely outside the tooth of gear *A*. The chances are that for any ordinary width

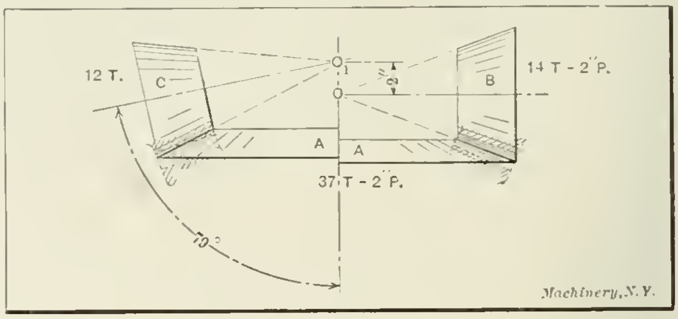


Fig. 2

of face for gear *C*, the tops of the teeth would come to a sharp edge before they reached the small end. Fig. 3 shows the method of cutting these gears. With the normal gear, the movement of the tool, the rolling of the blank, etc., all center on point *O*, where the tooth disappears, this point being located on the center line of the blank at the apex of the pitch cone. In the case of the abnormal gear, on the contrary, this

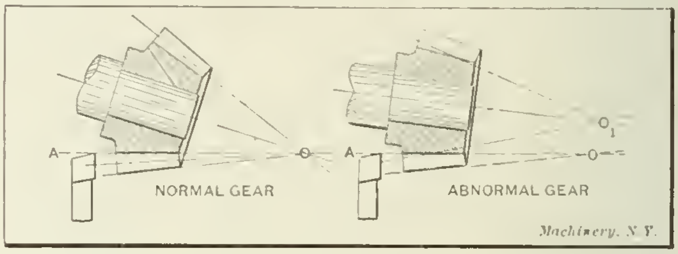


Fig. 3

point *O*, toward which the tool travels, is 2 inches away from the apex O_1 of the pitch cone of the abnormal gear.

Mr. Hugo Bilgram, 1233 Spring Garden St., Philadelphia, Pa., has cut abnormal gears of this type on his bevel gear generating machine; in fact, he exhibited a set of such gears seventeen years ago at the World's Fair in Chicago. He would be able to furnish you a pinion such as you desire, if it is a possible thing to make it.

So far as the horsepower is concerned, any gear *C* which could be cut at all, and have correct action, would transmit 5 H.P. if gear *A* is transmitting 25 H.P.

* * *

At the recent convention of the British Medical Association an interesting paper was read on the subject of electric shocks. It has been noted that deaths have occurred due to shocks from 100-volt currents, while at other times a 1000-volt circuit has failed to kill. It was pointed out that aside from voltage, the amperage and the character of the current, whether direct or alternating, the duration of the shock, and its point of application, must be considered. The resistance of the skin has much to do with the matter, and the effect on one individual may differ greatly from that on another. The condition of the mind is also of importance, for a person who is prepared to receive a shock is less liable to be affected by it than one who receives it unexpectedly and accidentally.

* * *

It was stated by Mr. F. J. Kean in a paper read before the Institute of Marine Engineers that as the result of extended experiments with an 8½ by 14-inch single cylinder oil engine, running at 250 revolutions per minute, the following conclusions had been drawn: Economy in oil consumption is greater with moderately high compression than with a very low compression before ignition; a very hot vaporizer is conducive to greater economy than one only moderately hot; injecting water with the oil vapor, damps down the total combustion and, hence, lowers the economy.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

VAN NORMAN NO. 3 DUPLEX MILLING MACHINE

The Waltham Watch Tool Co., Springfield, Mass., has placed on the market the No. 3 Van Norman duplex milling machine shown in Fig. 1. The special feature embodied in the construction of this machine that distinguishes it from other types of milling machines, is the movable cutter head, which is mounted on a ram or frame that may be adjusted in or out over the table to adapt the cutter for use in either a vertical or horizontal position, the cutter spindle being adjustable to any angle from the horizontal to the vertical. Among the features incorporated in the design of the No. 3 size which are not found in the sizes formerly built, may be mentioned the single pulley or constant speed drive with a change gear mechanism for varying the spindle speeds, located in the ram; a geared feeding mechanism; an improved box type of knee; and a solid steel overhanging arm, with braces to give rigidity for either vertical or horizontal cuts.

This machine is solidly constructed throughout and it has ample power for both spindle drive and feed mechanism. The details of the drive and the spindle change gear mechanism are seen in the sectional views, Figs. 2 and 3. The driving pulley *A*, Fig. 2, is mounted on a splined shaft *a*, which is supported in a bracket *B*, attached to the side of the machine column, as shown in Fig. 1. By means of a pair of bevel gears *C* and *D*, the driving shaft is connected with shaft *b* within the ram, on which is mounted the loose clutch gear *E* and the combined sliding gear and clutch *F*, which is keyed to the shaft. These gears engage with gears *G* and *H*, which are keyed together and revolve on a stationary stud or shaft *c*, and the drive is through gear *E* or *F*, depending on the position of the latter, which is controlled by the lever *P*, Fig. 3. A swinging frame or yoke *Y*, pivoted on shaft *c*, has a stud *d* which carries a sliding gear *I* that is in mesh with the long gear *G*. This tumbler gear *I* may be brought into mesh with any one of a cone of gears *J*, *K* and *L*, which are keyed together, and mounted on the stud or shaft *e*.

The swinging frame *Y*, carrying the sliding tumbler gear *I*, has at its upper end (see Fig. 3) a spring-pin mechanism to locate it in the different positions, and also a lever *Q* to securely lock and clamp it in place. An index lever *R*, operating through a pinion r_1 that engages a rack on the sliding forked piece r_2, locates the sliding gear *I* for suitable engagement with cone gears *J*, *K* and *L*. Loose clutch gears *M* and *O* on shaft *f* mesh with the cone gears *J* and *L*, and one or the other of these gears may be connected to shaft *f* by the clutch *N*, the position of which is controlled by lever *S*, Fig. 3. Thus it will be seen that shafts *b* and *f* revolve, while the studs *c*, *d* and *e* are stationary and carry free-running gears. By means of this mechanism twelve changes of spindle speeds, varying from 15 to 276 revolutions per minute, may be obtained, the speed changes being effected by operating the sliding gears *F* and *I* and the clutch *N*. All the gears are of steel, and those within the ram run in an oil bath. A handwheel on the end of shaft *f* may be used to facilitate bringing the gears into mesh when making changes.

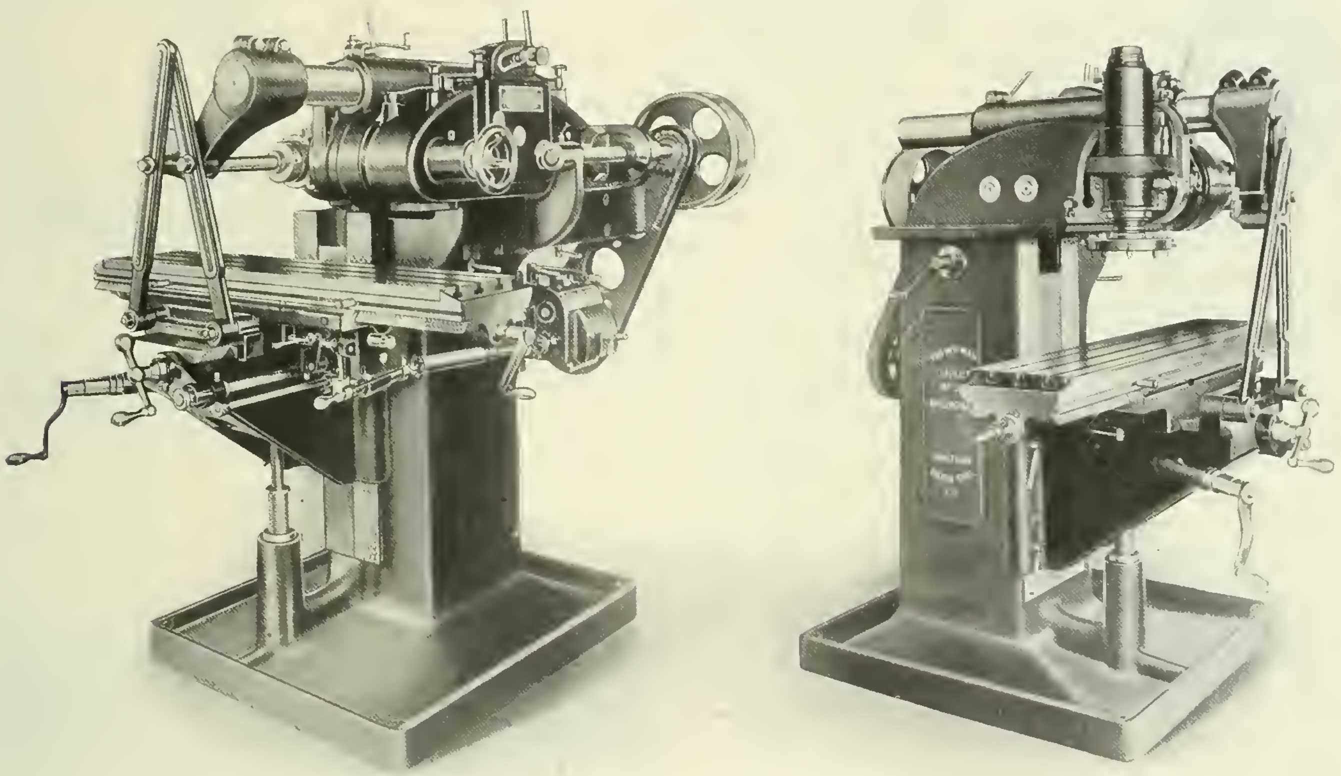
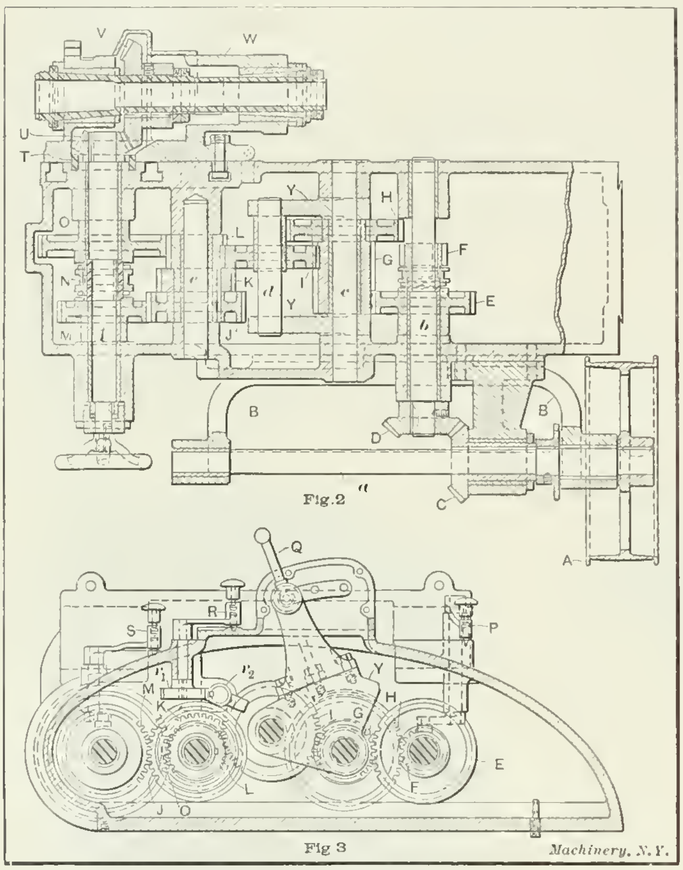


Fig. 1. Two Views of the Van Norman No. 3 Duplex Milling Machine

The cutter-head *W*, which has a 90 degree angular adjustment, pivots on the trunnion ring *T*. The head is securely clamped on the face of the ram by three locking bolts which move in circular T slots. A bevel gear *U* on the end of shaft *f*, and a bevel gear *V* on the spindle, complete the drive connection. The cutter spindle has the conical form of bearings, and is made with a No. 13 B. & S. taper, to adapt it for holding the large collet holder or reducing collets that are used in this machine. The ram may be securely clamped to the column by means of two binder levers, after the cutter spindle is located in the most advantageous position for operation. This ram has a 13-inch movement in and out over the column, and the adjustment is effected by means of the crank shown near the top of the column to the right in Fig. 1. The length of the ram is 35 inches and the width 11½ inches. The driving pul-

ley is 12 inches in diameter, with a 4¼-inch face, and should be run at a constant speed of 300 revolutions per minute.

The feed change mechanism gives sixteen changes of feed, ranging from 7/16 inch to 13 inches feed of the table per minute. The drive to the feed-box is by a chain which connects with the main driving shaft. The table, which has a working surface of 45 by 10 inches, has a longitudinal feed of 30 inches, a transverse feed of 12 inches, and a vertical feed of 19 inches. The knee also has a vertical movement of 19 inches. The



Figs. 2 and 3. Sectional Views showing the Spindle Speed-changing Mechanism

countershaft furnished with the machine has pulleys 13 inches in diameter and 4½-inch face, for forward and reverse speeds. The swivel vise, also included in the equipment, has jaws 7 inches wide, 1½ inch deep, with a maximum opening of 4½ inches. The weight of this machine is approximately 4000 pounds.

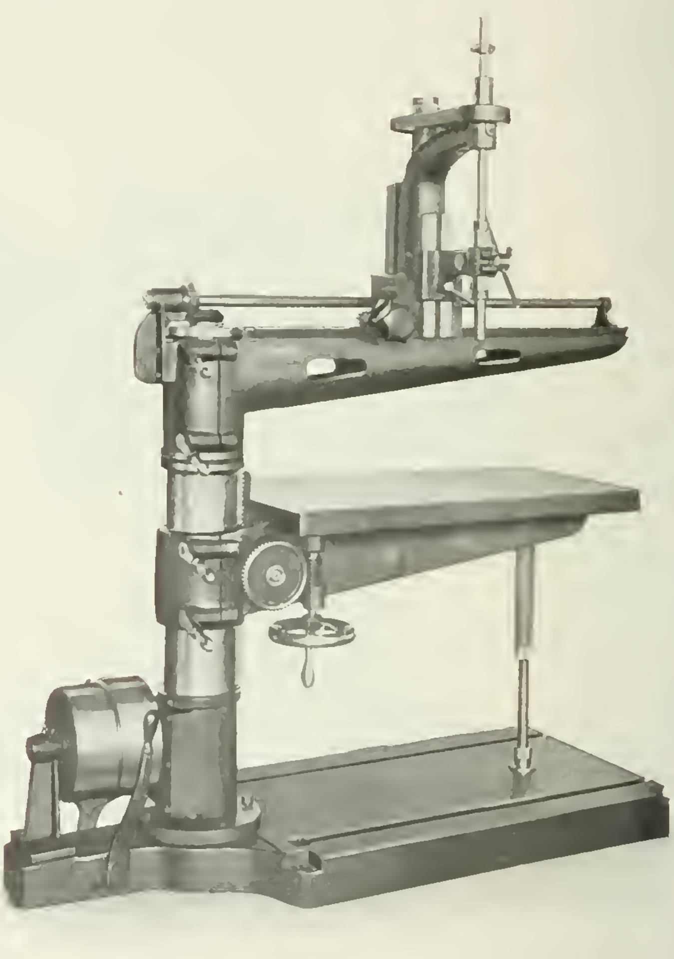
The equipment regularly furnished consists of a draw-in spindle for holding large taper-shank mill mounts or arbors; one ⅞-inch split collet; one reducing collet with No. 7 B. & S. taper hole; one 2¾-inch end-mill; one cutter arbor; one vise; a set of wrenches and countershaft. There also can be furnished extra, if desired, semi-universal or full universal centers and sub-head, and also a slotting attachment.

TAYLOR & FENN RADIAL DRILLING MACHINE

The radial drilling machine illustrated herewith is a design that has recently been added to the line of drilling machinery built by the Taylor & Fenn Co., Hartford, Conn. This drill press contains all of the principal features of the standard line built by this company, with the addition of a greatly increased capacity. By the adjustment of the head and the radial arm, holes may be drilled in pieces that are too long or too heavy to be conveniently handled on the company's other types of machines.

This drill press is designed for drilling holes up to ¾ inch in diameter, and by the application of drilling heads of different types it can be made to cover a wide range of drilling requirements. An automatic power feed, lever feed, high-speed sensitive or tapping heads may be used on this machine, either singly or in combination. The drilling head is mounted on dovetailed ways on the arm along which it is adjusted by means of a rack and pinion. A binder at the rear provides means for clamping the head to the arm. The spindle is positively driven by a silent chain, and the gear box on the back of the drilling head gives three spindle speed changes. The arm is tubular in section, and has an exceptionally long bearing on the column supported by a ball thrust collet. The table is heavily ribbed and, in addition, is provided with a support for the outer end that may be used when heavy work is mounted on it. Both the arm and table may be clamped to the column by the binder screws shown, the handles of which are conveniently located.

This machine is driven by tight and loose pulleys at the rear of the column and does not require a countershaft. The principal dimensions are as follows: Length from the center of the column to the end of the arm, 42½ inches; maximum distance from the center of the spindle to the column, 36 inches, and the minimum distance, 11 inches; maximum distance from the end of the spindle to the base, 48 inches, and the minimum distance, 36 inches; maximum distance from the end of the



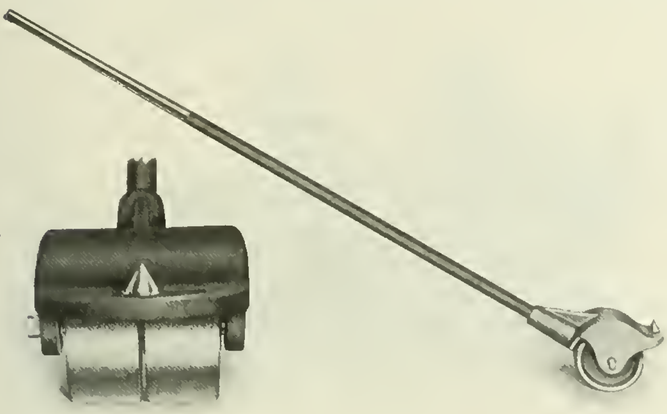
Radial Drilling Machine built by the Taylor & Fenn Co.

spindle to the table, 26 inches, and the minimum distance, 3¼ inches. The traverse of the spindle is 11 inches, and the length of feed, 4¼ inches. The size of the table is 20 by 35 inches, while the base is 24 by 36 inches. The over-all height of the machine with the spindle in its highest position is 79 inches. The floor space required is 2 by 5 feet. The width of the driving belt is 3 inches, and the speed of the driving pulley 310 revolutions per minute. The approximate net weight of this machine is 1070 pounds.

GROVER BAR TRUCK

A moving truck or crowbar, equipped with wheels to expedite the moving of heavy parts around a shop or in other places where heavy loads must constantly be handled, is shown in the accompanying engraving. On the end of the bar there is attached an enlarged head which furnishes a bearing for two wheels that move independently of each other. In the

nose of this head a conical point is inserted, as shown more clearly in the enlarged view to the left, which gives the bar a firm grip on the load. These trucks are sold in sets of three, and in use two are placed under one end of the load and the other under the opposite end, thus giving a support at three points. By bearing down on the levers or bars, the load is raised from the floor and is supported on the three sets of rolls or trucks, so that it can be easily moved in any desired direction. It is said that these trucks are capable of handling

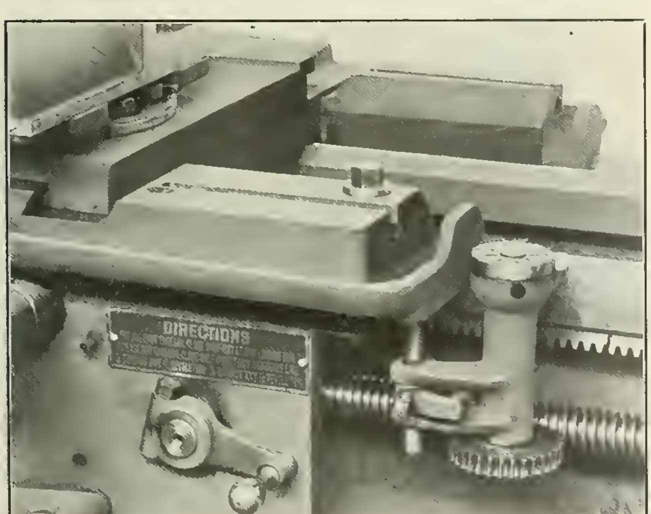


Moving Truck of the Bar Type

expeditiously pieces weighing three or four tons or under. They are easily manipulated and can be used effectively by any laborer. Even in modern plants equipped with traveling cranes, they doubtless could be used to advantage by relieving the cranes of considerable work. These bar trucks are manufactured by the Grover File Co., Nashua, N. H.

LODGE & SHIPLEY THREAD INDICATOR

The chasing dial or thread indicator, as most mechanics know, is a lathe attachment for thread cutting, which permits disengaging the half-nut at the end of each cut, running the carriage back by hand and re-engaging the half-nut at the proper point to "pick up" the thread, the tool following the previous cut. Running the carriage back by hand not only saves time, but also allows both countershaft driving pulleys to be run forward, thus giving the lathe twice as many forward speeds as would be obtained if one backing belt were used. Because of the foregoing reasons, the Lodge & Shipley

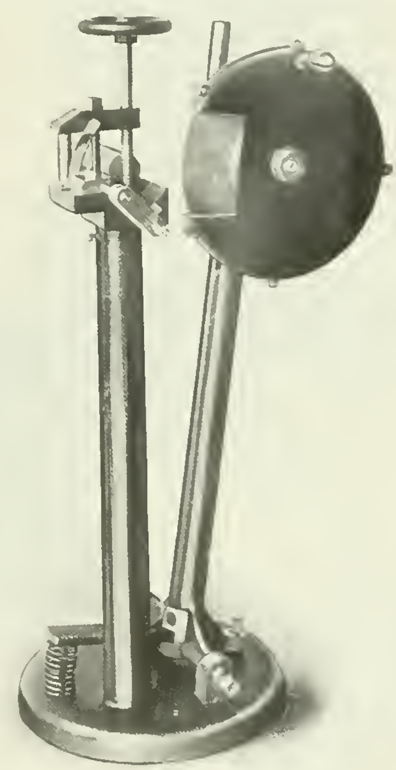


Lathe Carriage with Thread Indicator Attached

Machine Tool Co., Cincinnati, O., is now furnishing a thread indicator as a part of the regular equipment of every lathe. As shown in the accompanying illustration, this thread indicator, which has several novel features, is attached to the front arm of the carriage on the right side. The worm-wheel indicator is held lightly against the lead-screw by a coil spring and it can be swung back out of engagement when desired, or if a quantity of work which requires no threading is to be machined, the whole attachment can be quickly removed. Attached to the front of the apron close to the thread indicator, there is a brass instruction plate containing the following information: "Directions.—For all even threads close half-nut at any line on dial; for all odd threads close half-nut at any numbered line; ½ threads any ¼ revolution; ¼ threads any ½ revolution." Thus all the necessary instructions for using the attachment, briefly stated, are continually before the operator.

NUTTER & BARNES METAL-CUTTING MACHINE

The "elastic wheel" metal-cutting machine shown in the accompanying engraving is intended for cutting either bar stock or tubing and is surprisingly rapid in its operation. This machine has a capacity for tubing or piping up to 3 inches in diameter, and solid pieces up to ¾ inch in diameter, of either soft or hard steel. As the engraving shows, the machine is simple in construction, there being a base with a column for supporting the work and a swiveling arm carrying the cutting disk. This disk or wheel, which is 12 inches in diameter and 3/32 inch thick, should run at about 3000 revolutions per minute. As it requires no sharpening, the machine is always ready for use. It will be noted that the material to be cut remains stationary in the V workshoe, the elastic wheel being swung forward to take the cut by either the right or left hand or the foot, there being, in addition to handles, a treadle at the base. This movement of the wheel instead of the work has a decided advantage, particularly when operating on long pieces which could only be fed to the wheel with difficulty. After taking its cut, the wheel is returned to its rest position by means of the spring shown inserted beneath the treadle. The V-block for supporting the work is equipped with a swinging gage, which is convenient when cutting duplicate lengths. Owing to the simplicity of construction, there are no parts on this machine to become deranged, and it is easily operated. It is manufactured by the Nutter & Barnes Co., Boston, Mass.



"Elastic Wheel" Metal-cutting Machine

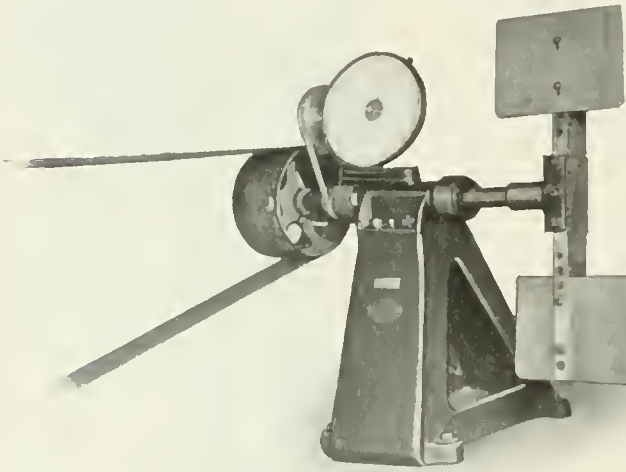
FAN DYNAMOMETER FOR TESTING SLOW-RUNNING MOTORS

Heretofore, the fan dynamometer, when used for testing fast-running engines of the automobile type, has been connected, during the test, directly to the engine shaft. This method, however, has not been applicable to comparatively slow-speed gas engines of the stationary type, for the obvious reason that insufficient power would be absorbed by the fan, owing to its slow speed.

Mr. Joseph Tracy, 116 West 39th St., New York City, designer and builder of the dynamometer illustrated herewith, has found after a series of tests that the necessary increase in speed when testing comparatively slow-running motors may be obtained satisfactorily by belting the dynamom-

eter to the engine fly-wheel, as indicated in the illustration. Ordinarily the width of the fly-wheel is sufficient to permit the use of a belt that will transmit the required power, so that a special pulley is not necessary. This is a convenient and inexpensive method of testing stationary gas and other engines developing up to 100 horsepower at relatively slow speeds. As the dynamometer gives the best results when driven at a speed of 800 revolutions per minute or more, its pulley should, of course, be smaller in diameter than the engine fly-wheel.

This fan may also be used as a load to absorb the power when "running in" an engine, or working down the piston and bearings. As those familiar with the fan dynamometer know, it requires neither water nor electrical connections, the power delivered by the engine being absorbed in driving the fan against the atmospheric resistance. There is a tachometer attached directly to this dynamometer which has, in addition to the revolution per minute graduations, a set of six scales giving the horsepower for different positions of the fan blades, so that in operation the power being developed, less the transmission loss through the belt, is indicated directly by the pointer on the dial. To find the revolutions per minute of the engine, the revolutions per minute indicated by the tachometer are divided by the ratio between the pulley and the fly-wheel diameters. For example, if the tachometer indicates 1200 revolutions per minute and the dynamometer pul-



Fan Dynamometer driven by Belt from Flywheel when Testing Slow-running Motor

ley is one-quarter the diameter of the fly-wheel, the latter will be making 300 revolutions per minute.

This application of a tachometer, giving both revolutions per minute and horsepower direct, is a distinct advantage over the type described in the January, 1906, number of MACHINERY, as the latter requires, in addition to a timepiece and revolution counter, a table of tests giving the horsepower for various speeds and positions of the vanes.

In the dynamometer as designed by Mr. Tracy the horsepower readings are calibrated by actual tests with an electric dynamometer. In these tests the fan dynamometer is driven by the electric dynamometer, in place of a gas motor, at various speeds covering the range of the fan dynamometer, and a power speed curve is obtained from which the tachometer is calibrated.

WALTHAM THREAD MILLING MACHINE

The accompanying illustrations, Figs. 1 and 2, show front and rear views, respectively, of a small thread milling machine which has been brought out by the Waltham Machine Works, Waltham, Mass. This machine is intended for work of smaller size and of greater precision than that which larger machines are, as a rule, designed to handle. Several features of design not found on other machines of this type have also been included. The machine is especially adapted for making taps of the smallest dimensions, for cutting micrometer screws, and for similar work. A detailed description is given in the following.

The headstock spindle is driven from a pulley by worm and worm-gear. The driving pulley is connected to the worm-shaft by a toothed clutch which is automatically disengaged upon the completion of the cut on the work. A handwheel is provided for turning the worm-spindle by hand when setting the cutters, etc. The spindle takes a regular lathe chuck, and has a 5/8-inch hole bored clear through it. Double, triple and quadruple threads can be cut by means of an indexing device attached to the spindle. The worm-shaft pulley has four steps. It is interchangeable with the driving pulley on the countershaft, and has a round driving belt which can run either on

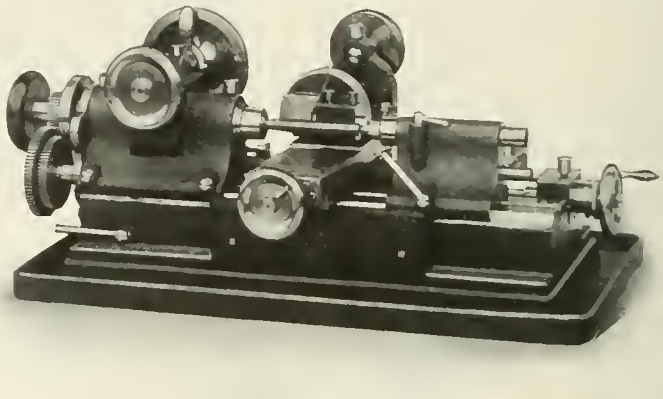


Fig. 1. Thread Milling Machine for Small Precision Work, made by the Waltham Machine Works, Waltham, Mass.

the next larger or the next smaller step than the one exactly in line with the step in the pulley above; hence, at least 16 changes of speed can be obtained for the headstock spindle.

The movement of the spindle is transmitted to the lead-screw by means of a train of gears. Threads ranging from 10 to 80 per inch can be cut with the change gears regularly furnished. The machine can be arranged for cutting as coarse as 4 and as fine as 100 threads per inch if desired. The tailstock and its spindle are milled away very close to the center, so that the milling cutter can be brought near to the center line. Two tailstock spindles, one with a male and one with a female center, are provided.

The cutter used in the machine is 1 1/2 inch in diameter and is mounted on a hardened spindle driven through a train of gears. The cutter head can be swiveled in a vertical plane around the center line of the cutter. It can also be swiveled in a horizontal plane. The graduations for the vertical swivel are on an arc of 4 inches diameter, and are in clear view on the top of the head. By using the horizontal swivel and a cut-

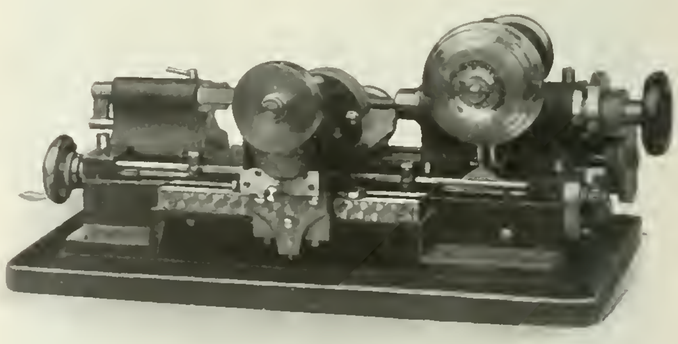


Fig. 2. Rear View of Thread Milling Machine for Small Work

ter of the proper angle, a buttress thread with one side square can be cut, and by reversing the work, and taking a second cut, a complete square thread can be obtained.

The bearing of the cross-slide is 10 inches long and its feed-screw has a friction index with divisions reading to 0.0005 inch. A stop screw is provided as a safeguard against setting the cutter too deep when milling a number of pieces of the same dimensions. The nut for the feed-screw consists of a block which can be secured either to a part of the carriage or to the sliding bar of the taper attachment. The taper attachment provides sufficient taper so that pipe taps and similar work can be milled.

A V-bearing 12 inches long in the rear of the bed

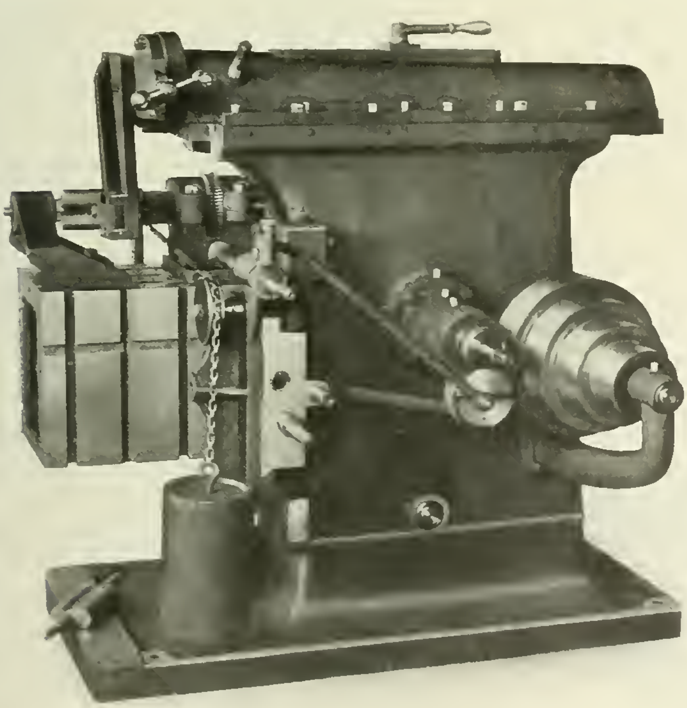
and a flat bearing in the front of the bed are provided for the carriage. The lead-screw is placed in the center of the machine and its center line is only 3½ inches removed from the center of the cutter. The lead-screw nut is held in a fixed position lengthwise, but can be rotated slightly. An arm is fastened to the nut, and its outer end is held by a spring against a swivel-bar. With this device the feed of the carriage can be accelerated or reduced by setting the swivel-bar at an angle, thus obtaining an increased or decreased lead, and making is possible to cut an accurate thread with a slightly inaccurate lead-screw.

At the left end of the lead-screw a hand-operated clutch is provided. This clutch is disengaged when the cut is completed, so that the carriage can be returned to its starting position by turning the handwheel attached to the right-hand end in Fig. 1. A friction index, similar to the one used on the cross-slide screw, is attached to this handwheel.

The maximum length of thread that can be cut in this machine is 6 inches, and the maximum diameter 2 inches. If the portion of the work which is not threaded does not exceed the chuck capacity—5/8 inch in diameter on one end, or the size of the tailstock spindle, 13/16 inch, on the other end—then the work can have any desired total length, as it can pass right through the spindles. The machine illustrated is of the universal type. For manufacturing purposes a plain machine will be made by omitting the horizontal swivel of the cutter head, the taper turning attachment, the screw compensating bar, and the extra tailstock spindle and change gears. The machine is fitted with a pan base 14½ by 26½ inches. An individual oil pump will be provided if desired. The weight of the machine as illustrated, without pump, is 190 pounds.

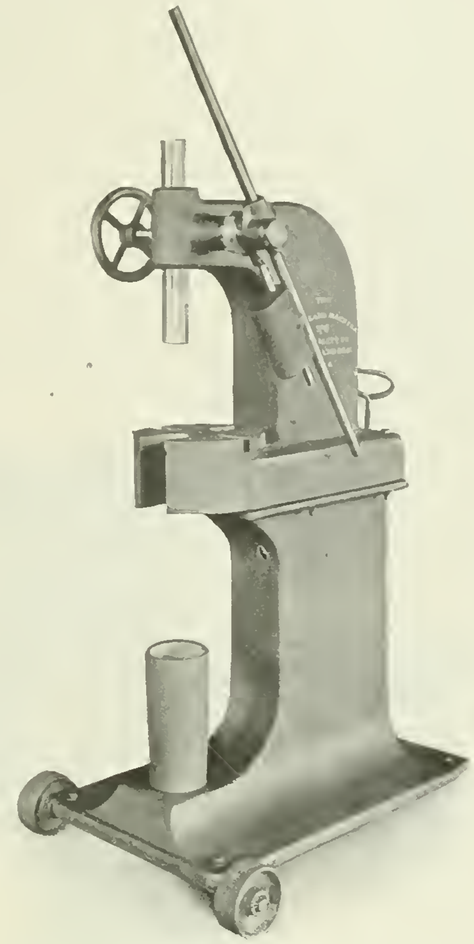
ATTACHMENT FOR ROCKFORD 16-INCH SHAPER

A special attachment recently built by the Rockford Machine Tool Co., Rockford, Ill., for a customer, that is intended to be applied to the regular 16-inch Rockford shaper is shown in the accompanying illustration. (This machine was described in the November, 1905, issue of MACHINERY.) The device as applied to the machine is designed for automatically machining the impellers or exhausters used in vacuum cleaning machines, one of the finished impellers being shown on the base of the shaper. Another impeller is shown set up in the machine, ready for the machining operation.



Attachment for Machining Parts with Curved Outline, made by the Rockford Machine Tool Co., Rockford, Ill.

The fixture is applied on the table of the shaper and consists of an inner and outer bearing, the inner or head bearing carrying a hollow spindle with work driver on the outer end and a master-plate or cam on the inner end; this cam is of the exact form of the work to be machined. The cross-feed screw of the machine is removed so that the saddle with the work-table is free to move on the cross-rail slide. The master-plate or cam is held against a roller by the weight shown. The rotating motion of the cam is produced by a worm and wheel, the worm being attached to the feed shaft of the device and operated in a manner similar to that by means of which motion is ordinarily transmitted to the regular cross-feed of the saddle. The roller pressing against the cam is mounted on a stud held in a casting clamped in a fixed position to the vertical slide of the shaper column. Hence the whole table, with fixture and work, is caused to move back and forth when the cam rotates. The cutting tool used is of circular contour and is of the same diameter as the roller.



Cleveland Portable Arbor Press

The fixture has been found to work very satisfactorily, the impellers being finished rapidly and with a high degree of accuracy. The device can be used for machining various shapes of cams or other irregular parts having no sharp corners, simply by the substitution of the proper master-plate. Any shape that can be rotated against the roller will be accurately reproduced.

CLEVELAND PORTABLE ARBOR PRESS STAND

In many shops where there is need for only one or two arbor presses, it is often desirable to have one of these presses on a certain floor or part of the shop where the work is to be done. As it would be very inconvenient and often impossible to mount the press on a bench located near the work, or to use a stationary stand, the Cleveland Machine Specialty Co., 1523 Williamson Building, Cleveland, O., has placed on the market a portable stand suitable for the Nos. 5 and 6 Cleveland arbor presses. The particular stand illustrated is equipped with a No. 5 press similar to the one illustrated and described in the department of New Machinery and Tools for October, 1910. The stand of this press is of box construction and open in the back. Ribs inside the column permit the use of three shelves for holding arbors, collets, broaches and other special fixtures which it may be desirable to keep with the press when it is moved about. The stand has a depth of throat of 10 inches which is the same as the press itself, so that there is clearance under the bed for work up to 20 inches in diameter. A pot is provided for receiving the arbors as they drop from the work. This receptacle has a lead-lined bottom to prevent injury to the arbors and may be detached from the base when necessary. This stand is also made without the truck when it is desired to keep it permanently in one place. The net

weight of the portable stand is 450 pounds, and with a No. 5 press, as shown, 880 pounds. The floor space required is 24 by 41 inches.

GRAND RAPIDS PLAIN MILLING MACHINE

A milling machine of a plain type, which is a recent product of the Grand Rapids Machine Tool Co., Grand Rapids, Mich., is shown in Fig. 1. This machine, while similar in its general design to other millers of the column and-knee type, has a number of features which give it greater rigidity and strength, as well as convenience of operation.

The column, which is cast in one piece, has an exceptionally wide base to resist the overhanging weight of the table when the latter is at the extremes of its travel. The knee is one of the box type with an extended top and an extra long bearing on the column. As the engraving shows, it is fitted with a telescoping screw for vertical adjustments. The saddle is equipped with a compensating stationary nut; it is very deep and has a length of 22 inches. The table has a working surface of 8 by 32 inches, and T-slots which extend beyond the oil pockets; this gives additional space for fixtures, etc., and if

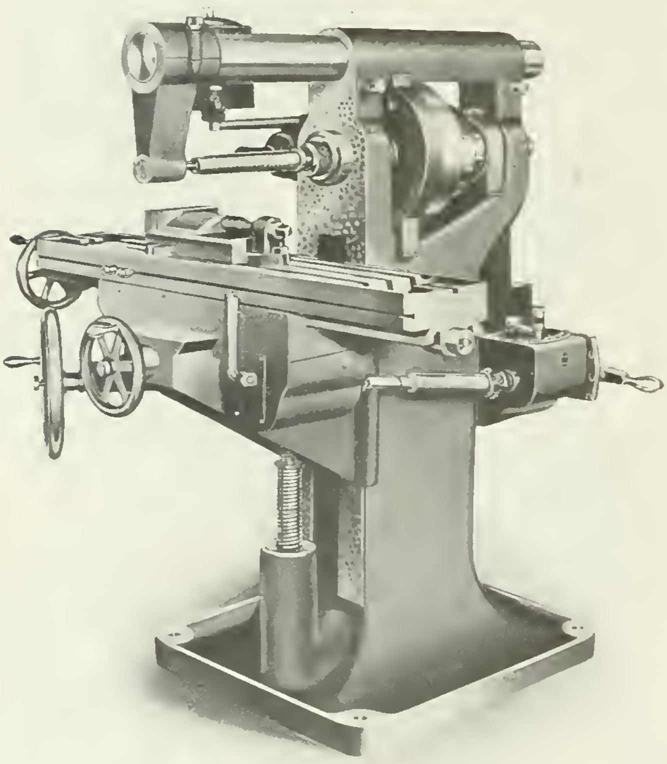


Fig. 1. Plain Milling Machine built by the Grand Rapids Machine Tool Co.

necessary permits a 10-inch index outfit to be so placed that the full range of the machine may be employed for milling between centers. The T-slots have plenty of stock above the T, which makes them "fool-proof." The spindle, which is of crucible steel and bored for a No. 10 B. & S. taper, runs in journals that are tapered to compensate for wear. The driving facilities consist of a cone of three steps and back-gearing with a ratio of 6½ to 1. When back-gears are not provided, a 4 step cone is used.

The feed change mechanism, which is of the selective sliding gear type, gives twelve different feeds. The mechanism for obtaining these feed changes is shown in the phantom view, Fig. 2. On the upper shaft shown, which is driven from the spindle by a nickel steel chain and sprockets, there are two driving gears, either of which may be engaged or disengaged with their shaft by means of a driving key that is operated by the push-rod to the right. These gears are in mesh with corresponding gears on an intermediate shaft, which has two speeds depending on the position of the driving key. Connecting with this intermediate shaft there are two sets of tumbler gears, which are driven independently by gears of different sizes on the intermediate shaft. These cones of tumbler gears are identical and each contains three different sizes. By the engagement of the sliding gear to the left (through which the table feed mechanism is driven) with the different tumbler gears, six speeds are obtained for each position of the driving key, thus giving twelve in all. This sliding gear is brought into the correct position by the indexing lever on the top of the case, which has six positions. The tumbler gears are brought into proper mesh with the sliding gear by engagement of the large lever shown, with one of its

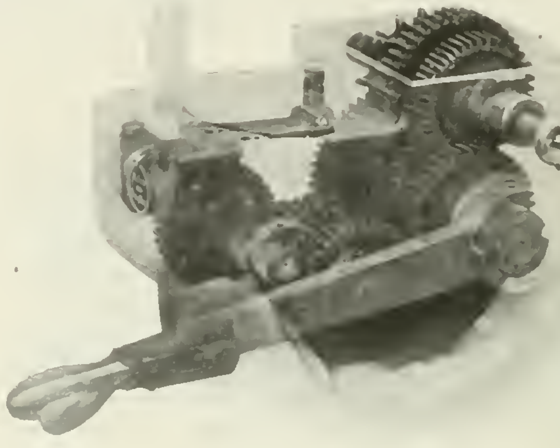


Fig. 2. Phantom View of Feed-changing Mechanism

three indexing holes. The feed per revolution for the various gear combinations is indicated by an index plate attached to the case.

In the phantom view, Fig. 3, the table feed controlling mechanism is shown. The central spur gear in the group of three shown is driven by the telescopic shaft from the feed change box. The outer spur gears are mounted on shafts carrying right- and left-hand worms, which are engaged or disengaged with their worm-wheels by rocking them about the central driving gear. This rocking movement is effected by the lever shown. When this lever is thrown to the left, longitudinal feed in that direction is obtained, while a movement to the right gives a feed in the opposite direction, and the central or neutral position disengages the feed.

The table has a maximum longitudinal travel of 24 inches, the saddle a cross movement of 8 inches, and the knee a vertical adjustment of 18 inches. The machine is fitted with a substantial arbor brace, and a countershaft with friction clutches and ring oiling boxes; a complete set of wrenches, a large vise, and an oil pot of liberal capacity are included in the equipment.

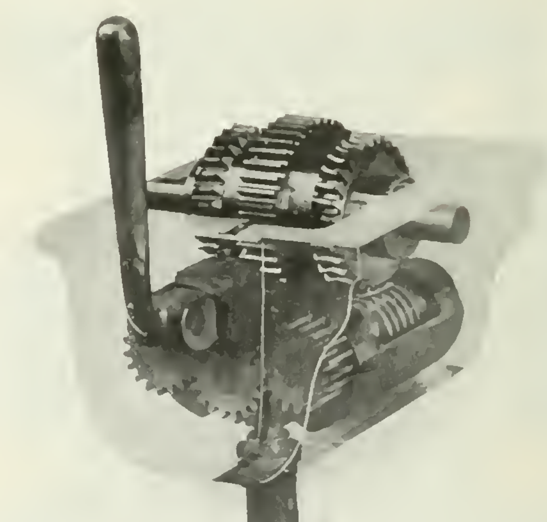


Fig 3 Feed-controlling Mechanism

PRATT & WHITNEY RELIEVING ATTACHMENT

The relieving attachment manufactured by the Pratt & Whitney Co., Hartford, Conn., has been improved and a number of refinements in the construction introduced which have increased its scope of usefulness considerably. These changes,

by making possible the use of cams with sharp rises, have adapted the attachment, which is essentially for the radial and spiral relieving of hobs, cutters, taps, etc., to the boring or turning of irregular shapes, such as ellipses, etc., or those having sharp corners, such as squares or hexagons.

An example of the work done with this attachment is shown in Fig. 1. The part shown has a hexagonal hole through it, and the exact condition of the work as left by the boring tool is indicated by the illustration, the sharp corners having been formed by the tool. The adaptability of this attachment for internal work makes it useful for boring such parts as square or hexagon socket wrenches and similar work, as practically the entire stock can be removed with the boring tool.

Fig. 1. Part with Hexagon Hole bored, by Use of Pratt & Whitney Relieving Attachment

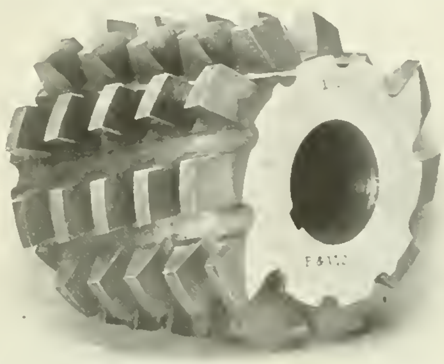


Fig. 2. Hob that was relieved and ground on Angle of Thread with Pratt & Whitney Attachment

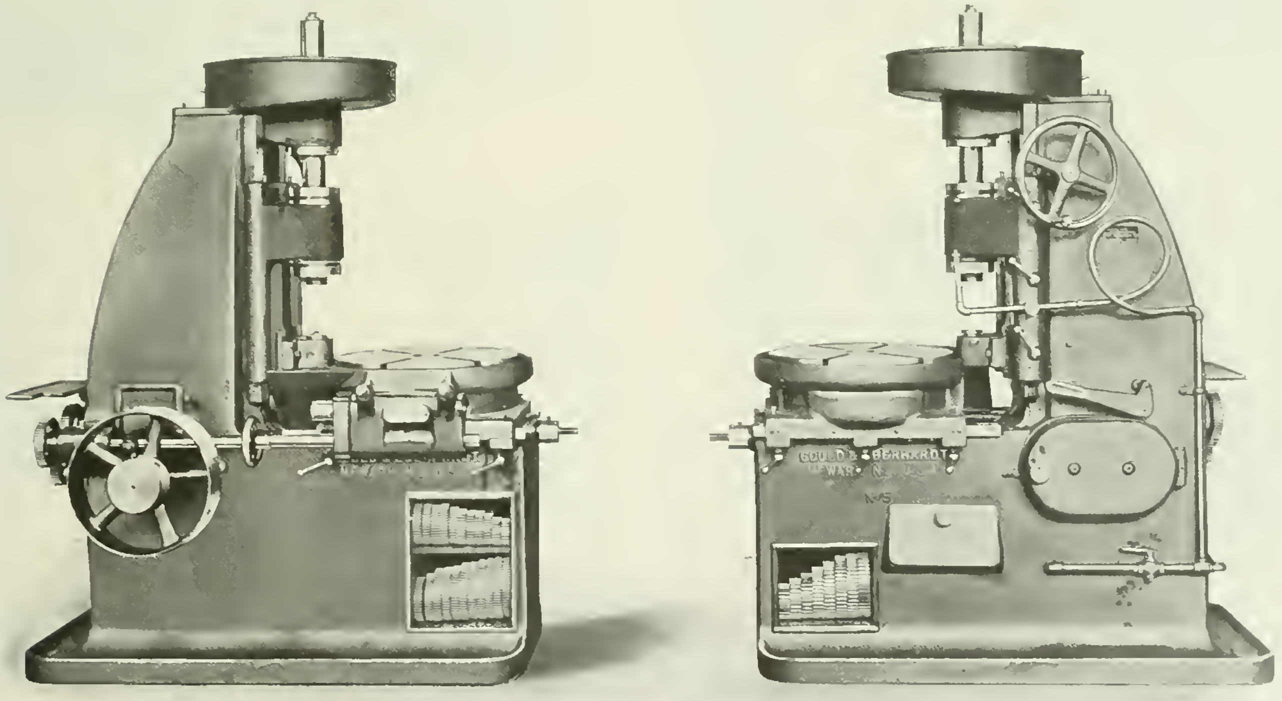
Hobs of extreme accuracy, which would ordinarily be considered a difficult proposition, are relieved, it is claimed, by the use of this attachment without the slightest difficulty, and the operation requires no chipping or filing which would distort the correct shape of the teeth, thus rendering the hob or tap useless after the first sharpening. In Fig. 2 an accurate hob is shown which has been relieved and also ground on the angle of the thread after hardening by means of this attachment.

The method of applying this attachment to the back of a lathe is a distinct advantage, in that it is always ready for instant use, and at the same time its position is such as not to interfere with the use of the lathe for other work. This attachment is also made in a slightly modified form for the side relieving of cutters, counterbores and similar tools. It may be applied to any of the Pratt & Whitney 14- and 16-inch lathes.

GOULD & EBERHARDT CONTINUOUS MILLING MACHINE

The vertical milling machine, two views of which are shown in the accompanying halftone, is now being manufactured by Gould & Eberhardt, of Newark, N. J. In the construction of this machine it has been the object of the manufacturers to produce a simple tool having a powerful drive both for the spindle and for the continuous revolving table. It is designed for the use of high-speed steel cutters and is intended particularly for the rapid production of duplicate work of a class that can be inserted in a suitable fixture and removed without stopping the machine, thus eliminating any waste of time.

The main body or frame is cast in one piece and is of the box section construction, making it strong and rigid. The faceplate or revolving work-table is integral with the worm-wheel which lies just below the table, thereby reducing to a minimum any torsion at this point. The driving worm which engages this worm-wheel has a coarse pitch, is made of high-carbon steel, and is hardened and ground. If desired, the driving worm can be quickly disengaged from the worm-wheel, so that the table can be revolved by hand. This enables the operator to see if work which is to be milled on the periphery runs true. Means are provided for taking up any wear which may occur between the worm and the worm-wheel. The table is direct gear-driven and it has circumferential changes of feed for the work, ranging from 4 inches to 14 inches per minute, the variations in feed being obtained by means of change gears. The table revolves upon a large floating washer and it is mounted on a slide that may be adjusted longitudinally. The movement of this slide and the work-table is indicated by a dial graduated in thousandths of an inch. The slide is provided with a guard that encloses the table, thereby preventing chips from being scattered over the machine and floor. By means of a small scoop attached to the revolving table, the chips are automatically conveyed to the base of the machine.



Vertical Milling Machine built by Gould & Eberhardt

The spindle, which is of large diameter and is made of chrome-nickel steel, runs in bronze bearings and has hardened and ground steel thrust washers. Means are provided for taking up any wear that might take place in the main spindle bearing. The spindle is threaded on the end to accommodate end or face milling cutters, and there is also a slot or keyway for driving these cutters. The spindle is also arranged to receive the ordinary taper-shank cutters, and is provided with a draw-bar through the center for holding such cutters firmly in position. The drive to the spindle is by belt to a single pulley at the side of the column, connected to a vertical shaft that, in turn, transmits power to the spindle through spur-gears. The main spindle slide, which is in one piece with the bearing, is long and rigid and may be adjusted vertically. On its lower end it carries an outer support for the spindle, which support can also be adjusted vertically independent of the main slide.

If desired, a pump may be furnished with the machine, located in the base of the frame. An oil pan that extends around the bed catches any lubricant that might drop around the machine. The total weight of this miller is 3000 pounds. It is strictly a manufacturing tool and the parts are designed to meet modern requirements.

OSBORN MOLDING MACHINE

The Osborn Mfg. Co., Cleveland, O., has placed on the market the molding machine illustrated herewith. This machine is of the "direct-draw", roll-over type, and is designed to supply a method of molding dry-sand and green-sand cores or drags.

The lower portion or drawing table of this machine, as is shown in the illustration, can be swung out from under the frame, on which is mounted the flask and pattern. After the mold is rammed and rolled over by hand, the drawing table is swung into position beneath it; the core or green-sand drag

Osborn "Direct-draw" Roll-over Molding Machine

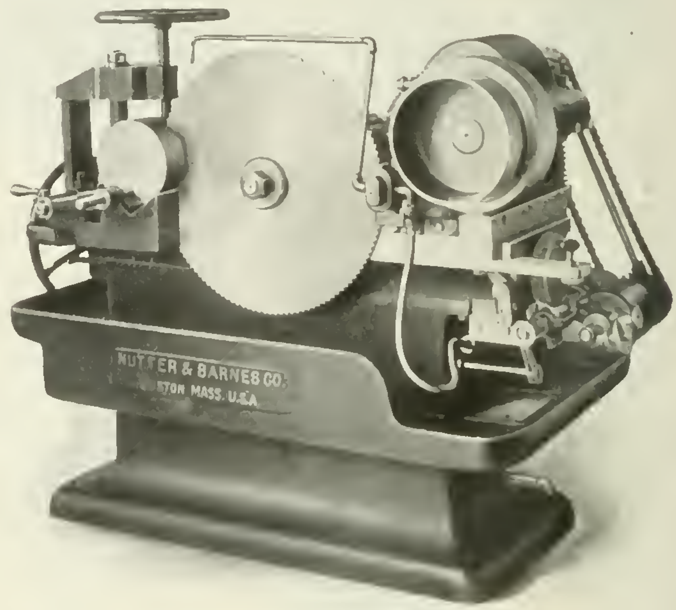
can then be drawn down from the pattern by a half turn of the crank, giving a full pattern draw of 7½ inches. The drawing table with the completed mold upon it can then be swung out at right angles to the rest of the machine, where it is in a convenient position for removing the mold.

If necessary, the mold can be swung back again and the machine will print back with considerable accuracy. It is claimed, however, that owing to the accurate draw and the elimination of all unevenness in the bottom boards or dryer plates by the automatic leveling device on the drawing table, printing back becomes practically unnecessary, as the molds repeatedly come out in perfect form and without the vestige of a broken edge.

This machine is particularly adapted for the use of automobile manufacturers and others who have large quantities of cores or green-sand drags to make. It will be found convenient in the molding of housings, crank cases, gear cases and work of a similar nature. The machine is quick in its operation as well as accurate, and it is claimed that one man can easily turn out twice as much work with it as can two skilled molders on the floor.

NUTTER & BARNES SAW CUTTING-OFF MACHINE

The Nutter & Barnes Co., of Boston, Mass., has brought out the 8-inch metal cutting-off machine of the saw type shown herewith. The feeding mechanism of this machine has a sprocket chain drive which connects with a gear-box giving four changes of feed, ranging from ½ to 2 inches per minute. This gear-box is mounted on feed brackets at the rear of the machine. The driving sprocket for the feeding mechanism, which is mounted on the main driving gear pinion shaft, is held between two friction disks, to admit of its slipping should too much load be put on the feed, or the feed stop be set



Nutter & Barnes 8-inch Cutting-off Machine

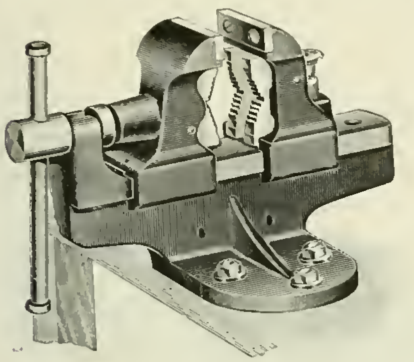
to trip at the wrong time. The feed is engaged by a foot-lever at the front of the machine (not shown in the engraving), the connection being made with the worm-shaft for engaging the worm and wheel by a suitable rod.

This machine has central spur gear drives throughout. The saw-spindle connecting gears, which are phosphor-bronze bushed, have a 4-inch face and are of 5 diametral pitch. The saw spindle is 3 inches in diameter and is equipped with four driving pins ½ inch in diameter. The main driving gear is 18 inches in diameter and has a 2½-inch face. All the driving gears (except the 18-inch size and the back-gears) and shafts are of crucible machinery steel forgings of 0.50 carbon. The saw is 22 inches in diameter and 3/16 inch thick. It will take a maximum depth of cut of 8 inches. The saw has two speeds obtainable from a cone pulley, and a similar number through the back-gears, which have a ratio of 43 to 1. The carriage is 22 inches long, 17 inches wide, and it has a movement of 9 inches. The plain work-table measures 18½ by 13 inches, and the work-shoe has a maximum capacity for 8-inch round stock. The height of this shoe from the floor is 30 inches.

By removing the work-shoe, provision is made for using a bevel gage on the plain work-table when cutting flats, squares and structural shapes, at an angle. An oil pump is provided to supply lubricant to the saw, and there is a large reservoir inside the base. A drip pan cast integral with the upper part of the base surrounds and forms a part of it. A stock support with adjustable screw elevation, and a counter-shaft with a 14 by 4½-inch friction pulley, is included in the equipment. The floor space occupied is 2 feet 6 inches by 4 feet 8 inches, and the net weight is 2500 pounds.

ARMSTRONG COMBINATION PIPE AND BENCH VISE

The accompanying illustration shows an improved design of quick adjusting combination pipe and bench vise which is now being built by the Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. The pipe vise is provided with four hardened steel serrated V-blocks. The rear jaw is free to slide along the base and it is firmly held in position by a pin which engages holes in the base. There are three of these holes and, consequently, three positions for the jaw. When the pin is in the first hole, the vise has a capacity for pipes ranging in diameter from 1/8 inch to 1 inch; when the jaw is moved to the second position, pipes up to 2 inches in diameter may be held, and when in the third position, it will grip 2½- or 3-inch sizes. The changes for the different sizes are quickly obtained, which is a feature that will readily be appreciated by any engineer or steam-fitter. This vise is made of malleable iron and has a steel screw. As the engraving shows, the vise proper has steel-faced jaws, so that it is also adapted to the work of an ordinary vise. Sockets for legs are provided, so that by the use of 1¼-inch pipe a stand can be made which enables the vise to be set in the most convenient position.



Armstrong Combination Pipe and Bench Vise

SPRINGFIELD-BRANDES VERTICAL GRINDING PLANER

The Springfield-Brandes vertical grinding planer shown in Fig. 1 is a new design that has been brought out by the Springfield Mfg. Co., Bridgeport, Conn. This machine has been greatly improved in its general construction as well as in its details. The design is heavy and substantial throughout, the weight of the grinder being 8000 pounds.

The particular machine illustrated has a capacity for grinding widths up to 12 inches, a height of 12 inches, and a length of 4 feet, though the capacity as to length can be increased if desired. The wheel head and spindle are of a particularly heavy design, the spindle being large in diameter and mounted in long bearings. It is provided with ball thrust bearings on the under side and is equipped with a ball-bearing spring take-up on the upper part of the bearing to prevent backlash when the wheel is running off the work. The driving pulley is mounted upon an independent bearing which relieves the spindle of all belt strain. The grinding wheel is 16 inches in diameter and it is mounted in a chuck which permits the wheels to be easily changed. In case of damage to a wheel, the danger of accident is avoided by the use of a guard giving ample protection.

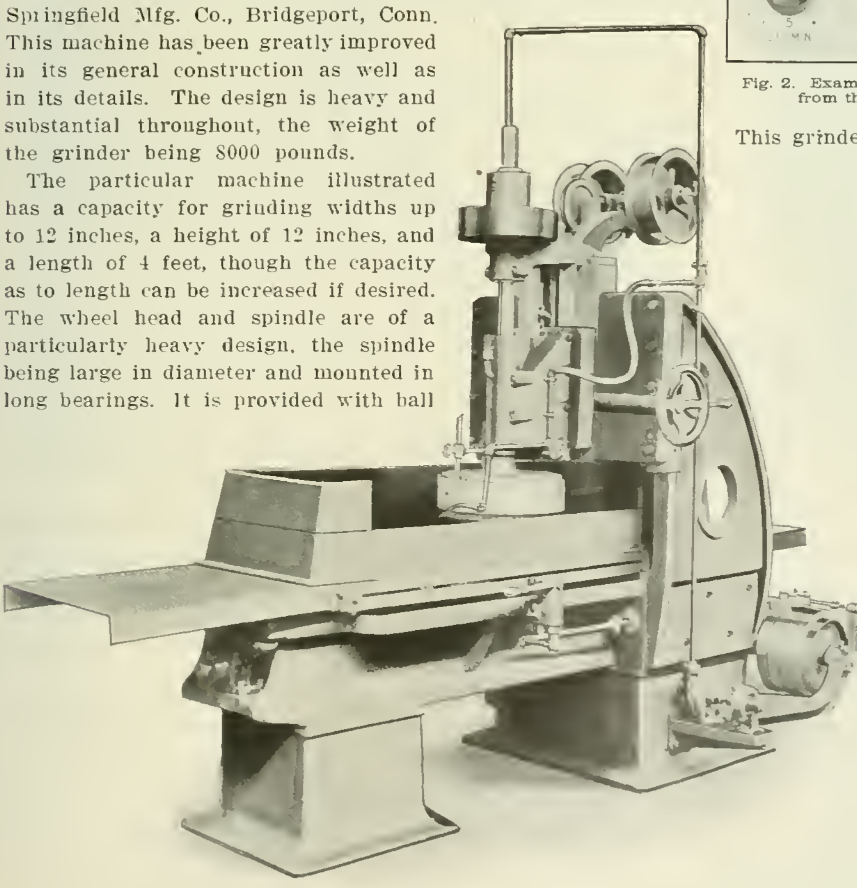


Fig. 1. Grinding Planer built by the Springfield Mfg. Co.

This grinder, as the illustration shows, has all the advantages, as far as rigidity is concerned, that are possessed by the modern planer; in fact, there is a striking similarity in the general appearance of the two machines. The table drive is of the general planer construction, except that the power for the grinder is transmitted through a worm and worm-gear at the rear of the machine direct to a large and substantial screw, which runs through a long nut, thus giving a smooth action to the table. The machine, as shown, is arranged with a hand-feed for feeding the wheel to the work, and the adjustments of the wheel are as indicated. While the design illustrated is arranged for hand-feed only, it will also be built with a power feed when desired.

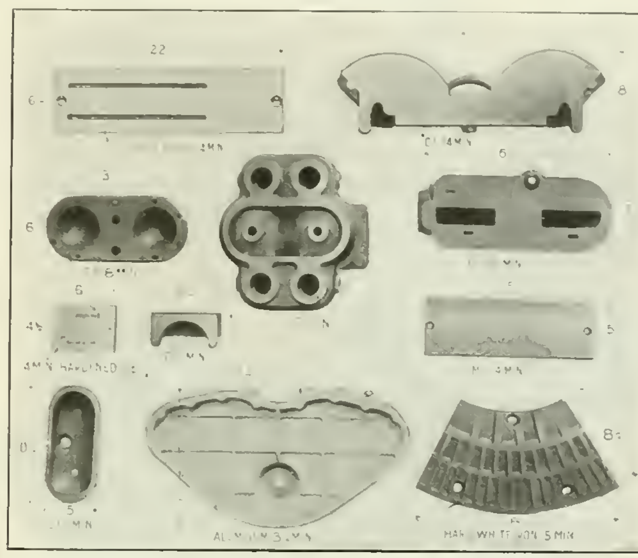


Fig. 2. Examples of Work done on Grinding Planer—All Parts ground from the Rough and from 1/32 to 1/8 inch Metal Removed

This grinder is furnished with a pump for supplying lubricant to the wheel and the lubricant can be applied either through the spindle or from the outside. This pump is mounted on a bracket that is bolted to the base, and it is driven by belt from a pulley on the driving shaft. The lubricant is forced through the vertical pipe shown, to the outside or inside of the wheel by the manipulation of two valves located at the junction of the vertical pipe and lower outside connection. When applied through the spindle, the water is forced against a deflector on the under side of the spindle so as to force it to the periphery of the wheel, which is essential when grinding narrow or interrupted surfaces. The guard around the table, which encloses the work, is made in sections on the front side, so that it can be easily removed. The engraving shows the planer with the upper section of this guard taken off.

In Fig. 2 some examples of the work ground on this machine, together with the dimensions of the various parts and the time required in grinding them, are shown. In all cases these parts were ground from the rough, the wheel removing anywhere from 1/32 to 1/8 inch of stock. The time could, of course, have been considerably reduced if the proper amount of finish had been allowed on these pieces for grinding, which method of finishing does not require, of course, anywhere nearly as much stock as a milling or planing operation.

SCHUCHARDT & SCHUTTE AUTOMATIC WORM MILLING MACHINE

Schuchardt & Schutte, 90 West St., New York City, has placed on the market a thread milling machine, which is adapted to the milling of right- and left-hand worms, to the cutting of spiral gears of extreme angles, and for other helical milling operations, such as the threading of bolts, etc. This machine, which is shown in Figs. 1 and 2, is similar in some respects to a universal milling machine when the latter is set up for helical work, in that the table has a longitudinal movement past the cutter and there is a dividing head through which the work is rotated.

The milling cutter on this machine is rigidly mounted and, aside from its rotary movement, remains stationary. The work is supported on an arbor carried in an index head and outer support, or between centers. It has a longitudinal movement depending, of course, on the lead of the thread being milled, which is obtained through change gearing. The drive to the cutter spindle is by belt to a 3-step cone mounted on a horizontal shaft passing through the center of the head; this shaft drives an intermediate shaft which transmits movement to the cutter spindle through spur gears having a ratio of 2½ to 1. The casing in which these gears are enclosed may be seen in Fig. 1. The drive to the work-arbor is taken from an intermediate shaft in the head, which is connected to the driving shaft of the change gear box by a chain-and-sprocket drive. From this box, in which twenty speed variations for the work may be obtained, the movement is transmitted to a horizontal shaft extending to the front of the machine, which connects with a splined driving shaft beneath the table. This splined shaft transmits motion, through bevel gears, to the worm-shaft of the dividing head, which, in turn, drives the work-arbor through a 40-tooth worm-wheel. Longitudinal movement is given the work-table by a lead screw which is connected to the splined shaft through change gearing for obtaining various pitches. The gears included in the equipment enable leads ranging from ¼ to 10 inches to be obtained, and by making a slight change in the gearing, a maximum lead of 20 inches is available.

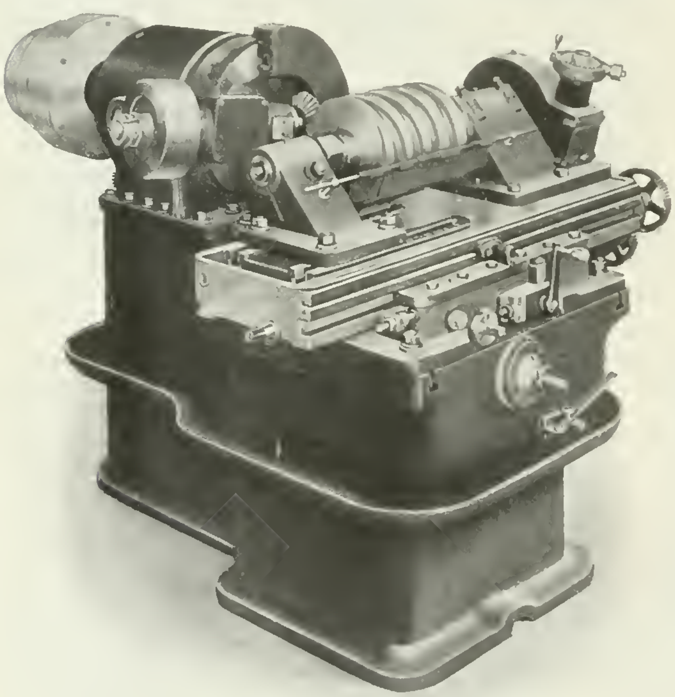


Fig. 1. Schuchardt & Schutte Worm Milling Machine

The cutter spindle is mounted on a swiveling head, so that the cutter can be set to the helix angle of the thread. This head may be adjusted to an angle of 45 degrees on either side of the zero or vertical position of the cutter. The cutter spindle and driving shaft are inclined backward to an angle of 12½ degrees from the right-angle position. The object in setting the cutter spindle in this angular position is to obtain a large ratio of gearing between the cutter spindle and its driving shaft and also the use of a comparatively small cutter, without interference on the part of the spindle driving gears with the work or outboard support. Because of this offset position of the cutter spindle, the sides of the cutter itself are not equi-angular. For example, the cutter for milling an Acme thread would be made with an angle of 26½ degrees on one side and 2½ degrees on the other, so that each side would be at an angle of 14½ degrees with the axis of the work, which is the angle for the sides of a standard Acme thread.

When a thread is to be milled, the cutter is first set to the helix angle. The work, after being mounted in place, is then set to depth by feeding the table inward. This is done by applying an interchangeable handled lever to the squared feed-screw shown, which has a graduated collet reading to thousandths of an inch. When the work is correctly positioned, the saddle may be securely locked to the bed by tightening four locking bolts. If desired, the thread, even when of coarse pitch, may be finished in one cut, though for extremely accurate work a finishing cut would be taken. The travel of the table may be automatically disengaged by an adjustable stop located at the front as shown. A conveniently located lever also provides means for stopping the work by hand. If a bastard thread or one whose pitch is coarser than any available cutter needs to be milled, this may be accomplished by adjusting the table and work longitudinally, after one cut has been taken, means for making this adjustment being provided. On the speed change gear box, an index plate shows how the change gear levers should be set for milling various diameters. The speeds obtained in this way are, of course, tentative, and subject to variation for different materials. The index plate also shows the circumferential feed of the work per revolution of the cutter for different positions of the speed controlling levers.

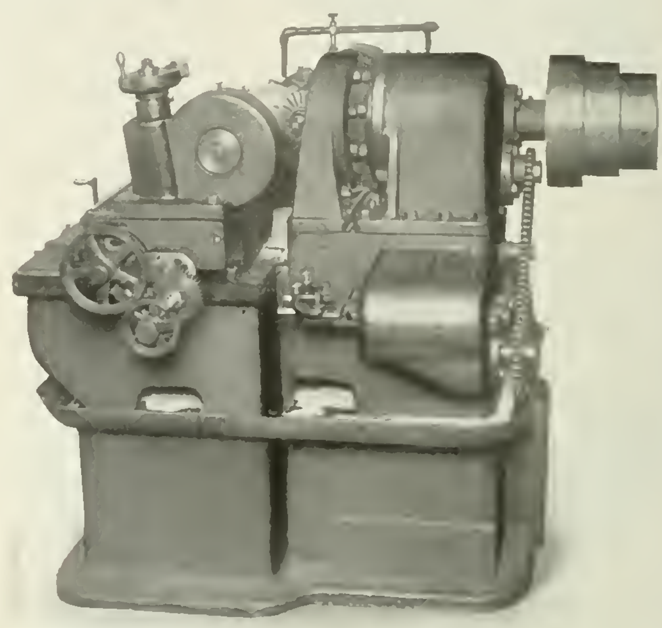


Fig. 2. Side View showing Outboard Support for Swiveling Head and Gear Box for Controlling Work Speed

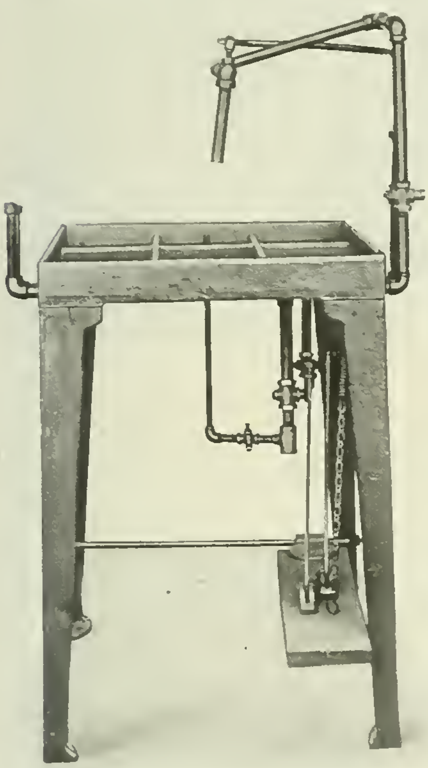
A dividing mechanism is provided for indexing the work when milling multiple threads or spiral gears. The machine is provided with a pump and reservoir (not shown) for supplying lubricant to the cutter, and there is also a large pan cast integral with the base for catching and returning all lubricant to the reservoir. The maximum diameter that can be milled in this machine is 9 inches and the greatest length of thread, 16 inches. The minimum distance between the cutter and work-arbor is 2⅛ inches. The circumferential feed of the work per revolution of the cutter ranges from 0.012 to 0.052 inch. The regular equipment includes a countershaft, a reservoir and pump for supplying lubricant, one work-arbor,

a complete set of wrenches and the other accessories necessary to operate the machine.

An important feature in the design is the means for giving additional rigidity to the cutter. This consists of a heavy bracket that is bolted to the outer face of the swiveling head, thus reducing the unsupported overhang to a minimum. The machine is massively constructed throughout as the illustrations show, and it is capable of accurate work and rapid production.

LUCAS BRAZING FORGE

In shops where much soldering or brazing is done the gas bill is an important item of shop expense. In order to decrease to a minimum the amount of gas used in brazing, J. L. Lucas & Son, of Bridgeport, Conn., have brought out the brazing forge shown herewith. This forge is the outcome of considerable experience in brazing and soldering of automobile parts, and the principal points claimed for it are economy and efficiency.



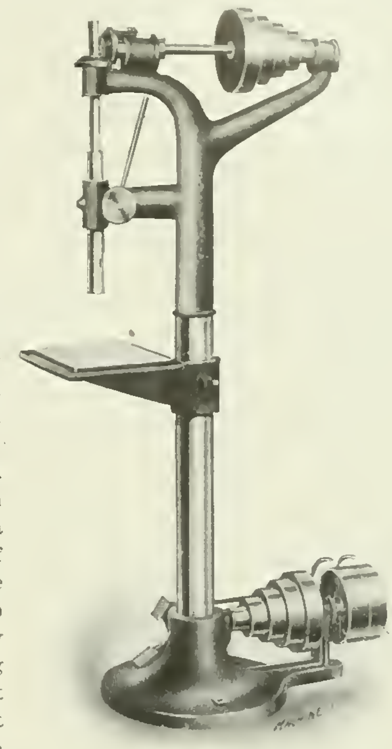
Brazing Forge with Foot Treadle for Controlling Gas and Air Supply

The chief difference between the design of this and other brazing forges is the addition of a foot-treadle for controlling the gas and air supply. This treadle is hinged at the rear of the forge, and two connecting-rods which are attached near the center of the treadle extend to the gas and air valves located in the supply pipes. Normally, this treadle is kept raised by a spring, which is shown attached to the under side of the table. When in this upper position, both the air and gas valves are open to the extent that they have been adjusted for, but as soon as the brazer presses the treadle down both the air and gas are automatically shut down sufficiently to give only a pilot light. If the brazer desires to leave the forge, the treadle may be swung into a latch near the bottom of the leg near the treadle, which holds it in the downward position. Thus it will be seen that during the numerous intervals between jobs, when adjusting work, charging, or doing other work, the gas need not be left burning; furthermore, no time is wasted in adjusting the flame when it is again needed. It is claimed that this feature effects a saving of gas ranging from 15 to 25 per cent, and there is, of course, also a considerable saving in time, inasmuch as the adjusting of the air and gas each time the flame is shut down, before beginning another job, is rendered unnecessary by the foot control.

The illustration shows the forge equipped with a single torch, but double torches can also be furnished if desired. The table of the forge may be honeycombed for the reception of firebricks, or it can be furnished slotted to facilitate brazing bicycle tubing or similar work. The use of rubber tubes for connecting with the burner is eliminated in this forge by the construction of the piping shown above the table, which is flexible enough to permit the torch to be tilted to any angle. The castings, piping, and valves used on this forge are of the best quality and the forge itself is of strong and simple construction.

SIBLEY SENSITIVE DRILL PRESS

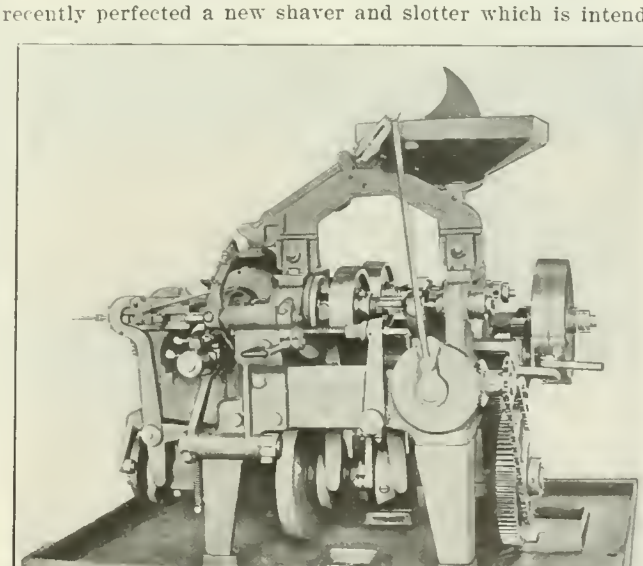
The accompanying illustration shows a new sensitive drill press of 16 inches swing that has been put on the market by the Sibley Machine Tool Co., of South Bend, Ind. In general lines this machine is of the standard type of light drill press, but it has the important feature of being self-oiling throughout. There is an oil chamber beneath each of the four horizontal bearings, which is filled with lambs' wool and saturated with oil. The oil is fed to the shaft by capillary action through a slot in the bottom of each bearing. The crown gear bearing is oiled by a wick which draws its oil from a chamber just back of the bearing. A tube screwed into the hub of the loose pulley contains a lubricating candle held against the shaft by a light spring. The spindle is not counterbalanced, but is held in any position by a brass friction. Miter driving gears insure quiet running at the highest speed, and a base of ample proportions makes the drill press solid and steady. With the countershaft running at 500 revolutions per minute, five spindle speeds, ranging from 150 to 1700 revolutions per minute, are obtained. The weight of this press is 300 pounds. The maximum distance from the spindle to the base is 44 inches, and to the table, 30 inches. The spindle is bored to receive a No. 2 Morse taper, and it has a feed of 8 inches. The table has a working surface of 10 by 12 inches. The machine occupies a floor space of 20 by 30 inches, and its maximum height is 68 inches.



Sibley 16-inch Sensitive Drill Press

MANVILLE SHAVING AND SLOTTING MACHINE

The E. J. Manville Machine Co., of Waterbury, Conn., has recently perfected a new shaver and slotter which is intended



Machine for Slotting or Shaving Wood-screw or Machine-screw Heads

for the shaving or slotting of wood-screw or machine-screw heads or for plain shaving or slotting operations as required.

The principal points of advantage of this shaver and slotter are extreme accuracy as to the diameter of head, the central location of the slots, and a head that in every case is round and true with the body.

All screws up to 4 inches in length are pushed into the spindle as far as the head, no back-rest being used to throw the heads out if the blanks are imperfect. The blank is held in a split chuck similar to that of automatic screw machines. The slotting saws are mounted on a rigid bracket and can be instantly adjusted to bring the slots central with the head of the screw. The fact that the screw head is turned by being held entirely in the spindle, and that the spindles are mounted rigidly in the frame, insures every head being round and having a smooth finish. The life of the tools is also increased.

These machines handle all sizes of screws from 1/4 inch (No. 0) up to 4 inches (No. 20). Large and small hoppers are provided that are not only interchangeable on these machines, but also interchange with the wood-screw threaders built by this company. All cams and other operating parts of the machine are easy of access, and nearly every adjustment may be accomplished while the machine is in motion. The shaving tool is so mounted that it can be brought to the head of the tool at any desired angle, so that heads may be made to the correct angles even if the tool itself is incorrectly formed. As nearly all movements are yielding and some in both directions, it is practically impossible to break any of the machine parts. All movements are also governed by positive stops instead of being brought to their working points by the cam faces alone. Any operator familiar with shavers of the old type can readily operate this new design, as the action of the tools is, of course, practically the same, the only radical difference being that both spindles are rigidly mounted in the frame and each spindle has its own set of tools which gives extreme accuracy to the product and increases the production, as it is unnecessary to throw the spindle over from side to side.

SENECA 14-INCH QUICK CHANGE FEED ENGINE LATHE

The accompanying illustration, Fig. 1, shows a new 14-inch quick change feed engine lathe placed on the market by the Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y. This lathe is provided with several new features not found in earlier designs, one of these features being the quick change feed mechanism, and another the micrometer stop for the cross-slide, shown in Fig. 2. The feed mechanism consists of a cone of eight steel gears located on the lead-screw at the right-hand side of the feed cage. A tumbler gear on a lower shaft can be brought into mesh with any one of the eight gears. This tumbler gear, in turn, is given three changes of speed through another tumbler and set of gears at the left-hand end of the gear cage. By means of the lever at the end of the headstock, two speed changes are imparted to the set of gears in the left-hand end of the cage, so that the lead screw, which is also used for the feed-rod, can be given forty eight changes in all. All standard threads from 1½ to 92 per inch, including 11½, and feeds ranging from 0.0023 inch to 0.144 inch per revolution of the spindle, can be obtained. The index plate provided shows clearly how to instantly obtain any desired number of threads per inch or any required feed.

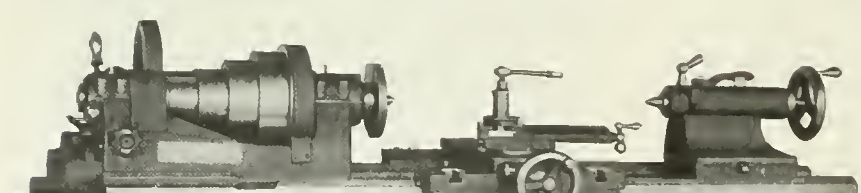


Fig. 1. Fourteen-inch Lathe made by the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

The micrometer stop for the cross-slide, shown in Fig. 2, permits minute adjustments to be easily made. The location of the stop is adjusted by means of a worm-gear operated by a worm or screw with a knurled knob. The adjustment is determined by graduations on a micrometer barrel, these graduations being about 1/4 inch apart and each equivalent to a 0.00025-inch motion of the stop. The stop mechanism is thrown in and out of engagement by pushing in and out a knob inside of the handwheel. The stop acts directly on the cross-feed screw, and is therefore more effective than a stop which acts on the cross-slide. It is positive and will be found of great advantage in the operation of the lathe, as it saves time and is conducive to accuracy. The stop may be used when the taper attachment is in action.

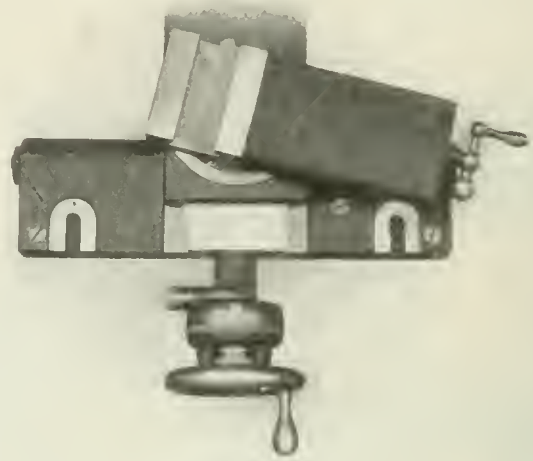


Fig 2. Micrometer Stop for the Cross-slide, as applied to the Seneca 14-inch Lathe

The reverse mechanism for both cross and longitudinal feeds and lead-screw consists of a set of spur gears and a clutch in the headstock operated through levers connected by the reversing rod to a hand lever on the apron, thus giving the operator control of the lathe from his normal position in front of the machine. This mechanism eliminates the reversing of the belt on the countershaft, and provides for sixteen forward speeds of the head spindle. An automatic stop for the carriage can be operated in either direction by means of adjustable stops on the reverse rod.

The general design of the machine makes it suitable for heavy work. The headstock is of a deep web pattern, with forged crucible steel spindle revolving in large bearings and ring oiled. The driving belt is 2½ inches wide. A new binding device, which is patented, secures the plain and compound rest to the cross-slide. This device facilitates the adjustments, and by omitting the usual slots for the binder bolts, the cross-slide is strengthened. All carriages are arranged for taper attachment, which may be affixed to the machine at any time. The cross-feed screw is provided with a graduated collar, reading to 0.001 inch, the graduations being about 1/16 inch apart. An automatic safety device, also patented, makes it impossible to engage opposing feeds at once. One feed is automatically disengaged when another is thrown in. The feed gearing is disengaged when threads are cut, and the handwheel for the longitudinal feed does not revolve.

MOLLER LATHE CHUCK FOR TURNING OVAL OR ROUND WORK

The lathe chuck shown in Fig. 1 has been designed for the turning of oval patterns, punches and dies of oval shape, or for work of a similar character. The designer and manufacturer, Mr. J. A. Moller, Box 240, New Rochelle, N. Y., has endeavored to produce a chuck which would be adapted to oval turning and at the same time be convertible into an efficient plain chuck for round turning.

The construction and operation of this chuck will be more apparent by reference to Fig. 2, which shows the chuck proper

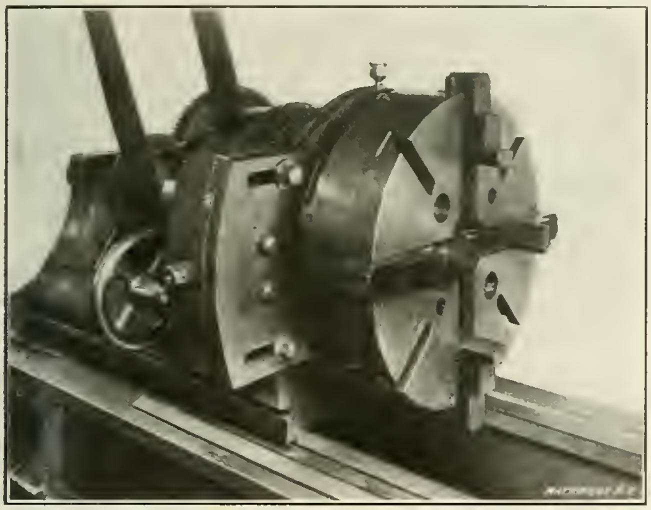


Fig. 1. Combination Chuck for Oval and Round Work

removed. Attached to the lathe headstock there is a stationary base-plate *B* upon which is mounted a slide *C* that may be adjusted horizontally, the adjustments being effected by turning shaft *S* which, through worm gearing, rotates a screw *D* passing through a nut attached to the slide *C*. When this slide has been set in the correct position, it may be locked by the bolts *A* which pass through elongated holes. The chuck itself (when used for oval turning) is free to slide in the dovetail ways of ring *R*, and it also has a movement

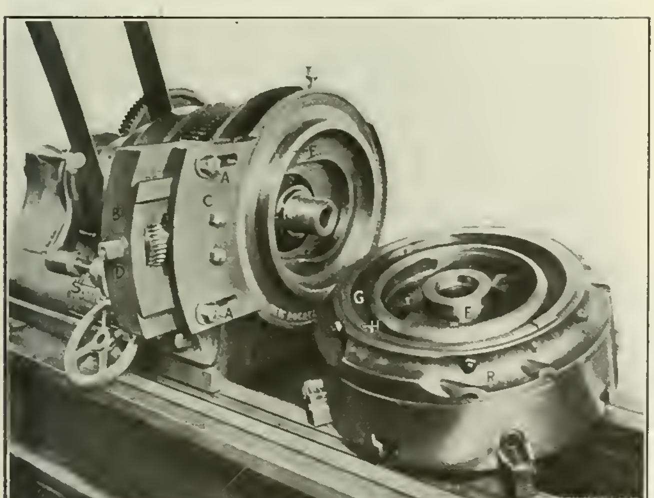


Fig. 2. View showing Chuck removed and Adjustable Slide for Varying the Ellipses

at right angles to these ways on the driving plate *E* to which it is dovetailed. When the chuck is in place, as shown in Fig. 1, this driving plate is screwed on the spindle and the projecting ring *F* sets into the annular groove *G*. When the lathe spindle and the driving plate *E* are rotated, the chuck is given a backward and forward movement (provided the ring *F* is set eccentric to the lathe spindle) which is correct for producing an elliptical shape. The proportions of this ellipse, or the difference between its major and minor axes, is determined by the position of the eccentric ring *F*, which may be adjusted as previously explained.

The chuck has a capacity for turning ovals having a maximum difference between the two axes of four inches. A scale on the top of the stationary base *B*, indicates the size of the ellipse, and a micrometer dial (not shown) on the screw *B* enables accurate adjustments to be made. The screw *S*, can, if necessary, be rotated uniformly by power, either from the main spindle gear or through the change gears so as to gradually alter the position of the eccentric ring. Such a uniform movement of this ring would be required when turning work having an oval shape—the ovals gradually diminishing in size but keeping the same proportion—to compensate for the inward or feeding movement of the turning tool. This power feed could also be employed to advantage for producing a surface which gradually changed in shape from oval to round, or *vice versa*.

When this chuck is to be used for round turning, the ring *F* is, of course, placed concentric with the spindle, and the driving plate *E* is locked to the chuck by screws which are inserted in the counterbored holes, seen in Fig. 1. The chuck also receives additional support from the ring *F*. All dovetailed slides are equipped with adjustable gibs, and means are provided for taking up wear around the eccentric ring, by the adjustment of a split tool steel ring *H* which may be contracted by suitable screws. The driving plate is of tool steel, the adjusting screw of machinery steel, and the worm-wheel of bronze. The stationary part of the chuck or the base-plate *B* is easily attached to a headstock, and means are provided for adjusting it centrally with the spindle. The chuck itself is of the four-jaw independent type, and the attachment may be applied to any lathe having a swing of over 18 inches.

STANDARD TOOL CO.'S ADJUSTABLE REAMER

The Standard Tool Co., of Cleveland, O., has recently added to its line a new adjustable reamer which is known as the "Stana R." This reamer has been developed to meet the demand for an adjustable reamer that is simple in construction, readily adjusted to compensate for wear, and yet solid enough to stand the most severe service.

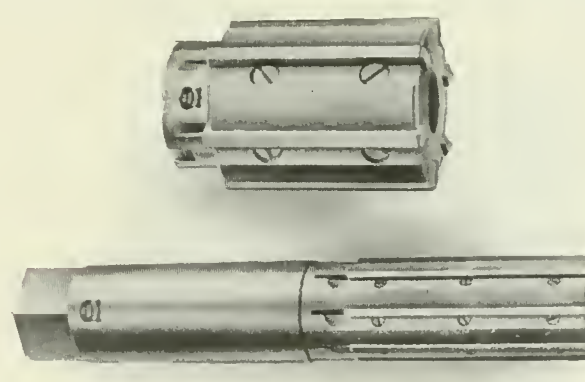


Fig. 1. Standard Adjustable Reamers of the Hand and Shell Type

The body of this reamer is made of hard, tough, machinery steel. The blades are unevenly spaced to prevent chatter and insure a smooth hole. Each blade is held rigidly in place by means of heavy screws provided with special shaped heads that are countersunk into the body of the reamer. The screw heads engage in V-shaped slots that are milled into the face of each blade, as shown in the sectional view, Fig. 2. This construction not

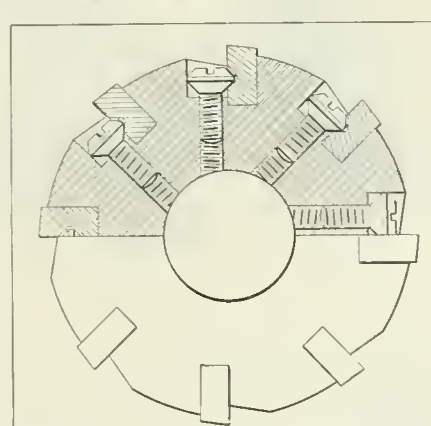


Fig. 2. Sectional View of Adjustable Reamer showing Method of Binding Blades

only seats and holds the blades rigidly against the bottom and back of the slot in the body—thus eliminating any tendency to spring—but prevents endwise motion as well.

The blades can be ground with end clearance for machine reaming or chucking work, as they extend a sufficient distance beyond the body to permit of this being done. After the blades are worn or when it is desired to increase the diameter, they can be taken out by removing the screws, and the diameter increased by placing a liner of some suitable material (preferably tin foil), and of the desired thickness, evenly in the slots under the blades, after which the blades are reground ready for use. By this method it will be seen that the blades can be adjusted until completely used up. By the substitution of new blades for those that are worn out, the reamer is to all intents and purposes as good as new.

"Stana R" reamers are furnished either in the hand or shell type and with carbon or high-speed steel blades.

LARGE TOGGLE DRAWING PRESS

The D. H. Stoll Co., of Buffalo, N. Y., has recently completed the large double-action toggle-motion drawing press, shown in Figs. 1 and 2. This press has been built especially for the heavy blanking and drawing work connected with the automobile trade, and it was primarily designed for drawing radiator fronts, the work being done in one operation from the blank. Samples of these fronts are shown in Fig. 3, those to the right being direct from the drawing die, while the one to the left has the center panel blanked out.

This press weighs 86,000 pounds, and has an over-all height of 14 feet. It is driven through gearing having a ratio of 35 to 1, which is arranged as shown in Fig. 1. The press is controlled by a lever extending to the front which operates a multiple disk friction clutch twenty-four inches in diameter. This clutch is fitted with friction blocks for a brake on its outside surface. It is designed for severe service and is capable of transmitting 100 horsepower at 250 revolutions per minute. The flywheel mounted on the driving shaft has a weight of 2300 pounds. The crankshaft, which is 8¼ inches in diameter, has two cranks of 7-inch throw. The pins of these cranks have a bearing of 10 inches and the shaft bearings are 17 inches in length. All these bearings are bushed with bronze specially proportioned to withstand great compression. The bolster plate measures 59 inches by 56 inches, which gives ample die space. The inside slide is 28 inches by 30 inches, thus permitting the use of a punch proportionate to the large die capacity.

The press is equipped with an outside or hold-down slide which is actuated by rock-shafts at the front and rear; these are connected with a slide at the side of the housing (as shown in Fig. 2), which, in turn, receives its movement from the main crankshaft with which it is connected by a pitman.

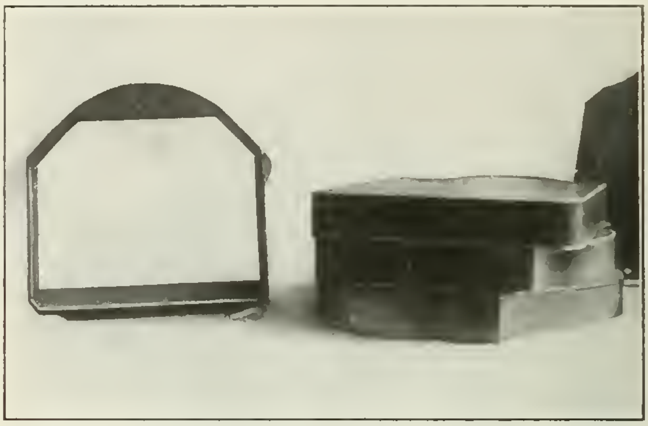
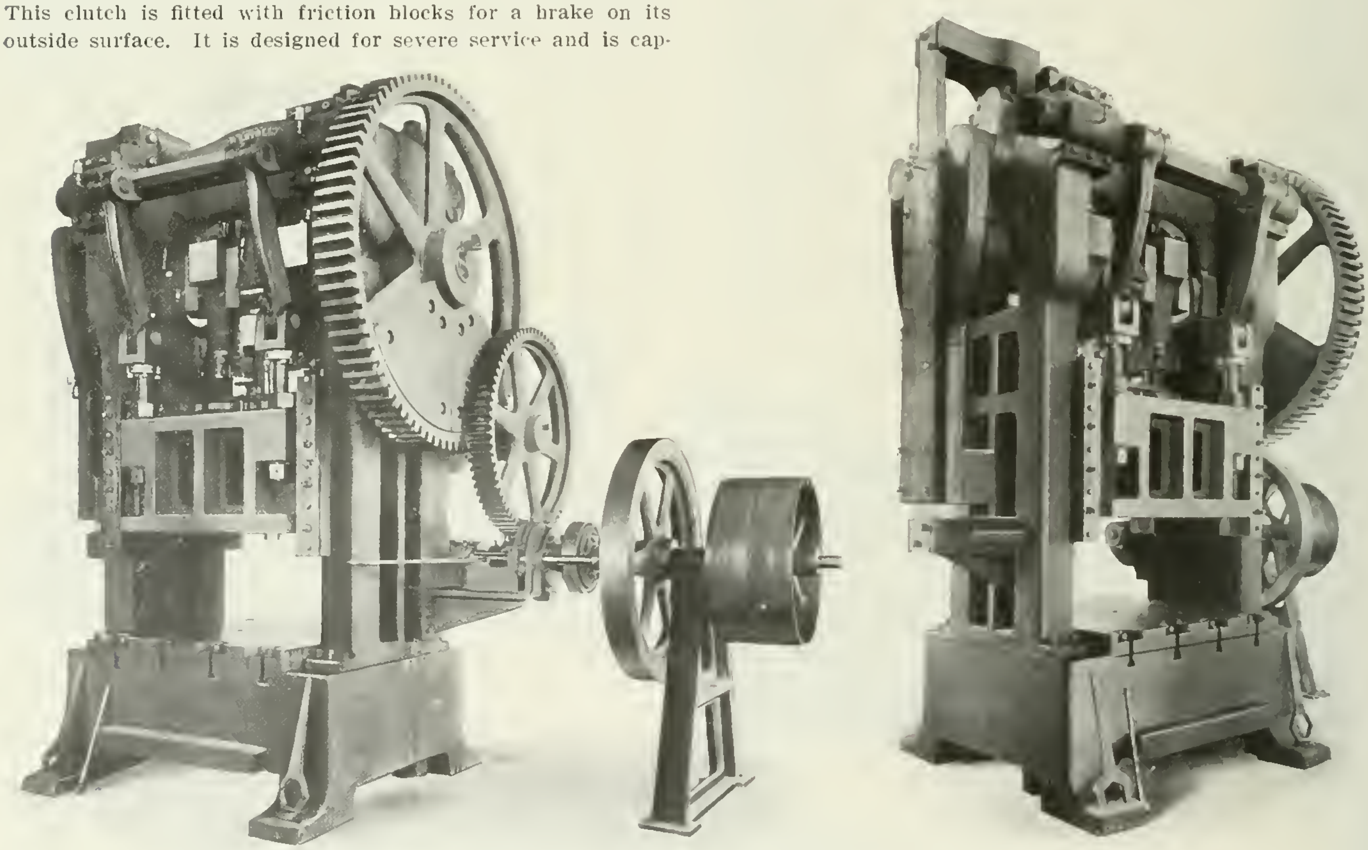


Fig. 3. Radiator Fronts Drawn on the Press Illustrated in Figs. 1 and 2

This toggle motion gives an exceptionally long dwell to the hold-down slide when the latter is at the bottom of its stroke, so that parts requiring a deep draw can be easily produced. This hold-down slide is provided with four adjusting screws which are 3½ inches in diameter and have four threads per inch, acme standard. The rock-shafts for operating this slide are of cast steel and have a diameter of 7 inches. The inner slide has an adjustment of 10 inches, the adjustment being effected by two screws that are operated by spur-gears. As these gears have a ratio of 7 to 1, adjustments are easily made. The two adjusting screws are 4½ inches in diameter and have four threads per inch. The entire tensional strain to which this press is subjected when in operation is taken by four 4½-inch tie-bolts that extend through the base casting, the housings and the arch piece at the top. These bolts are



Figs. 1 and 2. Double-action Toggle-motion Drawing Press built by the D. H Stoll Co.

shrunk in place during the final erection of the press.

The great economy effected by making radiator fronts in three simple operations, namely, blanking, drawing and center hole punching will doubtless induce many automobile manufacturers to adopt the enamelled steel front in preference to the formed and seamed brass ones, now mostly used, owing to the fact that all hand work is eliminated when the former process is employed.

BROWN RADIATION PYROMETER

A new type of radiation pyrometer for use in measuring temperatures beyond the limit of the well-known electric pyrometer with a platinum thermo-couple has been devised by Mr. Richard P. Brown, of the Brown Instrument Co., 311 Walnut St., Philadelphia, Pa. The pyrometer last referred to is very useful for temperatures as high as 2500 degrees Fahrenheit, but above this point the life of the thermo-couple is very short and its accuracy seriously impaired. In the radiation pyrometer the sensitive thermo-couple is located at the rear end of the tube or telescope and a concave mirror focuses the heat rays entering the tube on the thermo-couple, which is connected by wire to the millivoltmeter graduated in temperature degrees. The radiation pyrometer, therefore, has no part directly subjected to the excessive heat to be measured, so that, in consequence, no part is in danger of being destroyed by the furnace gases or high temperatures. This new pyrometer also has the advantage of instantaneous readings, the slightest change in temperature being shown immediately.

Radiation pyrometers heretofore manufactured have been of two types, the adjustable focus and the fixed focus. The imported type with an adjustable focus has been too complicated for general use, and the fixed-focus instruments have had no means for determining whether or not the telescope is too far from the furnace opening or heated body. With

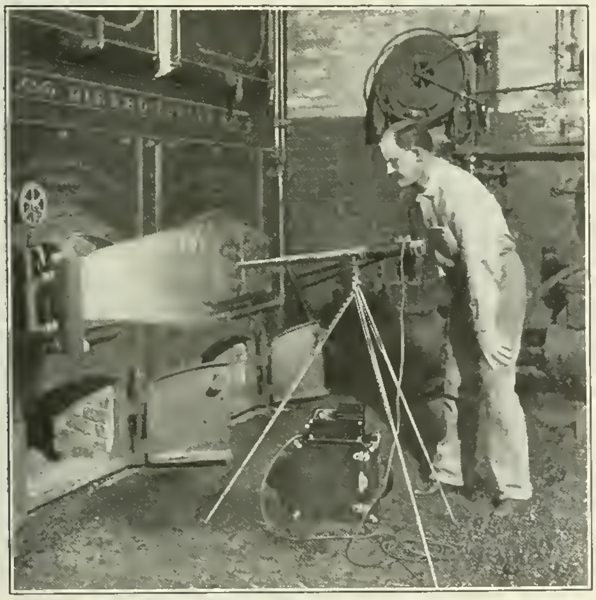


Fig. 1. Brown Radiation Pyrometer Mounted on Tripod

the fixed-focus type, the telescope or tube should not be distant more than ten times the diameter of the furnace opening or body, the temperature of which is being measured. In the new radiation pyrometer, illustrated herewith, which is of the fixed-focus type, a finder, somewhat similar to those used on kodaks, has been placed on the tube, and by means of this finder, the tube can be readily pointed directly at the furnace opening. It also acts as a measure of distances and it is only necessary that the bright red of the furnace opening occupy the whole view in the finder. If some of the dark outside wall of the furnace shows around the bright red opening, this is an indication that the tube is too far distant, and it should be moved closer until only the bright red can be seen. This attachment insures that the tube will always be within the correct distance for obtaining an accurate reading. It is said that this instrument, under ordinary working conditions, is accurate within 1 per cent or 30 degrees at 3000 degrees Fahrenheit.

Another desirable feature of the Brown pyrometer is the collapsible or telescopic tube which permits the indicator, tripod, tube and wire being placed in a small leather carrying case, which, with the instrument, weighs only 15 pounds.

This instrument is calibrated for measuring the temperature of a black body or the temperature of the walls or parts

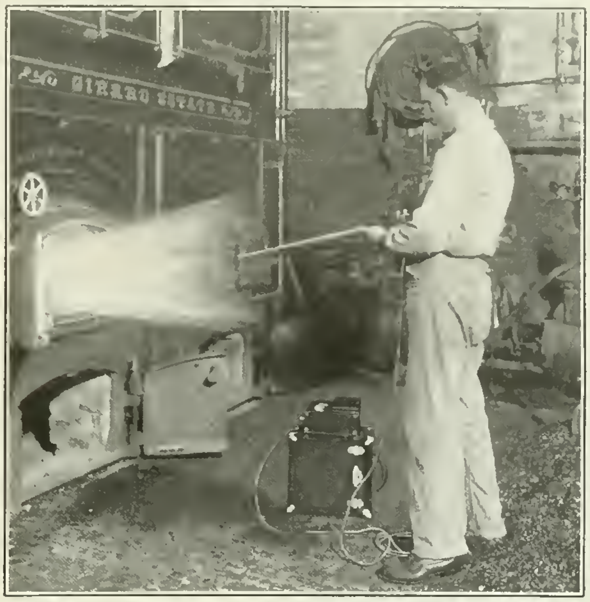


Fig. 2. Method of Using Pyrometer for Obtaining Readings Quickly

inside of furnaces which are practically black bodies. When using the pyrometer for measuring the temperature of molten metals, or highly polished surfaces which reflect, a correction is made. When the pyrometer is being used on a brick kiln or furnace, it is frequently inconvenient, if tests of long duration are to be made, to leave the door or other aperture open. A fire-brick tube is therefore inserted in the opening so that it projects into the kiln or furnace, the inside end of the tube being closed. The pyrometer telescope is then focused on the inner end of the fire-brick tube, and for permanent installation a bracket, bolted to the wall, is used for holding the tube, instead of a tripod.

This pyrometer is particularly adapted for measuring the temperature about a blast furnace plant, in the open-hearth furnaces of steel works, where there are excessive temperatures, in brick kilns for burning fire-brick and refractory materials, in rotary cement kilns where a temperature of about 3000 degrees must be measured 20 feet inside the furnace, and by engineers for testing the temperature of boiler furnaces, or in research work.

GOODYEAR OXY-ACETYLENE EQUIPMENT

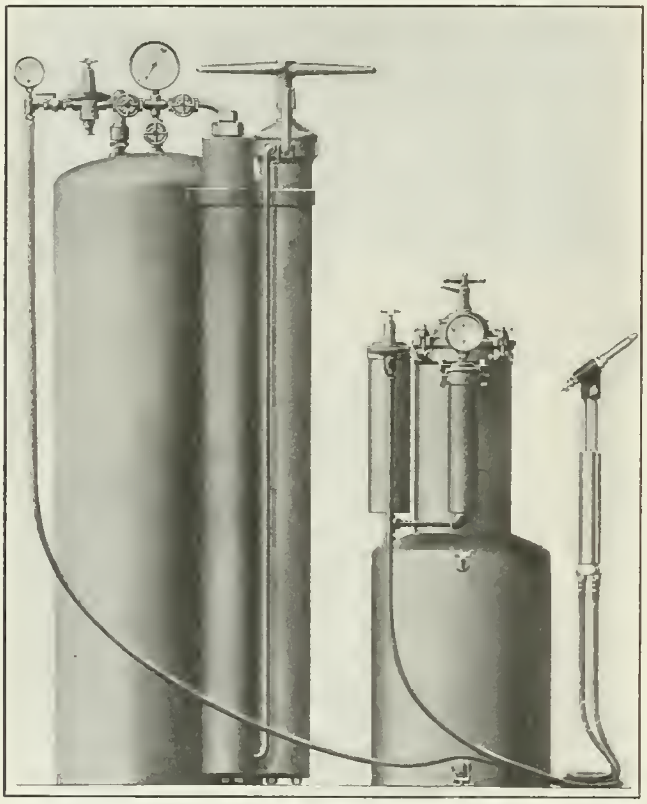
Nelson Goodyear, Inc., 50 Church St., New York City, has designed the oxy-acetylene equipment illustrated herewith in order to provide a simple yet efficient autogenous welding apparatus both for those whose ultimate needs will not be large, and also for concerns who desire a comparatively inexpensive equipment.

The oxygen-producing apparatus, which forms a part of the equipment, obviates the use of a compressor, as the gas is generated in a simple and reliable way to a pressure of 150 pounds per square inch. This oxygen generator which is at the left of the illustration, comprises a generating tower, scrubbing tower, and a storage tank with regulators and gages, as shown. Oxygen is generated from per-chlorate of potash mixed with other ingredients. This mixture is put into a perforated metal cylinder which is placed in the generating tower. To start generation, either a hot rivet or a small quantity of ignition is placed on top of the material; this causes incineration, the entire contents of the perforated basket being slowly consumed. The oxygen is given off

during this incineration, and, as generated, passes through the scrubber in which it is relieved of its impurities, to the storage tank. The manufacturers claim an improvement in this particular, in that there is no expense for heat, as in the case with gas-heated oxygen generators; furthermore, owing to the slow incineration of the material and to the fact that the cylinder containing it does not touch the walls of the generating towers, the excessive expansion and contraction of gas-heated retorts is obviated.

As each pound of the oxygen-producing material generates 5 cubic feet of gas, it will readily be seen that since the basket holds but 10 pounds of material, not more than 50 cubic feet of oxygen can be made at one charge, and hence an unsafe pressure is a practical impossibility. As a precautionary measure, and to conform to the Underwriters' rules, the oxygen storage tank is equipped with a regulator having a relief valve at its lower end. As the foregoing figures indicate, the daily capacity of the oxygen apparatus is 500 cubic feet, if recharged every hour.

In the acetylene generator, which is of a new design, the carbide is fed by means of a diaphragm and a rod passing



Goodyear Oxy-Acetylene Autogenous Welding Equipment

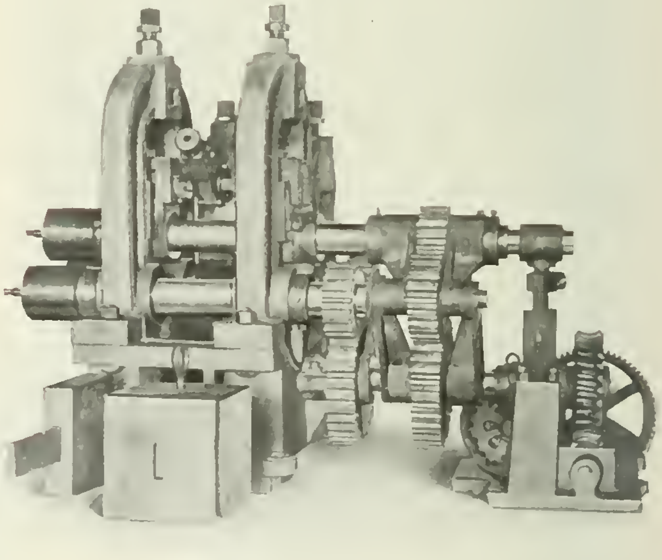
through an annular opening, at the lower end of the carbide chamber. The diaphragm is of rubber, and as rubber is not affected by acetylene gas, its deterioration is very slow. The feed-rod has small recesses in its lower end which fill with the carbide. As the gas is used and the diaphragm falls, the rod with the carbide resting in its recesses, passes through the annular opening; the carbide then drops into the water and the evolution of gas raises the diaphragm, carrying the rod back through the opening, so that it is again filled with carbide and the operation repeated until the charge is exhausted.

It will be seen that the principle employed in this machine is the carbide-to-water principle, which is generally accepted as the best means for generating acetylene, in that the dropping of carbide in small quantities at a time into a comparatively large volume of water, avoids high temperatures within the apparatus. This particular apparatus for feeding the carbide, has two strong advantages in safety: If, for instance, someone about the shop, either from mischief or some other motive, should press down on the adjusting handle at the top of the machine, only about a teaspoonful of carbide could be thus fed, for the evolution of gas would raise the diaphragm above its normal point and a spring would fly out and lock the device against a repetition. In event of the hose being pulled off, the machine would stop operating, for in this case the sudden outflow of gas would exhaust the gas which was under the diaphram so quickly that the feed-rod would fall below its normal point of operation and remain there, the generation of gas under these conditions being too small an amount to raise the diaphragm high enough for the rod to receive its next charge of carbide. This feed-rod is so designed that it will not feed carbide, and hence cannot make gas, at a rate faster than one blowpipe will consume. Thus, it is impossible for this acetylene generator to be run beyond its rated capacity. The generator is designed to supply gas to five different sized tips, and is adequate for all, excepting the very heaviest work. The generator is equipped with a filter and hydraulic back-pressure valve.

As the capacity of the oxygen generating apparatus is sufficient to supply gas for four men, other blowpipes can be supplied by the provision of additional acetylene units, though, of course, if welding operations are to be done at different points in the same factory, it would in that case be advisable, perhaps, to obtain other equipment, comprising both the oxygen and acetylene machines.

MOTOR-DRIVEN BENDING MACHINE

A motor-driven bending machine designed especially for bending the fifth wheels of wagons, but also applicable to the bending of small angles, tees, etc., is shown in the accompanying illustration. This machine consists essentially of the three rolls through which the material to be bent is passed. The bar, angle, or tee, is started edgewise into the rolls, and, in passing through, it is held from slipping to either side by grooves in the rolls from which it emerges in a circular form. By means of a screw in the center of each head, the top roll can be raised or lowered to vary the space between the rolls according to the thickness of the material to be



Motor-driven Bending Machine

formed. After the adjustment is made, the screws are locked with nuts, so as to keep the adjusting sleeve rigid.

All three rolls are positively driven, and by means of ratchets between the two uprights the top roll can be raised instantly for removing a completed ring without touching the screws in the housing. These ratchets operate on cams that allow the raising of the roll for the receiving and extracting of material. This arrangement saves much time and obviates the trouble of adjusting the top screw to bend another ring of the same diameter. The top roll can be put down instantly to its place and is then ready for bending another ring. On the rear of the machine there is a device that makes the first bend in the m tal so that it can be received in the other rolls. This machine is manufactured by the Danville Foundry & Machine Co., of Danville, Pa.

THE GEOMETRIC TOOL CO.'S BOLT THREADING MACHINE

Bolt cutting or threading machinery is ordinarily designed to handle a comparatively rough class of work of such a nature that quantity is of more importance than quality or accuracy. Consequently the average bolt cutter has not been adapted to that class of work which needs to be interchangeable and therefore requires an accurate and uniform thread. In designing the threading machine illustrated in Figs. 1 and 2 it has been the object of the builder, The Geometric Tool Co., of New Haven, Conn., to produce a machine that would have the advantages of the ordinary bolt cutter as to production, combined with the accuracy necessary on interchangeable work.

This machine is simple in construction and contains no parts likely to become deranged. The drive is to a single constant-speed pulley from which motion is transmitted to the spindle through a geared speed change mechanism, giving seven speed variations. The lever by which these speed changes are effected is conveniently placed and it is positively located by the engagement of a spring plunger with the various holes shown. The proper position of this lever for dies of different sizes is indicated on the outside of the casing by the figures 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4, located above the various holes and representing thread diameters.

The die-head used in this machine is the company's style D type with the exception of certain modifications necessary to adapt it to the changed requirements of operation. The style D die-head was originally designed for use on the turrets of screw machines where the work to be operated upon is rotated and the dies held stationary; therefore to adapt it for use on a rotary spindle the operating mechanism had to be modified and means provided for automatically opening and closing the die while running. The way in which the opening and closing is effected at any predetermined point is indicated at Fig. 2. The yoke by which the die is operated is attached to a rod that extends beneath the work carriage. On this rod there are adjustable stops which, by engagement with the carriage, operate the die. To facilitate setting the work in correct relation with these stops there is a swinging gage against which the end of the bolt or rod is placed before being clamped in the vise.

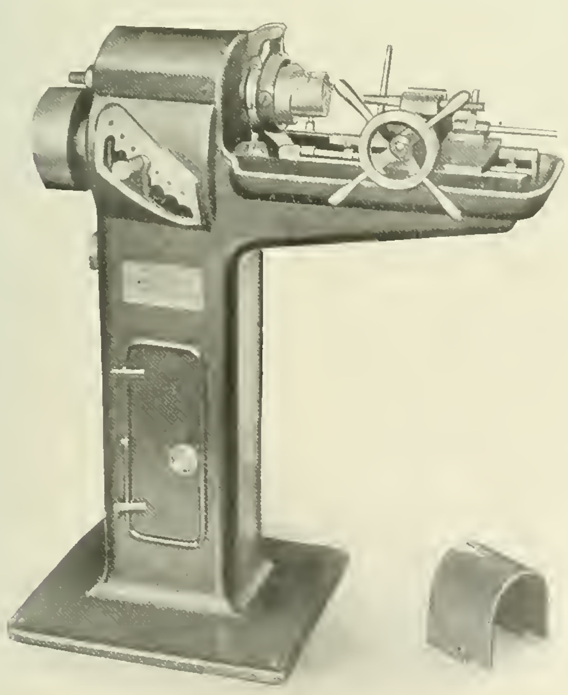


Fig. 1. Threading Machine built by the Geometric Tool Co.

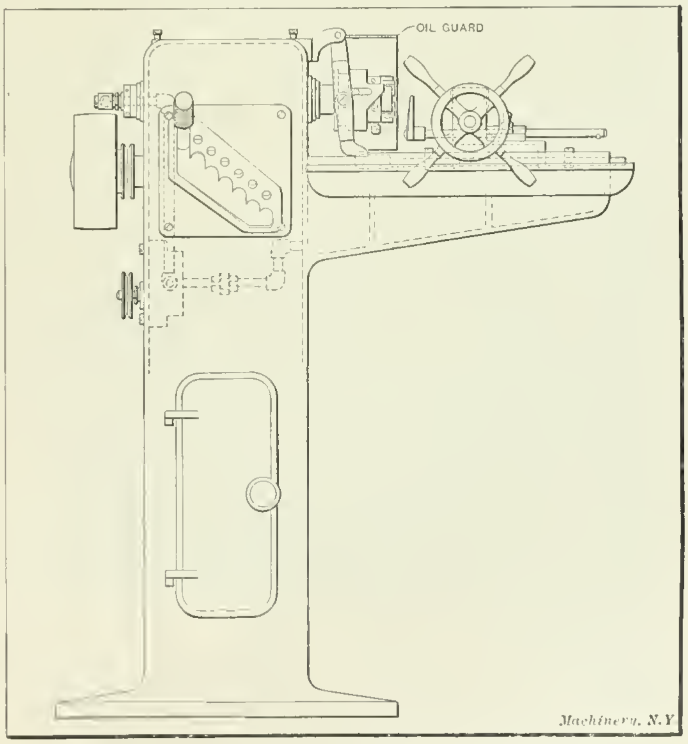
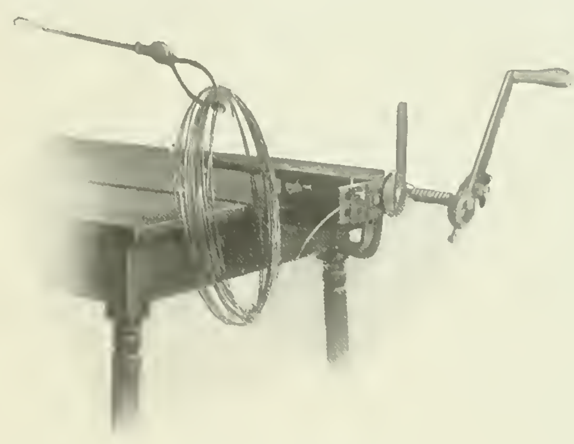


Fig. 2. Elevation of the Geometric Threading Machine

A liberal supply of oil is automatically forced to the dies by a small pump located within the column. This pump, as indicated in Fig. 2, is driven by a belt from the main shaft. Beneath the ways of the machine, which are surmounted by a wide channel for catching the lubricant, there is a partitioned reservoir where the chips are automatically separated. The pump takes its supply from the section to the left, into which only clear oil has entered, and forces it through the hollow spindle to the dies. This machine is, of course, adapted to the threading of long bars or rods, as well as bolts and studs. The work itself is held in a strong vise having V-jaws which accurately locate it with reference to the die.

MODEL SPRING WINDER

A spring winder of simple design is shown in the accompanying halftone, which is adapted to the winding of right- or left-hand helical springs of either the extension or compression type. This machine is so arranged that mandrels for springs of different sizes can easily be placed in position, and means are provided for varying the pitch of the coils.



Model Spring Winder

When a spring is to be wound, the wire is passed through a hole in the tension bolt and then through a slot to a clamp-bolt in the handle. The machine is then ready for operation. The tension is varied by adjusting a winged nut on the tension bolt, and the pitch of the coils is changed by shifting a spacing plate, the position of which is controlled by the handle seen in a vertical position in the illustration. The winder is fastened to a bench or table by means of a thumb-nut and the adjustments are easily and quickly made.

This machine has a capacity for springs varying in size from 1/16 inch to 1½ inch inside diameter, and for lengths ranging from ½ inch to 12 feet. This winder is made of malleable iron with the exception of the working parts which are of machine steel, casehardened. It is intended for use in connection with manufacturing work, repair shops, garages, or, in fact, wherever springs are used.

NEW MACHINERY AND TOOLS NOTES

Center Calipers: William H. Harris, Laurium, Mich. Calipers, the legs of which are linked to a central bar containing a scriber that automatically maintains a central position. This scriber has an in-and-out adjustment against the tension of a spring, and it may be used for locating the center of any part within the capacity of the caliper.

Pipe Wrench: Wright Wrench & Forging Co., Canton, O. Quick-acting pipe wrench which can be adjusted instantly to any size pipe with one hand. This wrench has a capacity for pipes ranging from ⅛ inch to 1½ inch in diameter. The mechanism is simple and the grip on the movable jaw interchangeable, so that it can be easily replaced when worn.

Wrench: Detroit Model Machine Works, Fremont, Ohio. Quick-acting wrench having an adjusting nut, the diameter of which is greater than the width of the bar (which is threaded only on the lower side), so that it can be quickly disengaged when making an adjustment. This disengagement is effected by pressing the sliding jaw and nut downward against the tension of a spring.

Machinists' Hammers: Van Doren Mfg. Co., Chicago Heights, Ill. New line of drop-forged ball-peen hammers. These hammers are forged from high-grade tool steel and are carefully hardened. Particular attention has been given to the weight which is within ¼ ounce of the nominal weight. The handles are of second-growth hickory of good quality, and the hammers are well-balanced.

Extensometer: Riehle Brothers Testing Machine Co., Philadelphia, Pa. Extensometer for tension tests in which the test piece is clamped between four pointed thumb-screws, contained in two yokes that are held apart by a connecting-bar or rod. The upper yoke is hinged to this bar, and by means of a lever construction, the deformation of the piece is doubled in the reading of the micrometer, as the latter indicates twice the extension of the test piece.

Geared Head Lathe: Hamilton Machine Tool Co., Hamilton, O. Lathe with single constant-speed driving pulley and all-geared head. The spindle of this machine can be stopped instantly from any point along the bed by operating a shifter-rod which connects with a friction clutch in the head. There are twelve changes of spindle speeds in all, six being obtained by the operation of a lever at the front of the head, which number is doubled by the back-gears. The sliding gears are of steel and run in an oil bath.

Tilting Shaper Table: Mark Flather Planer Co., Nashua, N. H. Combination tilting and swiveling shaper table which permits angular adjustment of the work to be made about axes parallel to or at right angles with the face of the column. The tilting table rests on the regular table which has lugs that form the bearings. The adjustments are effected by conveniently located screws which have thrust blocks to prevent end play. The limit of angular movement is 5 degrees below the horizontal and 8 degrees above it.

Pyrometer: Price Electric Co., Lakeview, Cleveland, O. Recording pyrometer the recorder of which is equipped with a roll of graduated chart paper which, by suitable means, is moved beneath a needle. The recording line is made by an electric spark which jumps from the end of the pointer and perforates the chart at regular and frequent intervals. The couple or business end of the pyrometer generates an electric current, the intensity of which is proportional to the difference in temperature between the ends.

Sheet-Metal Squaring Shear: Niagara Machine & Tool Works, Buffalo, N. Y. Power sheet-metal squaring shear equipped with an automatic feed which locates the stock in the proper position for cutting strips in any desired width up to 12 inches. The gripping mechanism is mounted on a slide the stroke of which can be readily adjusted for strips of different widths. This machine is back-geared with a ratio of 4 to 1, and the speed of the slide is 46, 60 and 80 strokes per minute, the slowest speed being used for the widest strip.

Graduating Machine: Modern Tool Co., Erie, Pa. Universal graduating machine which automatically stops when the work is completed. This graduating machine is made in two sizes, designated as Nos. 1 and 2. The smaller size is intended for light work, such as curved scales, surveying instruments, etc., while the No. 2 machine is adapted to the graduating of heavy milling-machine saddles, the faces or edges of disks and similar work. Means are provided for accurately adjusting all parts, and any width of spacing or length of line can be obtained.

Tumbling Barrel: Globe Machine & Stamping Co., Cleveland, O. Horizontal tumbling barrel for burnishing articles prior to plating and for polishing either plated or unplated parts. The burnishing is effected by the use of steel balls. The barrel is of cast iron lined with maple wood and has an octagonal cross section. These machines are made with three sizes of barrels, the smallest of which is 24 inches in diameter by 8 inches wide, and the largest 30 inches in diameter with a width of 16 inches. They are also furnished in either the single-, double-, or triple-barrel types.

Chain Hoist: Chisholm & Moore Mfg. Co., Cleveland O. Forty-ton chain hoist, the design of which is similar to that of smaller sizes made by this company. It has a multiple disk brake which effectually locks the load and at the same time permits free lowering by a reverse movement of the hand-wheel. There are two independent load chains which move together; the idler sheaves are placed so as to permit doubling up the chains and carrying the load on eight strands of ¾-inch chain. These hoists are also made in three smaller sizes having capacities of 16, 20 and 30 tons, respectively.

Hack-saw Machine: Massachusetts Saw Works, Chicopee, Mass. Power hack-saw machine with capacity for cutting stock up to 6 inches in diameter. The machine stops automatically and requires no attention after the cut is started. It has an adjustable stop so that cuts can be made to any desired depth. There is a rest for the piece being severed which prevents the breaking of blades when the severed part falls. By means of a patent adjustable lifting device, the blade can be raised on the return stroke, which greatly prolongs the life of the saw. This machine has a steady, even, forward stroke and a quick return stroke.

Variable Speed Planer: Hamilton Machine Tool Co., Hamilton, Ohio. Variable speed driving mechanism for the planer, by means of which four cutting speeds are obtained. These speed variations are controlled by a single lever located just back of the driving pulleys. The planer has a constant quick return speed. All gears are of steel and are engaged by direct contact and not by clutches. The speed change mechanism is located in the bed where it is out of the way and thoroughly protected. The different speeds available and the proper location of the levers for each speed is indicated by an index plate attached to the machine.

Core Machine: Brown Specialty Machine Co., Chicago, Ill. Core-making machine of the same general type as formerly manufactured by this company, but with the addition of back-gears which give a ratio between the driving shaft and the bit of 3 to 1. These back-gears are employed when making cores larger than 3 inches, a direct drive being used for cores under this size. This machine has a capacity for diameters ranging from ⅜ inch to 7 inches, and for square cores with widths ranging from ⅜ inch to 5 inches. By the use of special dies, round cores as large as 11 inches in diameter can be made, and square ones with widths up to 7½ inches.

Wheel Lathe Dog: Putnam Machine Co., Fitchburg, Mass. Dog for locomotive driving-wheel lathes; this dog has serrated jaws which move along inclined planes and are wedged against the tires, thus giving a powerful drive. When the wheels are in place, the jaws which are held in a retracted position by latches are released so that they come in contact with the tires. Opposite each jaw there are clamps which give a rigid support to the wheel. When the lathe is started and the rotary motion of the wheels tends to be retarded by the resistance of the cut, the jaws move slightly along the inclined planes and the serrations are embedded into the tires, thus giving a strong grip.

Power Press: Niagara Machine & Tool Works, Buffalo, N. Y. Double back-geared power press equipped with an automatic friction clutch designed for handling heavy work. In the operation of this clutch no drop weight is used as it is thrown into engagement by a positive mechanism consisting of a series of links and levers which cause it to be fully engaged before the press begins to work. The clutch can be tripped either by a foot-treadle or by hand. When the foot treadle is used, motion ceases at the highest point of the stroke, whereas, by the use of the hand lever, the machine can be stopped or started at any point. The distance between the uprights of this machine is 28 inches, the ratio of gearing is 25 to 1.

Wrenches: Bemis & Call Hardware & Tool Co., Springfield, Mass. A new line of screw wrenches designated as "No. 60 Steel Handle" and "No. 62 Screw Wrench," built in sizes ranging from 6 to 21 inches. The bars of both styles are forged from special open-hearth steel, and the slides which are of a tough semi-steel, are of a strong design. The operating screws are of a high-grade steel. The handle of the No. 60 style is of semi-steel, hollow, and well braced internally. It is forced on the shank under considerable pressure and is securely riveted at the tip, being also held with a lateral pin rivet. On the No.

62 style, the handle consists of a frame, which has selected hardwood sides that are locked in place under pressure and securely riveted. The frame itself is also rigidly attached to the wrench bar.

Molding Machine: E. Killing's Molding Machine Works, Davenport, Iowa. Molding machine of the jarring power rockover type. When the machine is being operated, the pattern is mounted on a pattern board and the whole is fastened to the rockover table. After the flask is in place and filled with sand, the mold is jarred to the proper density by compressed air which is alternately applied and released automatically in the cylinder under the jarring table. Air is employed for this purpose and the pattern may be withdrawn at the speed which will give the best results. The jarring cylinder and the valve are simple in construction and the latter is of the expanding ring piston valve type. No springs are used on this machine and all working parts are protected against the abrasive action of the sand.

Vertical Milling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. A heavy design of vertical milling machine. The drive is by belt to a horizontal shaft at the top of the column which transmits movement to the spindle through a large worm-wheel fitted with roller thrust bearings. This worm-wheel has a bronze ring with teeth of steep lead and both the driving worm and worm-wheel are entirely encased, permitting continuous lubrication. All gears in the machine are of steel or bronze and all movements are clutched. The circular table is 60 inches in diameter and it has a large central bearing in the supporting saddle. The maximum distance from the end of the spindle to the table is 22 inches; length of the cross and longitudinal feeds 33 inches, and the distance from the center of the spindle to the upright, 34½ inches. The extreme height of the machine, with the spindle in its highest position, is 12 feet 6 inches.

Molding Machine: Osborn Mfg. Co., Cleveland, O. "No-shock-jolt" molding machine, which is mounted upon a heavy cast-iron bed-plate that acts as a shock absorber. To prevent any transmission of the shock from the bed-plate to the foundation, the former is mounted upon four steel springs that are similar to those used in freight car construction. There is also another set of lighter springs above the bed-plate which prevents any rebound and consequent loosening of the sand in the mold. Thus the weight of the mold, machine, and bed-plate, is held in suspension between two sets of springs which, in conjunction with the weight of the bed, absorb the blows required to pack the sand. One advantage of this construction is that a large foundation is unnecessary. In starting the machine, it is simply necessary to fill the flask and then set the machine in motion. The stroke can be varied while running, by regulating the compression, while the quantity of air admitted to the cylinder takes care of molds of varying weights.

* * *

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The thirty-second annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, beginning Tuesday evening, December 6, which will be the occasion of the annual presidential address and of a reception by the president and president-elect. The professional papers to be presented are unusual in variety and merit. A variation in the usual program has been introduced in the time of engineering excursions. These will be on Friday after all the professional papers have been presented. Members will be able to attend all of the sessions and still not miss one or more of the excursions in which they are interested. Following is the list of papers, subject to change and addition:

"The Transmission of Heat in Surface Condensation," by George A. Orrok.

"Combustion and Boiler Efficiency," by Edward A. Uehling.

"Automatic Control of Condensing Water," by B. Viola.

"Test of a 10,000-K.W. Steam Turbine," by S. L. Naphtaly.

"Test of a 9,000-K.W. Turbo-Generator Set," by F. H. Varney.

"Notes on the Value of Napier's Coefficient with Superheated Steam," by Isaac Harter, Jr.

"A New Theory of Belt Driving," by Selby Haar.

"Stresses in Connecting-Rods," by W. H. Herschel.

"Operating Conditions of Passenger Elevators," by Reginald Pelham Bolton.

"Modern Shoe Manufacture," by M. B. Kaven and J. B. Hadaway.

"The Field for Grinding," by C. H. Norton.

"Precision Grinding," by W. A. Viall.

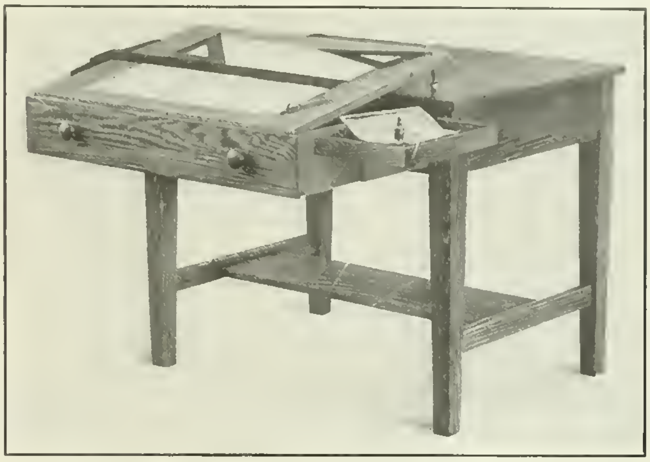
"Modern Grinding Methods," by B. M. W. Hanson.

"First Large Gas Engine Installation in American Steel Works," by E. P. Coleman.

"Industrial Continuation Schools of Munich," by Dr. George Kerschensteiner, superintendent of schools, Munich, Bavaria.

COMBINATION DRAFTING AND OFFICE TABLE

A combination table which may be converted from a library or office table into one suitable for drafting is shown in the accompanying half-tone. As the engraving indicates, this table is arranged for drafting purposes by simply pulling out the drawer and placing the rear part of a drawing-board, which is set in the top of the drawer, on the table. The drawing instruments and other paraphernalia can be kept in a small drawer or tray that is inserted in the side of the main drawer.



Office or Library Table with Drawing Board ready for Use

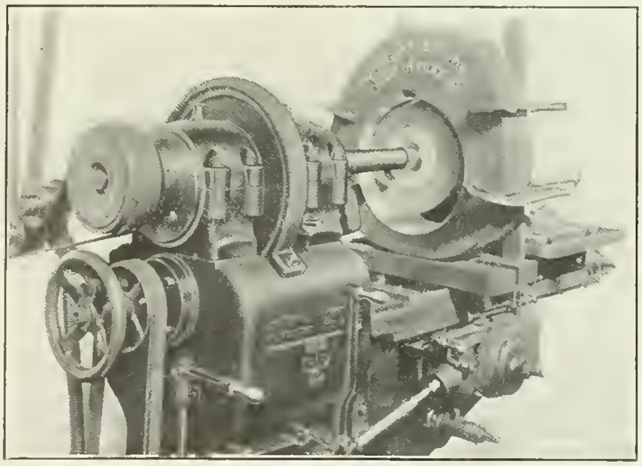
The space beneath the board can be utilized for drawing paper, books, etc. It will be noted that the drawing-board can be placed in the working position without disturbing whatever might be kept on top of the table.

This table is made of thoroughly kiln-dried oak and it has a golden oak polished finish. It is manufactured by the Fritz Mfg. Co., Grand Rapids, Mich.

* * *

GRINDING LARGE HOLES IN CAMS ON THE HEALD CYLINDER GRINDER

The accompanying illustration shows the cylinder grinder built by the Heald Machine Co., Worcester, Mass., grinding a 14½-inch hole in a cam weighing over 500 pounds. Although designed primarily for internally grinding automobile and



Heald Cylinder Grinder adapted to grinding 14 1-2-inch Hole in Cam weighing 517 pounds

other gas engine cylinders, it is an adaptable machine suited to varied classes of grinding. The illustration shows the special adaptability of the machine to pieces for which machines of the revolving work type are not well suited. This machine is of the sun-and-planet or universal type, the spindle being mounted in an eccentric bushing in a revolving head, with means for changing the amount of the eccentricity and thus controlling the size of the hole ground (see MACHINERY, August, 1905, for illustrated description). The job called for grinding out the shaft bore of two cams for a large shaft of a drawing press of massive proportions. When the press was being assembled at its destination it was found that the holes in the cams were too small to allow them to go on to the shaft

in the proper place, and about 0.025 or 0.03 inch had to be removed before they could be assembled.

The cams were mounted on parallels on the table of the grinder and brought into position against an angle-plate with the hole parallel with the grinding spindle and the travel of the table. Owing to the large diameter of the hole, it was necessary to secure a specially large grinding wheel for the job, which, in turn, necessitated a relatively large driving pulley mounted on the left-hand end of the wheel spindle, to produce the correct circumferential work speed. This feature alone, perhaps, illustrates the extreme capacity of the machine, inasmuch as the pulley commonly used is still in place, the wooden pulley having been mounted outside, as will be seen by noting the dark ring showing the edge of the pulley rim. This pulley is the one on which the belt ordinarily runs when grinding automobile and gas-engine cylinders, and is in proper proportion to the diameter of the grinding wheels used in that particular work.

* * *

APPRENTICESHIP THE BASIS OF TRADE TRAINING

That apprenticeship is a vital part of industrial training was the substantially unanimous opinion of the speakers on the topic "Apprenticeship and Corporation Schools," at the fourth annual convention of the National Society for the Promotion of Industrial Education held in Boston, Nov. 17 to 19. The subject named was considered in a series of papers presented Friday morning, Nov. 18, and the papers and discussions of the afternoon session of that day, although not confined to that specific topic, tended to emphasize still more strongly the fundamental necessity of providing for some form of apprenticeship in connection with all schools undertaking to train young boys in mechanical trades.

In opening the sessions of the day, Magnus W. Alexander, of the General Electric Co., Lynn, Mass., who presided at the morning session, sketched the transition from the medieval apprenticeship system to the new apprenticeship idea that arose when the use of power machinery had seemed for a time to destroy both the need and possibility of apprenticeship. That training under some form of apprenticeship system which would be adapted to the manufacturing conditions of the present was indispensable, had been recognized, Mr. Alexander said, by the majority of manufacturers. The present problem, therefore, was not whether there should be an apprenticeship system, but what kind of an apprenticeship system there should be.

Several different ways of working out this problem were described in formal papers which showed considerable variety in the manner of attacking the problem, but were alike in the one point of being based upon apprenticeship.

Tracy Lyon, of the Westinghouse Electric & Mfg. Co., Pittsburg, described the system employed by them, by which the trades' apprentices in the shops are instructed in the classroom four hours a week during the entire year, and are there taught mechanical drawing and arithmetic in the shape of shop problems. The main object is to awaken the boys' intelligence and to set them to thinking in an accurate way about the work they are doing in the shop; the final object being to make good, all-around mechanics of them. The present plan of teaching is to ground the boys thoroughly in the construction and use of a standard machine tool, a lathe, for instance, then send them into the shop to gain a certain amount of experience in the operation of this tool, and after this is acquired to bring them back and repeat the process with another tool. During their entire apprenticeship the boys are under the supervision of the foreman of the apprenticeship department, who keeps a record of the work and the progress of each one. A night school with very elaborate technical equipment has been provided for the adult workmen of the shops and this night school is also open to the boys so far as they are qualified and wish to broaden and advance their studies.

The notably successful apprenticeship system of the Atchison, Topeka & Santa Fe Railway System, Topeka, Kans., was described by F. W. Thomas, supervisor of apprentices for the Atchison Co. In these schools of the Atchison system, apprentices in the shops are taught as individuals according to their individual needs and capacities so as to make them better understand the work they are called on to do in the shops; the lessons are simple and each lesson refers to some part of a locomotive, car, shop tool or other feature common to railroad work. The function of the school-room and of the apprenticeship instructor is not only to teach the boy things, but to teach him to use his brains along with his hands and eyes, to reason out and to understand the work in the shop as he progresses. Although the Santa Fe is spending between thirty-five and forty thousand dollars a year in training boys for its future needs, Mr. Thomas declared that as a result of the instruction given to them the boys are accomplishing enough more work to more than pay for the cost of the teaching.

The methods of the Mechanics School of the Solvay Process Co., Syracuse, N. Y., were presented by George G. Cotton. The work of the mechanics of this company is repair work on the company's plant, and it requires the services of mechanics who have been trained in the special chemical work of the company. Employes obtained from the usual sources are lacking in the necessary special knowledge and must undergo a course of preliminary training in the company's shops before they can be used on regular work. The method of the school is substantially the original "Cincinnati Plan" of one week in the shop, one week in the school. The boys alternate week and week between the shop and school, the shop squad following the regular shop schedule of hours and the school squad attending from 8 a. m. to 3 p. m., with a noon recess. The boys are paid for their time both in the shop and in the school. All shop work is carried on in the shop, under shop conditions and management and always on the regular work, which work requires speed, accuracy and results. The character and ability of each boy is taken into account, and he is considered to have completed his course when he shows that he is properly prepared for the work for which he is being trained; he is then graduated into the regular shop employ. The boy's advancement in pay depends entirely upon his industry and ability.

Another type of trade school was described by Samuel F. Hubbard, superintendent of the North End Union School of Printing in Boston. This school depends finally upon a group of employing printers who are associated with the management and direction of the school and who provide the boys with the opportunity for further training and with wages by taking them into their shops as apprentices after the period of preliminary training in the printing school. Mr. Hubbard stated very forcibly the value of necessity of apprenticeship as a means of providing the partly taught boy with regular wage-producing work and thus saving him from the only too probable disasters that follow the hunting of a job by untrained or half-trained youngsters.

In summing up the morning's discussion, G. M. Basford, assistant to the president, American Locomotive Co., New York City, pointed out the fact that in all the schemes described, there was either an actual apprenticeship or some relation between the company and the boy that was pretty nearly the same as apprenticeship. Mr. Basford asserted that an apprenticeship is apparently the only way of securing for boys in trade schools the shop atmosphere and the familiarity with shop conditions which is necessary to make them efficient mechanics.

At the afternoon session of November 18 a very striking report was the paper of Frank B. Dyer, superintendent of schools, Cincinnati, on the Cincinnati Public Continuation School for apprenticeship in mechanical trades. Machine apprentices spend four hours a week in this school and the results in improved efficiency of these apprentices in the shops has been a very remarkable product of a system which has cost the city only $3000. The plan of the continuation school has proved as stimulating to the older workmen in the machine shops, and the industrial night schools have as a result proved attractive to these older men.

EDUCATION AND THE DEVELOPMENT OF THE APPRENTICE*

The various methods for securing an ample supply of skilled labor were discussed in this paper and the main point urged was that the employers and the school boards come together and organize industrial and trade preparatory schools as a part of the public school system.

Prof. Flather believed that general instruction on manual training would not need these requirements, from the limitation of its work; for with but few exceptions, the time devoted to any one subject does not exceed 250 hours and when it is considered that from 8,000 to 11,000 hours are spent in learning a trade, it can be readily seen that the manual training of our schools can have but little weight. The one marked advantage that it has, however, is the opportunity of affording teachers and parents as well as the boy, knowledge as to whether or not an industrial career should be followed.

Prof. Flather further pointed out that it is due to the democratic ideas held by our school boards that there has been so little differentiating in the courses. This should not be, for the same conditions exist in the status of our school children as in the commercial and business world, where it is recognized that all men are not equal.

It was urged that manual training be taught in the elementary schools up to the end of the sixth grade, when separate courses should be established, one, as at present, for professional and commercial training, as well as the higher technical training leading through the high school, and the other having in view the industrial training of the pupil. During the seventh and eighth grades of this industrial training, practical work should predominate, though the training should be general and not specific. During this period the school day might be increased to seven hours, to compensate for the decreased amount of study preparation. Of this amount, at least four hours should be devoted to practical work under skilled workmen.

Following this should be two years of specialized trade-preparatory work in which the time spent is devoted to one definite trade, to the end that by judicious and intelligent training the boy may enter some industry where he will be given an opportunity, at fair wages under an apprentice instructor, to finish the trade begun in the preparatory school.

Here, the time could be increased to eight hours a day with four hours on Saturday, throughout eleven months of the year. An advisory committee of representative men, selected from the leading industries of the locality, could cooperate as an advisory committee in this course. It could not be expected that all the boys would become skilled tradesmen, but the training could well be adapted to prepare all boys who so desired to enter industrial pursuits, and, by a process of elimination, those best qualified could be trained for the trades, while others of less promise could be trained for some special work. At any rate, the amount of time required to finish a trade might thus be materially reduced.

It was further pointed out by Prof. Flather that no universal system of trade education is applicable, but local conditions will suggest and demand modifications. It should also be borne in mind, in working out such a course of study, that some of the boys will reach a period in their life when they will want to keep on with their studies and enter a technical college. For these, provisions should be made, by modification of the high-school course with this in view. It is believed that this system will further the interests of both employers and employes, making for better citizenship and a more rapid development of our American industries.

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The pneumatic tool-holder for locomotive tire turning described in the October number on page 133, engineering and railway editions, by "Canadian Pacific Railway Apprentice," has been patented by W. Petersen, shop engineer of the Canadian Pacific Railway, Patent No. 971556.

* Abstract of paper by J. J. Flather, read before the National Foundrymen's Association, Chicago, Ill., November 17, 1910.

AMERICAN MUSEUM OF SAFETY OPENING

A permanent exhibit of safety appliances of the American Museum of Safety at the United Engineering Societies' Building, 29 West 39th St., New York, was opened November 21 with appropriate exercises in the auditorium. The gold medal offered by S. C. Dunham, president of the Travelers' Insurance Co. was presented to the United States Steel Corporation as being the concern that has done most for the protection of its workmen by the adoption of safety devices, etc. The medal was accepted by W. B. Dickson, first vice-president of the corporation.

The *Scientific American* gold medal for the best safety device exhibited at the museum was awarded to the Safety Scaffolding Co., of New York for its suspended platforms. Dr. W. H. Tolman, director of the museum showed his collection of lantern slides illustrating safety appliances in use abroad and in America.

The permanent exhibition of the museum is on the sixth floor of the Engineering Societies' Building where a good-sized room is filled with devices for promoting safety of life and limb. The museum is badly in need of funds for carrying on its humanitarian work, and a plea was made at the meeting for $25,000 to meet the need for expansion.

* * *

The running time between New York and Philadelphia on the New Jersey Central Railroad has been considerably shortened, it having been cut down to 1 hour and 50 minutes on all through trains between the two cities in both directions. As the trip between New York and Philadelphia includes a ferry transfer between Jersey City and New York with consequent delay, the actual running time for the 90 miles between Jersey City and Philadelphia will be only 96 minutes, including on some of the trains as much as twelve minutes for delays and stops. On some stretches, therefore, a speed of 90 miles per hour will be maintained, and the average speed, stops and slow-downs excluded, will be over 64 miles per hour. The service from Jersey City to Philadelphia will be the fastest hourly train service in the world.

* * *

Don't try to file a hardened mandrel.

Don't caliper a piece of work when it is running.

Don't make double lines when laying out die work.

Don't use a micrometer on work that has scale on it.

Don't make tight and loose pulleys the same diameter.

Don't use a three-foot pipe on a 12-inch monkey-wrench.

Don't resort to a triangular file to doctor up a poor thread.

Don't think your tool kit is complete without an oilstone.

Don't grind a right-hand tool to make it do a left-hand tool's work.

Don't use a soft oilstone to put an edge on a sharp-pointed tool.

Don't make punches a loose fit for blanking or piercing thin metal.

Don't take a heavy chip for a finishing cut when turning threads.

Don't think that all machinists are "mechanics," for they are not.

Don't forget that you can file an emery wheel with a common file.

Don't hit a hardened die or any hardened work with a steel hammer.

Don't use fatty oil on an ice machine, where ammonia will get at it.

Don't use lard oil when cutting cast-iron threads; kerosene is better.

Don't think that weight necessarily means value in a machine tool.

Don't use a hardened steel hammer to drive arbors out of or into work.

Don't try to force a screw into a hole when it is not properly fitted.

Don't make punches a tight fit for blanking or piercing thick metal.

Don't use a tool with too broad a nose for finishing small steel parts.

PERSONALS

Robert R. Keith, for five years mechanical engineer and general superintendent of the Sight Feed Oil Pump Co. of Milwaukee, Wis. and The Richardson-Phoenix Co., its successor, has resigned and is now on a Western vacation trip, taking a short rest before resuming his activities.

Robert Wilde, foreman of the gear cutting department of the Cadillac Motor Car Co., Detroit, Mich., by which concern he was employed for eight years, has resigned his position to become superintendent of E. J. Kruce & Co., Detroit, manufacturers of transmission gears and auto parts.

J. M. McDowell, formerly president and manager of the Russell Drill Chuck Co., is now associated with the Morrow Mfg. Co., Elmira, N. Y. in the capacity of general sales manager of the drill chuck department. Mr. McDowell's long experience in the manufacture of drill chucks qualifies him as an expert in that line.

Fred H. Moody, formerly associate editor of *Canadian Machinery*, Toronto, Ont., has joined the staff of MACHINERY. Mr. Moody is a graduate of the mechanical engineering course of the University of Toronto, and has had the practical shop and drafting-room experience that well qualifies him for editorial work on this journal.

Walter Brinton, superintendent of the manganese steel department of the Taylor Iron & Steel Co.'s plant at High Bridge, N. J., since 1895, has resigned and has taken a position as consulting engineer for the Edgar Allen American Manganese Steel Co., manufacturers of manganese steel at Chicago Heights, Ill., and at New Castle, Del. Mr. Brinton's headquarters will be at the New Castle plant.

Fay L. Faurote, advertising manager of the E. R. Thomas Motor Co., Buffalo, N. Y. has resigned to become associated with a large corporation in Chicago. Mr. Faurote is a graduate of the University of Michigan, class '03 with degree of M.E. and has specialized in gas engine work. He has been actively engaged in publicity work, and is the author of three books on automobiles and gas engines.

John I. Rogers has opened a New York office in the City Investing Building, 165 Broadway, which will henceforth be used as his main office. Mr. Rogers makes a specialty of forging by the steam hammer, the drop hammer and the hydraulic press; special rolling such as railway tires and rolled wheels; the use and manufacture of alloy steels; machine shops and power plants; and general iron and steel works engineering. He resigned from the Midvale Steel Co. of Philadelphia about one year ago to take up professional practice, and since has been engaged in consultation work and design along the above lines.

* * *

OBITUARIES

Philip Corbin, president of the American Hardware Corporation and founder of P. & F. Corbin, died at his home in New Britain, Conn., November 3, aged eighty-six years.

Prof. Stillman W. Robinson died at his home in Columbus, Ohio, October 31, aged seventy-two years. He was the author of technical books, including "Principles of Mechanism."

Rawson Hathaway died October 23, aged eighty-two years. Mr. Hathaway worked for thirty-three continuous years, and after a short break, for seven more years at the United States Armory, Springfield, Mass.

Edmund S. Shepardson, formerly superintendent at the L. S. Starrett Co.'s factory in Athol, Mass., died October 29 at his home in that place after a year's illness, aged sixty-two years. Mr. Shepardson had been in the employ of the company for twenty-eight years.

Willard Steven Whitmore, inventor of the papier-mache matrix process of stereotyping used by nearly every newspaper in the country, died in October at his home in Washington, aged sixty-eight years. Mr. Whitmore held a position as stereotyper in the government printing office. It is said that he never received any material benefit from his very valuable process.

Octave Chanute, a distinguished engineer whose early investigations of mechanical flight and writings on the theory of air-supported planes perhaps justly entitled him to the appelation "father of the aeroplane," died at his home in Chicago November 23, aged seventy-eight years. Mr. Chanute was born in Paris, France, and came with his parents to America when only six years old. He achieved eminence as a railroad engineer and at one time was chief engineer of the Erie R. R. He was builder of the Kansas Pacific Railway, the Union Stock Yards of Chicago and the Missouri River Bridge. His writings on mechanical flight were not recognized as authoritative or of importance until Orville and Wilbur Wright had made their first successful flights and had acknowledged that it was Chanute's book "Progress in Flying Machines," published in 1894, which had turned their attention toward aeroplane experiments. They gave him credit for working out the theory of design of aeroplanes and blazing the trail for a practicable machine. Chanute's prestige as an aerial authority is even greater in Europe than in this country.

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COMING EVENTS

December 5-6.—Annual meeting of the American Society of Refrigerating Engineers, New York. W. H. Ross, secretary, 154 Nassau St., New York.

December 6-9.—Annual meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York. Calvin W. Rice, secretary.

December 12-15. Convention of the National Gas and Gasoline Engine Trades Association, Racine, Wis. Albert Stritmatter, secretary, Cincinnati, Ohio.

December 31-January 7. International Automobile Show, Grand Central Palace, New York.

January 7-21.—Association of Licensed Automobiles tenth annual exhibition of automobiles and automobile appliances. M. L. Downs, 7 East 42d St., New York.

NEW BOOKS AND PAMPHLETS

THE INVOLUTE GEAR SIMPLY EXPLAINED. 41 pages, 6 x 9 inches. 35 illustrations. Published by The Fellows Gear Shaper Co., Springfield, Vt., for free distribution.

This interesting pamphlet is a "direct, concise treatise, which makes plain the action of involute gearing, and yet avoids the use of higher mathematics." It is written by one who has made a study of gearing and gearing problems and is expressed in the simplest language, with diagrams to illustrate. Any mechanic or student interested in practical gear making and the theory of involute gear action will do well to get this pamphlet and study the principle of the involute and its application in the design of that interesting machine, the Fellows gear shaper.

THE VOLATILE MATTER OF COAL. By Horace C. Porter and F. K. Ovitz. 56 pages, 6 x 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 1.

This bulletin is issued by a new bureau in consequence of the various fuel investigations that were being carried on by the technologic branch of the United States Geological Survey being transferred by law on July 1, 1910, to a new federal bureau, the Bureau of Mines, which was authorized to continue the investigations, and make public reports of the results. The bulletin is a report on an investigation of the volatile matter in several typical coals—the composition and amount at different temperatures of volatilization. It is merely a preliminary report, stating the problems studied, the methods used, and the results thus far obtained, as the experimental work is still in progress.

EFFECT OF KEYWAYS ON THE STRENGTH OF SHAFTS. By Herbert F. Moore. 26 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This is Bulletin No. 42 of the University of Illinois Engineering Experiment Station, and gives the results of a series of tests recently carried out on the effect of keyways on the strength of shafts. This set of experiments was planned and conducted with the realization that, while the strength and proper proportion of keys have been the subject of considerable study and some experimentation, the effect of the keyway on the torsional strength of the shaft has apparently been studied but little, though it had been generally conceded that the keyway must weaken the shaft in which it is cut. The effect of combined bending and twisting was also the subject of experiments. For comparison of the shaft before and after keyseating, the ratios of the strengths are used as in riveted joints, and spoken of as "the efficiency."

MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1911. 423 pages, 4¼ x 6¼ inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6d. net.

The twenty-fourth annual edition of this handy book has just been issued. It contains the usual information, gotten up in convenient form, for ready reference, and has been enlarged by the addition of thirty-four pages. It is a much thicker book than the last issue, not being printed on as good a quality of paper, which materially detracts from its value as a reference. There are the usual chapters on steam and its properties, steam engines, indicators, steam turbines, boilers, gas and oil engines, producers, beams and girders, shafting, gearing, belting, cutting tools, ball-bearings, and numerous standard tables of weights, measures, etc., and serves as a very good guide for general purposes. Considering the small price it is a remarkable book, and few having need of the data contained can afford to be without it.

CONCRETE WALL FORMS. By A. A. Houghton. 62 pages, 5 x 7¼ inches. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, 50 cents.

This is number one of a series called "Concrete Workers' Reference Books," all written by the same author. Mr. Houghton prepared this work, realizing that with the increasing demand for monolithic walls instead of block construction, such a treatise was needed by the worker who constructs the forms or centering for this work. Simple but effective methods of bracing wooden forms, as well as many styles of easily made wall clamps, separators, and wire ties, are described, all calculated to save expense of construction. A hopper described herein makes the rapid placing of the concrete a simple matter. The placing of doors, window frames, etc., is also dealt with, and many other valuable ideas illustrated and described in the simplest possible language to be readily intelligible by all concrete workers.

CONCRETE FLOORS AND SIDEWALKS. By A. A. Houghton. 63 pages, 5 x 7¼ inches. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, 50 cents.

Number two of the series of "Concrete Workers' Reference Books," written by Mr. Houghton, has this title, and is a reference book, written in simple but forceful language to meet the requirements of those for whom it was especially intended. The writer has not only treated of the subject of molding concrete floors and sidewalks comprehensively, but has gone into the production of the more ornamental effects made possible by employing mosaic concrete floor tile. The rules of construction are taken up in regular order, as the work should progress, treating of the essential points on foundations and the plac-

ing of the forms, as well as materials, proper proportioning and mixing, placing and tamping, size of slabs, joints, and finishing the surface. Causes of defects are also outlined. More detailed work on floors and sidewalks is gone into, but the above gives the essential points of the book.

DESIGN OF MARINE MULTITUBULAR BOILERS. By James D. McKnight and Alfred W. Brown. 48 pages, 6½ x 10 inches. 17 plates. Published by the Technical Publishing Co., Ltd., 55 and 56 Chancery Lane, London, England.

There are many books on the design of steam boilers in general, but heretofore the field of the multitubular marine boiler has not been dealt with very fully by the various writers on the subject. As explained by the authors of the book, it is a treatise intended primarily for the use of such engineers and draftsmen who have had most of their experience in engine design and who are desirous of knowing more about the boiler side of their business. With this object in view the authors have attempted to lay down the principles of design in order that the customary long period of drafting-room training might be materially reduced. The reasons and laws governing the size of boilers, such as steam capacity and the merits of the different types, are not brought up, for as previously mentioned the book deals solely with the draftsmen's work, which consists of designing to the requirements of the various surveys. The seventeen plates are from actual working drawings and are illustrative of the practical nature of the work. Chapters are included on: Particulars of the Boiler, Position of Views, Furnace Centers, Tube Spacing, Detail of Furnace, Longitudinal Section of the Boilers, Firebox Side Stays and Bottom Joints, Detail of Firebox Top Staying, Staying in Steam Space, Staying of Firebox Backs, Details of Shell Riveting, Position of Breast and Bottom Water Space Stays, Detail of Portable Stay, Front and Back Tube Plate Staying, and other chapters of a minor nature. All the involved calculations are explained at some length, so as to be readily understood by anyone with a small mathematical foundation. Standard dimensions are tabulated in convenient forms for ready reference.

STANDARD PRACTICAL PLUMBING. By R. M. Starbuck. 406 pages, 6½ x 9½ inches. 347 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $3.

In this work Mr. Starbuck attempts to overcome what, to him, is the common failing of writers on such subjects; he means the over-technical manner in which the matter is usually broached. The mathematical treatment is very limited, it being the author's purpose to present the subject as simply as possible, and where any such calculations are involved, simple arithmetical methods are given. Minor details, too frequently omitted in such books from a failure on the part of the writer to grasp the reader's position, are gone into just fully enough to still remain interesting to all. The thirty chapters are on the following subjects: Plumbers' Tools, Wiping Solder, Joint Wiping, Bad Work, Traps, Syphonage of Traps, Venting, Continuous Venting, House Sewers and Connections, House Drains, Soil Piping, Main Trap and Fresh-air Inlet, Floor Drains, Yard Drains, Cellar Drains, Rain Leaders, Fixture Wastes, Water Closets, Local Ventilation, Modern Improved Plumbing Connections, Plumbing for Residences, Plumbing for Larger Buildings, Modern Methods and Devices in Country Plumbing, Filtration of Sewage and Water Supply, Hot- and Cold- Water Supply, Range Boilers and Theory of Circulation, Circulating Pipes, Problems on Range Boiler Work, Hot Water Supply for Office and Apartment Buildings, the Water Lift and its Applications, Multiple Connections for Hot Water Boilers and Radiators and Coils Heated by Range Boilers, Theory for the Plumber, and Drawing for the Plumber. The 347 illustrations tend to make the work very intelligible to all. One thing that strikes us in particular in the work is the large number of ways shown for connecting up hot water boilers, a subject that to the majority seems quite obscure, but which is here explained in an interesting manner, making that particular branch of plumbing very clear.

AMERICAN MACHINIST GEAR BOOK. By Charles H. Logue. 348 pages, 6¼ x 9¼ inches. 302 illustrations. Published by the *American Machinist*, New York. Price, $2.50.

The work is written essentially for the mechanic in the shop, to present to the latter practical data on cutting, molding, and designing of commercial types, and these subjects are presented in plain language by the use of simple rules, diagrams and tables, arranged for ready reference, in order that accurate information may be obtained quickly, when occasion arises, without a complete study of the subject having to be made to ascertain the desired information. Having this in view, we believe that Mr. Logue has carried out his object, and at the same time has presented deeper technical knowledge of the principles of gearing for those who desire to carry their studies further. In the introductory chapter the two principal types of gear teeth are explained, showing the development from the early days when they were first introduced. The underlying principles of gearing are shown and the manner of tooth generation illustrated. Proceeding, the interference of involute gears is discussed, and formulas and diagrams shown for the location of the point of interference. The advantages of a universal standard follows a brief outline of those at present existing, and succeeding this are buttressed teeth, stepped teeth, hunting teeth, and definition of pitches, the different ones being clearly differentiated. The second chapter deals with spur gear calculations, followed by a chapter on speeds and powers in which speed ratio, gear trains, power ratio, factor of safety and strength of teeth, as well as other similar matters, are discussed. Chapter four deals with gear proportions and details of design, where such matter as formulas, weight, key-seats, and other details of importance to the designing draftsman are discussed at some length. The theory, actual construction and manufacture of bevel and worm gears are investigated in the next two chapters, the subject being very fully dealt with. The chapter on worm gears contains a short dissertation on the Hindley worm. Following are chapters on the less important gearing subjects, such as helical and herringbone gears, spiral gears, skew bevel gears, intermittent gears, elliptical gears, epicyclic gear train, friction gears, odd gearing, pattern work and molding, with a final chapter on suggestions for ordering gears. The whole is treated in a comprehensive manner and is fully illustrated.

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer. 317 pages, 6½ x 9½ inches. Published by McGraw-Hill Book Co., New York. Price, $3.00, net.

In this intensely practical age, when everything that can be systematized is undergoing that process, there is plenty of room for another good book on the above subject. This book is as up-to-date as it is possible to be, and can be looked upon as an authority, for Prof. Diemer has had many years' experience, not only as professor of industrial engineering at the Pennsylvania State College, but also as a consulting industrial engineer. His name has always been linked with any improvement in industrial engineering education. In all, there are twenty-six chapters—devoted to the various branches of the subject. In the first chapter, entitled "Industrial Engineering," a brief review of the development of the last twenty years is given, emphasizing the hard road the mechanical engineer has trod in coming into his own, that is, in having industrial engineering recognized as a part of the work of the mechanical engineer. Chapters are included on the economic theory of factory location, the planning of factory buildings and the influence of design on their productive capacity, staff and departmental organization, executive control in the factory, departmental reports, the general office, the order department, bills of material, the drafting department, the pattern department, the purchasing department, stores and stock departments, the production department, foundry systems, the machine shop and tool department, shipping and receiving departments, time taking, cost department, aids in taking inventory, inspection methods in modern machine shops, employment of labor and labor problems, wage systems, fixing of piece-work rates, principles underlying good management, and a bibliography of works management. From a glance at the above list, it will be seen that the subject is treated in a comprehensive manner. In addition to the text matter, the book is made more intelligible and practical by the addition of 150 illustrations of card forms, etc., the majority of which are taken from actual practice. An interesting feature of the book is the last chapter, in which some twenty-seven books on the subject are briefly reviewed, the salient features of each being pointed out, so that the interested student of industrial engineering may continue his researches as deeply as desired.

CATALOGUES AND CIRCULARS

E. G. SMITH, Columbia, Pa. Catalogue of Columbia calipers and "Which Way" pocket levels.

AJAX MFG. CO., Cleveland, O. Reference book and catalogue of Ajax hot metal working machines.

NUTTER & BARNES CO., Boston, Mass. Circular illustrating and describing 8-inch, 1910 model metal saw cutting-off machine.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4777, an attractive and profusely illustrated booklet on building lighting.

HENRY L. LEA, consulting gas engineer, Peoples' Gas Building, Chicago, Ill. Illustrated blotter showing one of Mr. Lea's installations.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet on the protection of steel cars by the use of Dixon's silica graphite steel car paint.

WELLS BROTHERS CO., Greenfield, Mass. Catalogue No. 28 on bolt cutters, nut tappers, pipe threaders, and general information on threading.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlet descriptive of the thermit process of rail welding, the process being well illustrated.

GOLDEN-ANDERSON VALVE SPECIALTY CO., Pittsburg, Pa. Catalogue No. 14, on valves of all kinds for water and steam, and for steam and water specialties.

CRANE CO., Chicago, Ill. Special steel catalogue No. 70 on Crane cast-steel valves and fittings for high pressures, steam and water, and superheated steam.

QUEEN & CO., INC., 1211-1217 Arch St., Philadelphia, Pa. Circular listing Acme Helio blue process papers which are supplied in four grades and several weights.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 67, descriptive of locomotives recently built for passenger service, with illustrations and general dimensions.

BELLEVUE FURNACE CO., Detroit, Mich. Catalogue describing and listing Bellevue furnaces for heat treating, casehardening, tempering, brazing and forging by gas or oil.

JOSEPH TRACY, 116 West 39th St., New York. Circular illustrating and describing fan dynamometers adapted to testing the power of automobile and other gas engines.

ALLIS-CHALMERS CO., Milwaukee, Wis. Bulletin No. 4025, describing Allis-Chalmers motor-driven air compressors for industrial purposes, illustrating their varied uses.

INSTITUTE OF OPERATING ENGINEERS, Engineering Societies Bldg., 29 West 39th St., New York. Prospectus containing the proposed constitution, by-laws and plan of organization of the Institute.

HENDEY MACHINE CO., Torrington, Conn. Catalogue on Hendey milling machines, plain and universal, column and knee pattern, constant-speed drive and belt cone types, and attachments for the same.

AUTOMATIC TRANSPORTATION CO., 2933 Main St., Buffalo, N. Y. Booklet describing the automatic system of transporting ore, mail, baggage, etc., on elevated tracks and also the underground, flexible, and independent systems.

WESTINGHOUSE, CHURCH, KERR & CO., engineers, 10 Bridge St., New York. Booklet relating to the work performed by this company on the New York passenger terminal and improvements of the Pennsylvania and Long Island Railroads.

CROCKER-WHEELER CO., Ampere, N. J., has issued a bulletin, No. 120, on Form L motors, which contains a large amount of useful information on direct current motor design, with illustrations showing various examples of motor-driven machinery.

C. U. SCOTT, Davenport, Ia. Illustrated catalogue on heat treating and hardening of steel, gas blast furnaces, tempering furnaces, high-speed steel furnaces, fuel gas plants, pressure blowers, cooling tanks, pyrometers, calorimeters, brazing furnaces and bench torches.

C. J. ROOT CO., Bristol, Conn. Catalogue of the "Bristol," "Elm City," and "Ro-co" counters. These counters are made to register revolutions or strokes, to count by the pair, dozen or gross, and in capacities ranging from one hundred to ten millions. Applications to printing press, measuring machine and loom are illustrated.

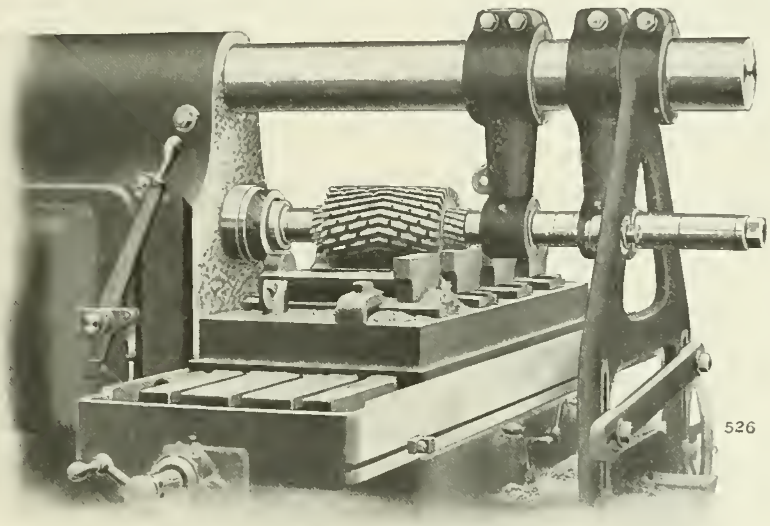
JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet entitled: "Graphite Products for the Railroad," 40 pages, illustrated. The object of the publication was to bring together in one pamphlet all the products in the Dixon line of interest to the mechanical departments of railroads. These include various graphite lubricants, protective paint, crucibles, etc.

AMERICAN SWISS FILE & TOOL CO., Elizabethport, N. J. E. P. Reichhelm & Co., distributors, 24 John St., New York. Price list of American Swiss files. It is a complete catalogue, illustrating and listing the line made by this firm. Files for all classes of work, from the heavy rasp down to the die-sinker's and silversmith's riffler, are illustrated in their varied forms.

NATIONAL-ACME MFG. CO., Cleveland, Ohio. Loose-leaf wall calendar, November, 1910, to October, 1911. The loose leaves are held in a suitable pocket or receiver and may be transposed from month to month, to display the current month. The upper part of the pages illustrates the Acme multiple-spindle screw machine and its tools and products. The calendar is an artistic creation that must be seen to be appreciated.

L. S. STARRETT CO., Athol, Mass. Catalogue No. 19 of fine mechanical tools. This well-known catalogue of machinists' tools continues to grow; No. 19 contains 274 pages, 42 more than in the last issue, No. 18, and over 350 illustrations. Among the new tools listed are shrink rules, metric keyseat rules, builders' combination tool, double square,

Do Your Milling the Cincinnati Way



This operation roughs out the inside of the Vise Bodies illustrated last week. Total width of cut 15″; greatest depth 3 16″; length 6″. The largest cutter is 6″ in diameter, 9⅜″ face, runs 32 revolutions, feeding 4¾″ per minute.

The pieces are held in a string jig—each one clamped independently. The milled pieces are removed as fast as traversed by the cutter and others chucked in their places.

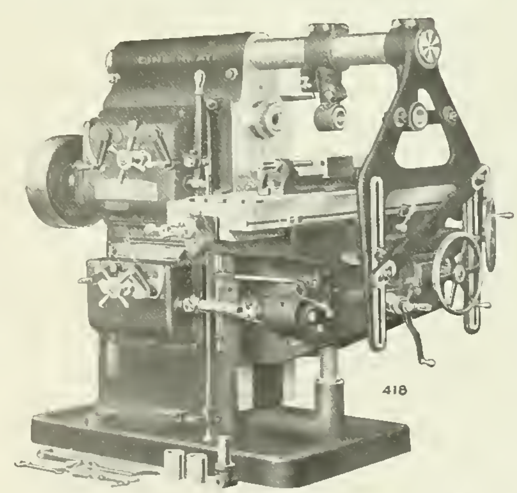
By this time the first one at the left has been milled and he repeats the above process by again chucking new pieces behind the cutter.

Both the operator and the machine are busy all the time. Neither waits for the other. The only time lost is returning and readjusting the table, and the TOTAL TIME PER PIECE IS ONLY 4¼ MINUTES.

At the end of the cut the knee is lowered, the table returned, readjusted and the new cut started.

The operator then removes the last piece at the right-hand end of the jig and chucks a new one.

Let us show you how to mill your work the Cincinnati Way.



The No. 4 Plain Cincinnati High Power Miller which does the work.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.
JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana.
ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

CONTENTS FOR DECEMBER

The first column of page numbers applies to the Engineering and Railway Edition; the Second to the Shop Edition.

vernier calipers, micrometers, protractors, metric micrometer depth gage, hack saws, frame tension pliers, ratchet wrench, etc.

Bristol Co., Waterbury, Conn. Bulletins No. 128 on Bristol's round form, Class II recording thermometers; No. 129 on Bristol's thermometer thermostats; No. 135 on the Wm. H. Bristol recording shunt ammeters; No. 141 on Bristol's round form recording pressure gages; No. 145 on Bristol's class II indicating thermometer; No. 146 on Bristol's long-distance recording tachometer, and No. 147 on the Bristol-Durand radii averaging instruments.

Crocker-Wheeler Co., Ampere, N. J., has recently placed a line of lighting transformers before the public under the trade name of "Remek." (In the Hungarian language "remek" means masterpiece.) These transformers are different in design from any other on the market. The core loss is low and average efficiency high, both advantages having been combined with other valuable features. The descriptive bulletin, No. 125, contains much valuable information to users of lighting transformers.

Dodge Mfg. Co., Mishawaka, Ind. Pamphlet describing severe test of a wood-rim pulley made by the company. The test was made on a Dodge iron-spider, wood-rim pulley, 46½ inches in diameter, 16-inch face, 4-inch bore, which was to run at the high speed of 9000 feet per minute, to meet the customer's requirements. The company decided to make a conclusive test, and rigged up for the purpose in a vacant room. The pulley was run up to 2400 revolutions per minute without perceptibly weakening it at any point. The result of the test was over three times that required by the customer, being 29,200 feet or a little over 5½ miles rim travel per minute.

Westinghouse Machine Co., East Pittsburg, Pa. Reprint from the New York *Tribune* of October 23, 1910, entitled: "George Westinghouse and His New Inventions," describing the pneumatic spring for automobiles which Mr. Westinghouse believes will supersede the pneumatic tire. The pneumatic spring is shockless and is expected to be more economical in use than the pneumatic tire. It automatically pumps up the required pressure for carrying the load. The reprint also describes the Melville-Macalpine gear for reducing the speed of marine turbines to the economical speed for screw propulsion, thus making the use of direct-connected steam turbines for marine propulsion practicable and economical for all conditions of service.

R. K. Le Blond Machine Tool Co., 4609 Eastern Ave., Cincinnati, Ohio. Catalogue of the Le Blond cutter and tool grinder, illustrating its construction and application to grinding many classes of work, comprising spiral milling cutter, double angle cutter, cut-off saw, hand reamer, taper roughing reamer, circular form tool, universal grinding attachment, inserted tooth milling cutter, side teeth of a side milling cutter, four-lipped drill, double taper stem reamer, angular cutter, etc. The list of illustrations mentioned is only a part of the views contained in this interesting and attractive catalogue, which should be in the hands of every tool-room foreman and machine shop employe responsible for the maintenance of tool-room equipment.

Crocker-Wheeler Co., Ampere, N. J., points out in its recently issued bulletin that large direct current machines hold an important place in our modern industrial development. They are applied as motors on nearly all large machinery for every class of work from the making of paper to the manufacture of steel. As generators they have often demonstrated their usefulness where more power has been needed in a hurry and also when cost has been an important consideration. In such cases spare engine capacity makes the belt type generator the cheapest and quickest method of supplying the need. The pamphlet illustrates the construction of the magnet frame, armature and commutator, the design and method of application of the field coils, the arrangement of the brush rigging, etc.

TRADE NOTES

Toledo-Massillon Bridge Co., Toledo, Ohio, has changed its name to Toledo Bridge & Crane Co.

Jones & Lamson Machine Co., Springfield, Vt., has not begun the construction of a new shop. The statement published in the November number was erroneous.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., manufacturer of drilling machinery, was awarded a gold medal for its display at the Brussels Exhibition.

Davis Expansion Boring Tool Co., formerly of 237 North 2nd St., St. Louis, Mo., has changed its name to Matthews-Davis Tool Co., and is now located at 219 North 2nd St., St. Louis.

United Engineering Co., Bridgeport, Conn., is a newly formed corporation. The company is prepared to design special machinery, press tools, jigs, fixtures, etc., and to develop inventions and modernize manufacturing methods.

E. Horton & Son Co., Windsor Locks, Conn., was awarded a medaille d'or (gold medal) for its exhibit at the Brussels Universal and International Exposition, 1910. This is the highest award ever given for chucks and is next to the "grand prix," the highest award possible for anything.

Foote-Burt Co., Cleveland, Ohio, manufacturer of multiple-spindle drilling machines, "Reliance" bolt cutters and nut tappers, has opened a sales office in Detroit to take care of the territory adjacent. The office will be located at 827 Ford Bldg., and will be in charge of Mr. H. C. Rose, manager.

Landau & Howe have succeeded to the engineering business of Landau & Golden. They will retain the offices at 1779 Broadway, New York, and will carry on a consulting and designing business with special attention to the automobile and kindred power applications and tests of materials and mechanisms.

Davis Expansion Boring Tool Co., St. Louis, Mo., was reorganized in September and the name changed to Matthews-Davis Tool Co.; address, 219 North 2nd St., St. Louis, Mo. The officers are W. N. Matthews, president and treasurer; Emery E. Davis, vice-president and general manager; and Claude L. Matthews, secretary.

Pawling & Harnischfeger Co., Milwaukee, Wis., manufacturer of traveling electric cranes, horizontal drills, boring machines, etc., has opened a branch office in the Washington Building, Portland, Oreg., in charge of Mr. R. K. Morse, who, for some years past has been a member of the company's engineering staff at the home office.

According to the *Business Monthly*, plans have been completed and contracts are soon to be awarded for new foundries and shops for the Westinghouse Electric & Mfg. Co. The plant, which will be located on 70 acres of ground recently purchased at Trafford City, near Pittsburg, Pa., will represent an investment of approximately $3,000,000, and will employ at least 3000 men when completed.

Republic Iron & Steel Co., Pittsburg, Pa., has just made a contract with the Westinghouse Electric & Mfg. Co. for seventy-nine crane and mill motors aggregating about 5000 H. P. to be used in the steel company's mill at Youngstown, Ohio. The contract also includes magnetic controllers for the larger motors and manually operated controllers for the smaller motors.

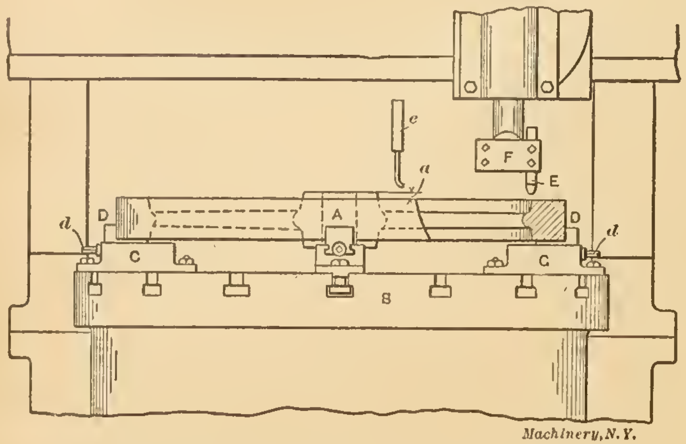
Bickford Machine Co., Greenfield, Mass., is the successor of Bickford & Washburn, Inc. At a meeting of the stockholders, November 5, Mr. H. L. Washburn, who recently disposed of his interest in the firm, resigned his position as secretary and director. The personnel of the officers is as follows: O. S. Bickford, president and treasurer; L. B. Weissbrod, secretary; O. S. Bickford, L. B. Weissbrod and A. L. Smith, directors.

Supplement to MACHINERY, January, 1911

Operations for the Article in this number entitled "Machine Shop Practice—A Vertical Boring-mill Operation"

SHOP OPERATION SHEET NO. 157

Oscar E. Perrigo — MACHINERY, January, 1911



Machining a Balance Wheel Casting on a Vertical Boring Mill.—To Set the Work and Face Rim and Hub

1. Place four independent chuck jaws C on the table B, at uniform distances from the edge, with their tongues in the T-slots, and secure them by the bolts at the ends.

2. With the screws d adjust the jaws D so as to admit the rim of the wheel casting A.

3. Place the casting A in the jaws D, and screw up the jaws lightly. Hold a piece of chalk against the inside of the rim, and rotate the table slowly. Move the casting by the jaw screws d, as indicated by the chalk marks, until it is set as nearly true as practicable. If the casting is slightly warped, place small steel wedges between it and the jaw faces, in order to equalize the distortion between top and bottom sides, which should be tested by a surface gage. Set up the jaws tightly.

NOTE.—When, as in this case, the inside of the rim is not to be machined, it is good practice to set the casting by the inside so that the wheel, when finished, will have a rim of uniform thickness. A handy tool for setting work of this kind consists of a wooden shank e into the end of which is inserted a bent wire as shown. The shank is clamped in the tool-head, and the wire, which is flexible, is brought against the work which is set by it.

4. Place a roughing tool E, in the tool clamp F. Set the tool and take a cut on the rim, deep enough to fully clean the casting and take off about half the surplus stock.

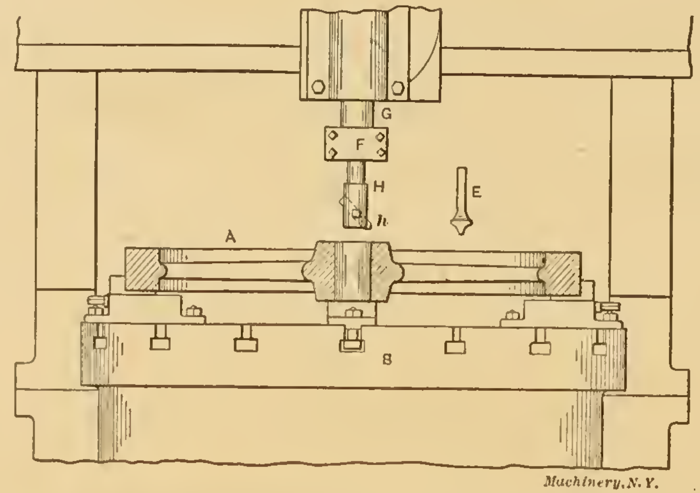
5. Start up the machine with a speed of about sixty feet per minute, and a feed of about 1/8 inch per revolution, and take a roughing cut. The feed will have to be regulated according to the power of the machine, the depth of the cut, and the nature of the material being turned.

6. Raise the tool a distance equal to the dimension a, and take a roughing cut over the hub.

7. Replace the roughing tool with a finishing tool having a cutting edge 1/2 to 3/4 inch wide, and take the finishing cut, using a coarse feed of at least 1/4 or 3/8 inch per revolution.

SHOP OPERATION SHEET NO. 158

Oscar E. Perrigo — MACHINERY, January, 1911



Machining a Balance Wheel Casting on a Vertical Boring Mill.—To Bore and Ream the Hole

NOTE.—The casting is supposed to be set in the chuck jaws as described in the previous Operation Sheet.

1. Bring the tool-head G over the center of the table B and insert in it the boring-bar H, carrying the rough-boring tool h.

2. Adjust the tool so that it will take a cut which will true up the inside of the cored hole, and take a roughing cut. Run the machine at about forty feet per minute, and with a moderate down feed.

3. Replace the rough boring tool with a sharp one for sizing, and with the same speed, but somewhat less feed, take a sizing cut to within 1/64 inch of the finish diameter.

4. Replace the boring-bar H with a shell reamer, preferably loosely attached, and with a slow speed, force it down by the hand feed until the lower end is an inch or so through the lower side of the hub.

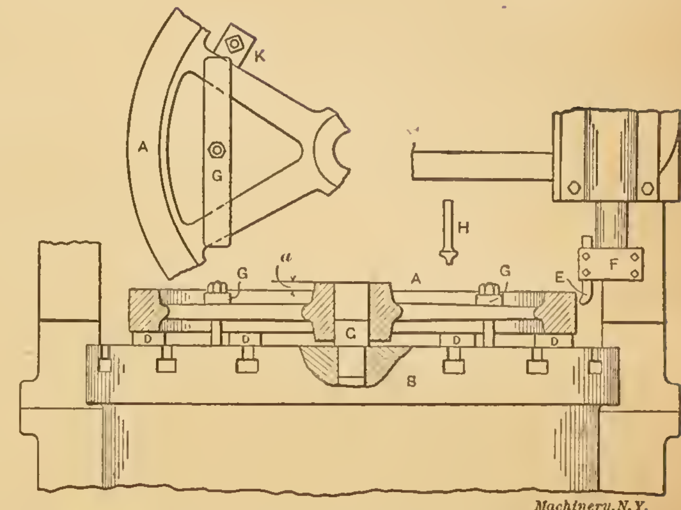
5. Remove the reamer and place, vertically, in the tool-clamp F, the formed tool E which is used for rounding the sharp corners of the rim and hub.

6. Bring this tool to a cutting position at the corner of the hub and, using the hand feed, carefully round the corner. Move the tool over to the inside of the rim and repeat the operation.

NOTE.—Some boring mills are provided with bars which not only fit into the tool-head F, but which have extensions passing through a bushed hole in the center of the table. This extension, of course, greatly steadies the bar. Double-ended cutters which pass through a slot in the bar are at times used instead of the type shown. These may be made in both roughing and finishing sizes. The reamer is, however, preferable when a number of wheels need to be bored to a standard size.

SHOP OPERATION SHEET NO. 159

Oscar E. Perrigo — MACHINERY, January, 1911



Machining a Balance Wheel Casting on a Vertical Boring Mill.—To Face the Rim and Hub and Turn the Outside

1. In the center hole of the table B, fit a plug C, whose upper end fits snugly the reamed hole in the casting A.

2. Place casting A on table B with hub raised clear of table by six parallel blocks D, plug C entering the bored hole in the hub.

3. Secure the casting to the table by two or three stiff bars G, tightened upon the arms of the wheel by bolts in the T-slots. Bolt a block K to the table and set it against one of the arms, to take the thrust of heavy outside cuts. If very heavy cuts are to be taken, it is well to have a second block K set against the arm on the opposite side of the wheel.

4. In tool-clamp F place a bent roughing tool E, and set it to fully clean the outside of the rim. Take the cut at a speed of about sixty feet per minute, and with as coarse a feed as possible.

5. If necessary, take a sizing cut to within 1/16 inch of the finish diameter.

6. Replace the roughing tool with a bent finishing tool having a straight cutting edge or face, and finish the casting to the required diameter, using a comparatively coarse feed.

7. Replace the finishing tool by a straight roughing tool, and take a roughing cut over the rim face, to within 1/32 inch of the finish width. Raise the tool an amount equal to dimension a, and take a roughing cut over the face of the hub.

8. Replace the roughing tool with a finishing tool, finish the rim to required dimension, and then the hub, raising the tool a distance a.

9. Replace the finishing tool by a formed tool H, set vertically, and with a hand feed, round the corner of the hub and the inner corner of the rim.

DATA FOR MILLING B. & S. SCREW MACHINE CAMS—I

USE OF TABLES IN MILLING CAMS

The formula below and the accompanying tables of leads obtainable on the Brown & Sharpe milling machines, and their logarithms, are used for determining the angular setting of the spiral head when milling constant-rise cams by the method here illustrated.

Let R be the rise of the cam in a given part, N, of the cam circumference. N is expressed as a decimal in hundredths of the circumference. Let L be the lead to be found for which the spiral head is to be geared, and a the angle to which to set the head and milling attachment.

$$\text{Then, } \sin a = \frac{R}{N \times L}$$

Hence, when R, N and L are known, angle a can be determined. As it is not practicable, however, to set either the head or the milling attachment closer than to whole or half degrees, the lead L must be so selected that angle a is within 5 minutes either way of a whole or half degree. Hence trial calculations must be made, and it is to facilitate these that the tables have been prepared.

Example: Rise of cam 0.155 inch in 0.24 of circumference. Find L and a.

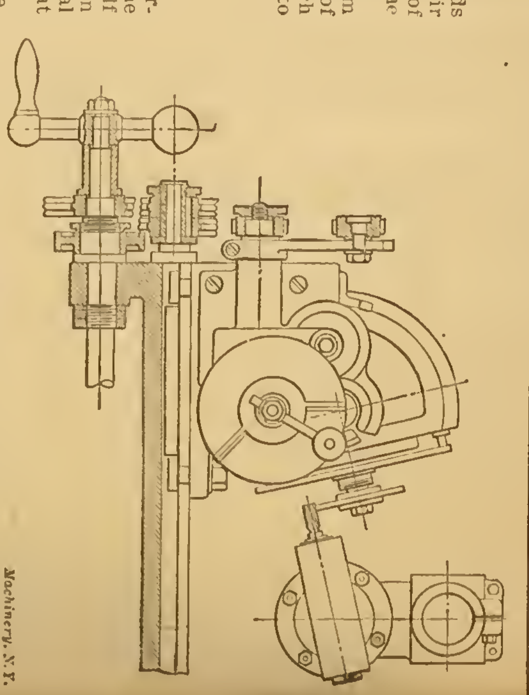
$$\sin a = \frac{0.155}{0.24 \times L} = \frac{0.6458}{L}$$

Find the logarithm for 0.6458. (See MACHINERY's Reference Series No. 53 for tables of logarithms.)

$$\text{Log } 0.6458 = \bar{1}.81010.$$

Now, beginning with a lead L *larger* than the numerator 0.6458, subtract the logarithms of the leads, as found in the accompanying tables, from the logarithm of the numerator 0.6458, until by repeated trials, a remainder is obtained which is the logarithm of the sine of an angle which is within 5 minutes of a whole or half degree. The angle thus found is the setting angle for the lead, and the lead giving this angle is the one for which the spiral head is to be geared.

Proceeding according to the directions above, we have



Index Head and Vertical Attachment Set for Milling Plate Cams

Machinery, N.Y.

$$\log 0.6458 = \bar{1}.81010$$
$$\text{(subtract) } \log 0.900 = \bar{1}.95424$$
$$\log \sin a = \bar{1}.85586$$

From a table of logarithms of sines (see MACHINERY's Reference Series No. 55), we find a = 45° 51'. As this angle is not within 5 minutes of a whole or half degree, try the next lead in Table II:

$$\log 0.6458 = \bar{1}.81010$$
$$\text{(subtract) } \log 0.930 = \bar{1}.96848$$
$$\log \sin a = \bar{1}.84162, \text{ and } a = 43° 59'.$$

This angle fills the requirements. Hence, set head and attachment to 44 degrees, and find the gears to use for 0.930 lead from Brown & Sharpe Mfg. Co.'s book "Table of Leads for Use with Universal Milling Machine."

Contributed by William W. Johnson

DATA FOR MILLING B. & S. SCREW MACHINE CAMS—II

Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm
0.900	$\bar{1}$.95424	1.776	0.24944	2.333	0.36791	2.894	0.46150	3.429	0.53517
0.930	$\bar{1}$.96848	1.778	0.24993	2.338	0.36884	2.909	0.46374	3.438	0.53631
0.933	$\bar{1}$.96988	1.786	0.25188	2.341	0.36996	2.917	0.46494	3.488	0.54258
1.029	0.01242	1.800	0.25527	2.368	0.37438	2.924	0.46598	3.491	0.54295
1.042	0.01787	1.809	0.25744	2.381	0.37676	2.933	0.46731	3.492	0.54307
1.047	0.01995	1.818	0.25959	2.386	0.37767	2.934	0.46746	3.500	0.54407
1.050	0.02119	1.823	0.26079	2.392	0.37876	2.946	0.46923	3.520	0.54654
1.067	0.02816	1.860	0.26951	2.400	0.38021	2.950	0.46982	3.535	0.54839
1.085	0.03543	1.861	0.26975	2.424	0.38453	2.977	0.47378	3.552	0.55047
1.116	0.04766	1.867	0.27114	2.431	0.38578	2.984	0.47480	3.556	0.55096
1.196	0.07773	1.875	0.27300	2.442	0.38775	3.000	0.47712	3.564	0.55194
1.200	0.07918	1.886	0.27554	2.445	0.38828	3.030	0.48144	3.565	0.55206
1.221	0.08672	1.905	0.27989	2.450	0.38917	3.044	0.48344	3.571	0.55279
1.228	0.08920	1.919	0.28307	2.456	0.39023	3.055	0.48501	3.572	0.55291
1.240	0.09342	1.920	0.28330	2.481	0.39463	3.056	0.48515	3.582	0.55413
1.244	0.09482	1.925	0.28443	2.489	0.39602	3.070	0.48714	3.588	0.55485
1.250	0.09691	1.944	0.28870	2.500	0.39794	3.080	0.48855	3.600	0.55630
1.302	0.11461	1.954	0.29092	2.514	0.40037	3.086	0.48940	3.618	0.55847
1.309	0.11694	1.956	0.29137	2.532	0.40346	3.101	0.49150	3.636	0.56062
1.333	0.12483	1.990	0.29885	2.537	0.40432	3.111	0.49290	3.637	0.56074
1.340	0.12710	1.993	0.29950	2.546	0.40586	3.117	0.49374	3.646	0.56182
1.371	0.13704	2.000	0.30103	2.558	0.40790	3.125	0.49485	3.655	0.56289
1.395	0.14457	2.009	0.30298	2.567	0.40943	3.126	0.49499	3.657	0.56312
1.400	0.14613	2.030	0.30750	2.571	0.41010	3.140	0.49693	3.663	0.56384
1.429	0.15503	2.035	0.30856	2.593	0.41380	3.143	0.49734	3.667	0.56431
1.433	0.15625	2.036	0.30878	2.605	0.41581	3.150	0.49831	3.673	0.56502
1.440	0.15836	2.045	0.31069	2.618	0.41797	3.175	0.50174	3.681	0.56632
1.447	0.16017	2.047	0.31112	2.619	0.41814	3.182	0.50270	3.686	0.56656
1.458	0.16376	2.057	0.31323	2.625	0.41913	3.189	0.50365	3.704	0.56867
1.467	0.16643	2.067	0.31534	2.640	0.42160	3.190	0.50379	3.721	0.57066
1.488	0.17260	2.083	0.31869	2.658	0.42455	3.198	0.50488	3.733	0.57206
1.500	0.17609	2.084	0.31890	2.667	0.42602	3.200	0.50515	3.750	0.57403
1.522	0.18241	2.093	0.32077	2.674	0.42716	3.214	0.50705	3.763	0.57553
1.527	0.18384	2.100	0.32222	2.678	0.42781	3.225	0.50853	3.771	0.57646
1.550	0.19033	2.121	0.32654	2.679	0.42797	3.241	0.51068	3.772	0.57657
1.556	0.19201	2.133	0.32899	2.700	0.43136	3.256	0.51268	3.799	0.57967
1.563	0.19396	2.143	0.33102	2.713	0.43345	3.267	0.51415	3.809	0.58081
1.595	0.20276	2.171	0.33666	2.727	0.43569	3.273	0.51495	3.810	0.58092
1.600	0.20412	2.178	0.33806	2.743	0.43823	3.275	0.51521	3.818	0.58184
1.607	0.20602	2.182	0.33885	2.750	0.43933	3.281	0.51601	3.819	0.58195
1.628	0.21165	2.188	0.34005	2.778	0.44373	3.300	0.51851	3.822	0.58229
1.637	0.21405	2.193	0.34104	2.791	0.44576	3.308	0.51957	3.837	0.58399
1.650	0.21748	2.200	0.34242	2.800	0.44716	3.333	0.52284	3.840	0.58433
1.667	0.22194	2.222	0.34674	2.812	0.44902	3.345	0.52440	3.850	0.58546
1.674	0.22376	2.233	0.34889	2.828	0.45148	3.349	0.52492	3.876	0.58838
1.680	0.22531	2.238	0.34986	2.843	0.45378	3.360	0.52634	3.889	0.58984
1.706	0.23198	2.240	0.35025	2.845	0.45408	3.383	0.52930	3.896	0.59062
1.711	0.23325	2.250	0.35218	2.849	0.45469	3.403	0.53186	3.907	0.59184
1.714	0.23401	2.274	0.35679	2.857	0.45591	3.409	0.53263	3.911	0.59229
1.744	0.24155	2.286	0.35908	2.865	0.45712	3.411	0.53288	3.920	0.59329
1.745	0.24180	2.292	0.36021	2.867	0.45743	3.422	0.53428	3.927	0.59406
1.750	0.24304	2.326	0.36661	2.880	0.45939	3.428	0.53504	3.929	0.59428

Contributed by William W. Johnson

DATA FOR MILLING B. & S. SCREW MACHINE CAMS—III

Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm
3.977	0.59956	4.572	0.66011	5.160	0.71265	5.848	0.76701	6.548	0.81611
3.979	0.59977	4.582	0.66106	5.168	0.71332	5.861	0.76797	6.563	0.81710
3.987	0.60065	4.583	0.66115	5.185	0.71475	5.867	0.76842	6.578	0.81809
4.000	0.60206	4.584	0.66124	5.186	0.71483	5.893	0.77034	6.600	0.81954
4.011	0.60325	4.651	0.66755	5.195	0.71559	5.912	0.77173	6.645	0.82249
4.019	0.60412	4.655	0.66792	5.209	0.71675	5.920	0.77232	6.667	0.82393
4.040	0.60638	4.667	0.66904	5.210	0.71684	5.926	0.77276	6.689	0.82536
4.059	0.60842	4.675	0.66978	5.226	0.71817	5.952	0.77466	6.697	0.82588
4.060	0.60853	4.687	0.67089	5.233	0.71875	5.954	0.77481	6.698	0.82595
4.070	0.60959	4.688	0.67099	5.236	0.71900	5.969	0.77590	6.719	0.82730
4.073	0.60991	4.691	0.67127	5.238	0.71917	5.972	0.77612	6.720	0.82737
4.074	0.61002	4.714	0.67339	5.250	0.72016	5.980	0.77670	6.735	0.82834
4.091	0.61183	4.736	0.67541	5.256	0.72066	6.000	0.77815	6.750	0.82930
4.093	0.61204	4.762	0.67779	5.280	0.72263	6.016	0.77931	6.757	0.82975
4.114	0.61426	4.773	0.67879	5.303	0.72452	6.020	0.77960	6.766	0.83033
4.125	0.61542	4.778	0.67925	5.316	0.72558	6.061	0.78254	6.784	0.83149
4.135	0.61648	4.784	0.67979	5.328	0.72656	6.077	0.78369	6.806	0.83289
4.144	0.61742	4.785	0.67988	5.333	0.72697	6.089	0.78455	6.818	0.83366
4.167	0.61982	4.800	0.68124	5.347	0.72811	6.109	0.78597	6.822	0.83391
4.186	0.62180	4.813	0.68242	5.348	0.72819	6.112	0.78618	6.825	0.83410
4.200	0.62325	4.821	0.68314	5.357	0.72892	6.122	0.78689	6.857	0.83613
4.242	0.62757	4.849	0.68565	5.358	0.72900	6.125	0.78711	6.875	0.83727
4.253	0.62870	4.861	0.68673	5.375	0.73038	6.137	0.78796	6.880	0.83759
4.264	0.62982	4.884	0.68878	5.400	0.73239	6.140	0.78817	6.944	0.84161
4.267	0.63012	4.889	0.68922	5.413	0.73344	6.143	0.78838	6.945	0.84167
4.278	0.63124	4.898	0.69002	5.426	0.73148	6.160	0.78958	6.968	0.84311
4.286	0.63205	4.900	0.69020	5.427	0.73456	6.171	0.79036	6.977	0.84367
4.300	0.63347	4.911	0.69117	5.444	0.73592	6.172	0.79043	6.982	0.84398
4.320	0.63548	4.914	0.69144	5.455	0.73679	6.202	0.79253	6.984	0.84410
4.341	0.63759	4.950	0.69461	5.469	0.73791	6.222	0.79393	7.000	0.84510
4.342	0.63769	4.961	0.69557	5.473	0.73823	6.234	0.79477	7.013	0.84590
4.361	0.63959	4.978	0.69705	5.486	0.73926	6.250	0.79588	7.040	0.84757
4.363	0.63979	4.984	0.69758	5.500	0.74036	6.255	0.79623	7.071	0.84948
4.364	0.63988	5.000	0.69807	5.556	0.74476	6.279	0.79789	7.104	0.85150
4.365	0.63998	5.017	0.70044	5.568	0.74570	6.286	0.79837	7.106	0.85163
4.375	0.64098	5.023	0.70096	5.581	0.74671	6.300	0.79934	7.111	0.85193
4.386	0.64207	5.029	0.70148	5.582	0.74679	6.343	0.80229	7.130	0.85309
4.400	0.64345	5.010	0.70243	5.600	0.74819	6.350	0.80277	7.143	0.85388
4.444	0.64777	5.074	0.70535	5.625	0.75012	6.364	0.80373	7.159	0.85485
4.465	0.64982	5.080	0.70586	5.657	0.75259	6.379	0.80475	7.163	0.85509
4.466	0.64992	5.088	0.70655	5.698	0.75572	6.396	0.80591	7.167	0.85534
4.477	0.65099	5.091	0.70680	5.714	0.75694	6.400	0.80618	7.176	0.85588
4.479	0.65118	5.093	0.70697	5.730	0.75815	6.417	0.80733	7.200	0.85733
4.480	0.65128	5.105	0.70800	5.733	0.75838	6.429	0.80814	7.268	0.86141
4.500	0.65321	5.116	0.70893	5.756	0.76012	6.450	0.80956	7.272	0.86165
4.522	0.65533	5.119	0.70919	5.759	0.76035	6.460	0.81023	7.273	0.86171
4.537	0.65677	5.120	0.70927	5.760	0.76042	6.465	0.81057	7.292	0.86285
4.545	0.65753	5.133	0.71037	5.788	0.76253	6.482	0.81171	7.310	0.86392
4.546	0.65763	5.134	0.71046	5.814	0.76448	6.512	0.81371	7.314	0.86415
4.548	0.65782	5.142	0.71113	5.818	0.76477	6.515	0.81391	7.326	0.86487
4.558	0.65877	5.143	0.71122	5.833	0.76589	6.534	0.81518	7.330	0.86510
4.567	0.65963	5.156	0.71231	5.847	0.76693	6.545	0.81591	7.333	0.86528

Contributed by William W. Johnson

DATA FOR MILLING B. & S. SCREW MACHINE CAMS—IV

Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm	Spiral Lead	Logarithm
7.334	0.86534	8.081	0.90747	8.953	0.95197	9.828	0.99247	10.800	1.03342
7.347	0.86611	8.102	0.90859	8.959	0.95226	9.844	0.99317	10.853	1.03555
7.371	0.86753	8.119	0.90950	8.960	0.95231	9.900	0.99564	10.859	1.03579
7.372	0.86759	8.140	0.91062	8.980	0.95328	9.921	0.99656	10.909	1.03778
7.400	0.86923	8.145	0.91089	9.000	0.95424	9.923	0.99664	10.913	1.03794
7.408	0.86970	8.148	0.91105	9.044	0.95636	9.943	0.99752	10.937	1.03890
7.424	0.87064	8.149	0.91110	9.074	0.95780	9.954	0.99800	10.945	1.03922
7.442	0.87169	8.163	0.91185	9.091	0.95861	9.967	0.99856	10.949	1.03937
7.465	0.87303	8.167	0.91206	9.115	0.95976	9.968	0.99861	10.972	1.04029
7.467	0.87315	8.182	0.91286	9.134	0.96066	10.000	1.00000	11.000	1.04139
7.500	0.87506	8.186	0.91307	9.137	0.96080	10.033	1.00143	11.021	1.04222
7.525	0.87651	8.212	0.91445	9.143	0.96109	10.046	1.00199	11.057	1.04364
7.543	0.87754	8.229	0.91535	9.164	0.96209	10.057	1.00247	11.111	1.04575
7.576	0.87944	8.250	0.91645	9.167	0.96223	10.078	1.00337	11.137	1.04677
7.597	0.88064	8.306	0.91939	9.210	0.96426	10.080	1.00346	11.160	1.04766
7.601	0.88087	8.312	0.91971	9.214	0.96415	10.101	1.00436	11.163	1.04778
7.611	0.88144	8.333	0.92080	9.260	0.96661	10.159	1.00685	11.169	1.04801
7.619	0.88190	8.334	0.92085	9.302	0.96858	10.175	1.00753	11.198	1.04914
7.620	0.88195	8.361	0.92226	9.303	0.96862	10.182	1.00783	11.200	1.04922
7.636	0.88287	8.372	0.92288	9.333	0.97002	10.186	1.00800	11.225	1.05019
7.639	0.88304	8.377	0.92309	9.334	0.97007	10.209	1.00898	11.250	1.05115
7.644	0.88332	8.400	0.92428	9.351	0.97086	10.228	1.00979	11.313	1.05358
7.657	0.88406	8.437	0.92619	9.375	0.97197	10.233	1.01000	11.314	1.05362
7.674	0.88502	8.457	0.92722	9.382	0.97230	10.238	1.01022	11.363	1.05549
7.675	0.88508	8.484	0.92860	9.385	0.97243	10.267	1.01144	11.401	1.05694
7.679	0.88530	8.485	0.92865	9.406	0.97340	10.280	1.01225	11.429	1.05801
7.680	0.88536	8.506	0.92973	9.428	0.97442	10.312	1.01334	11.454	1.05896
7.700	0.88649	8.523	0.93059	9.429	0.97447	10.313	1.01338	11.459	1.05915
7.714	0.88728	8.527	0.93080	9.460	0.97589	10.320	1.01368	11.467	1.05945
7.752	0.88941	8.532	0.93105	9.472	0.97644	10.336	1.01435	11.512	1.06115
7.778	0.89087	8.534	0.93115	9.524	0.97882	10.370	1.01578	11.518	1.06138
7.792	0.89165	8.552	0.93207	9.545	0.97978	10.371	1.01582	11.520	1.06145
7.813	0.89282	8.556	0.93227	9.546	0.97982	10.390	1.01662	11.574	1.06348
7.815	0.89293	8.572	0.93308	9.547	0.97987	10.417	1.01774	11.629	1.06554
7.818	0.89310	8.594	0.93420	9.549	0.97996	10.419	1.01783	11.638	1.06588
7.838	0.89421	8.600	0.93450	9.556	0.98028	10.451	1.01916	11.667	1.06696
7.855	0.89515	8.640	0.93651	9.569	0.98087	10.467	1.01982	11.688	1.06774
7.857	0.89526	8.681	0.93857	9.598	0.98218	10.473	1.02007	11.695	1.06800
7.872	0.89609	8.682	0.93862	9.600	0.98227	10.476	1.02020	11.719	1.06889
7.875	0.89625	8.687	0.93887	9.625	0.98340	10.477	1.02024	11.721	1.06896
7.883	0.89669	8.721	0.94057	9.643	0.98421	10.500	1.02119	11.728	1.06922
7.920	0.89873	8.727	0.94086	9.675	0.98565	10.558	1.02358	11.733	1.06941
7.936	0.89960	8.730	0.94101	9.690	0.98632	10.571	1.02412	11.757	1.07030
7.954	0.90059	8.750	0.94201	9.697	0.98664	10.606	1.02555	11.785	1.07133
7.955	0.90064	8.772	0.94310	9.723	0.98780	10.631	1.02657	11.786	1.07137
7.963	0.90108	8.800	0.94448	9.741	0.98860	10.655	1.02755	11.825	1.07280
7.974	0.90168	8.838	0.94635	9.768	0.98981	10.659	1.02772	11.852	1.07379
7.994	0.90276	8.839	0.94640	9.773	0.99003	10.667	1.02804	11.905	1.07573
8.000	0.90309	8.889	0.94885	9.778	0.99025	10.694	1.02914	11.938	1.07693
8.021	0.90423	8.909	0.94983	9.796	0.99105	10.713	1.02991	11.944	1.07715
8.035	0.90499	8.929	0.95080	9.818	0.99202	10.714	1.02995	11.960	1.07773
8.063	0.90650	8.930	0.95085	9.822	0.99220	10.750	1.03141	12.000	1.07918

Contributed by William W. Johnson

MACHINERY

January, 1911

DIE-CASTING—1

THE PROCESS, MACHINERY AND DIES USED IN AN INTERESTING MANUFACTURING OPERATION

By A. C. VON DREELE*

DIE-CASTING, a comparatively recent method for producing finished castings, is rapidly proving itself an important factor in the economical manufacture of interchangeable parts for adding machines, typewriters, telephones, automobiles and numerous other products where it is essential that the parts be nicely finished and accurate in dimensions. The term "die-casting" is self-explanatory, meaning "to cast by means of dies"; described briefly, the process consists of forcing molten metal into steel dies, allowing it to cool in them, and then opening the dies and removing the finished casting. It is the purpose of these articles to give a general outline of the die-casting process, showing its possibilities and limitations, and also to give a description of the die-casting machinery and its operation, of the fundamental principles involved, and of the methods used in the die-making. Illustrative examples of the best types of dies, based on results obtained from actual experience, will also be given.

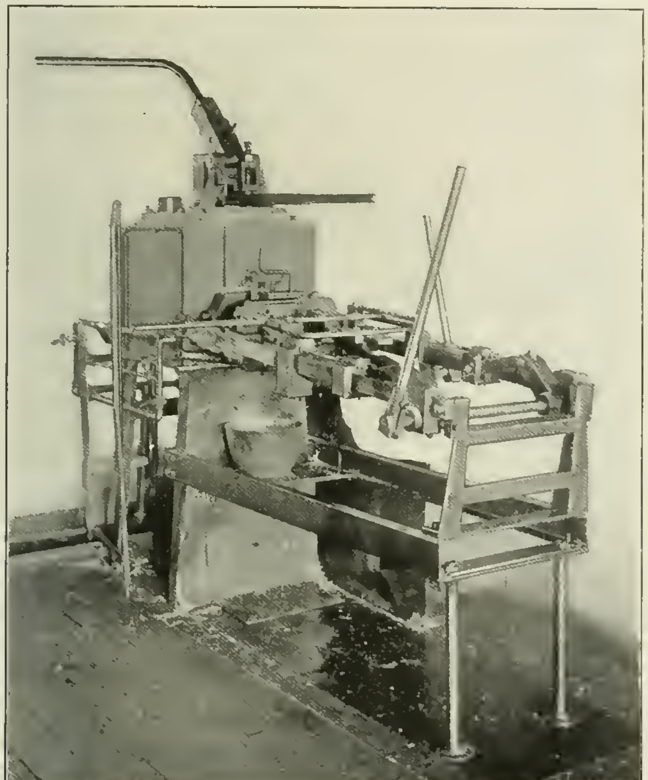


Fig. 1. General View of the Soss Die-casting Machine

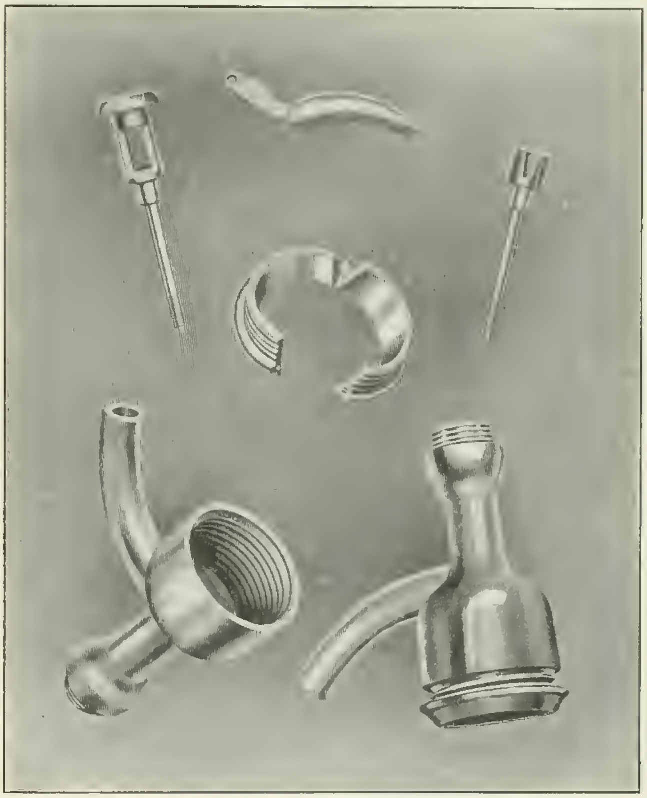


Fig. 2. Examples of Die-castings

Origin of Die-casting

The origin of the die-casting process is somewhat difficult to ascertain. We may look into the history of type founding and find that away back in 1838, the first casting machine for type, invented by Bruce, was a machine that involved the principles of die-casting as it is practiced today. More recently, in 1885, Otto Mergenthaler brought out the linotype machine, that wonderful product of the human mind that has revolutionized the printing industry. The linotype machine is a good example of a die-casting machine. However, as we interpret the word today, die-casting is a broader term than type-casting or linotyping, although its development without doubt is due to the success of the linotype machine. It is doubtful if die-casting, properly speaking, was originated until about fifteen years ago, and it is certain that it is only during the past few years that the activities in this line have been very noticeable.

Necessity is the mother of invention! One of the first experiments in the direction of die-casting was undertaken to get out some mold parts cheaply enough to leave a profit on a job that was commencing to look dubious—from the financial side. The molds were for making rubber plates about three inches square and one-eighth inch thick, the top side of which was decorated with fine raised scroll work; it was this latter feature that gave the trouble. After wasting much time and money trying to stamp the mold parts, a metal-tight box was made as shown in Figs. 4 and 5 with a block screwed in it, the purpose of which was to shape the mold impression and impart to it the scroll design. As shown, the ends of the box were removable, being screwed on. This box was placed under a screw press and a straight plunger that just filled the top of the box was fitted to the head of the press. After the two were lined up, molten type metal was poured into the box, and as soon as the metal had cooled to the "mushy" state, the ram of the press was forced down as shown in Fig. 5. Next, the ends of the box were removed, the screw holding the block taken out, and the die-casting pushed from the box. The object in having the inclined side to the box was to produce a piece shaped with the proper inclination for its position in the final mold used for casting the rubber plates. The illustrations give an idea of the compression that took place. The die-casting was found to be sharp at the corners and free from flaws, and the scroll work came up in fine shape. Naturally the rest of tne mold parts were made in the same way and the job turned from failure into success.

From such simple experiments as these, the die-casting in-

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dustry has developed to its present stage. In view of the advances that have been made in die-casting, it is singular that there are today only about a dozen concerns in the business in this country, but as the subject becomes better understood, and the possibilities of the process are realized, the demand for this class of castings will result in many other firms going into the work, and it is not improbable that a large number of factories will install die-casting plants of their own to aid them in producing better work in a more economical way.

Advantages, Possibilities and Limitations of Die-casting

The greatest advantage of die-casting is the fact that the castings produced are completely and accurately finished when

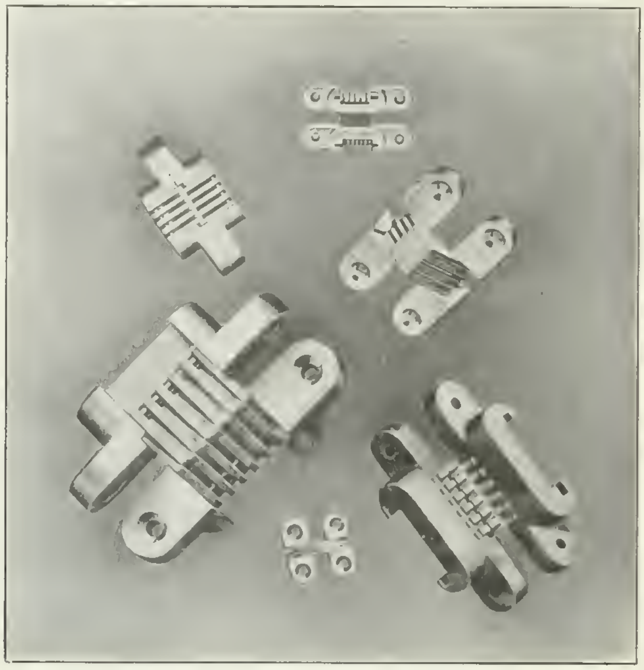

Fig. 3. Additional Examples of Die-castings

taken from the dies. When we say completely, we mean that absolutely no machining is required after the piece has been cast, it being ready to slip into its place in the machine or device of which it is to be a part. When we say accurately, we mean that each piece will come from the die an exact counterpart of the last one; aud if the dies are carefully made, the castings will be accurate within 0.001 inch on all dimensions, whether they are outside measurements, diameters of holes or radii. All holes are cast and come out smoother than they could be reamed; lugs and gear teeth are cast in place; threads, external and internal, and of any desired pitch can be cast. Oil grooves can be cast in bearings, and, in a word, any piece that can be machined may be die-cast.

The saving in machining works both ways; not only is all machine work eliminated by the one operation of casting, but the machine tools and the workmen necessary for their operation and up-keep are dispensed with, the expense of building jigs and fixtures is stopped; and no cutters, reamers, taps or drills are required for this branch of the production. In addition, the labor required for operating the casting machines may be classed as unskilled. No matter how intricate and exacting the machine work on a piece has been, and how skillful a workman was required to produce the work when machine-made, the same result may be brought about by die-casting, and usually the work is excelled, and, excluding the die-making, unskilled men can make the parts.

From a metallurgical standpoint a die-casting is superior to a sand-casting on account of its density, strength and freedom from blow-holes. Also, when the hot metal comes in contact with the cool dies, it forms a "skin" similar to the scale on an iron sand-casting. As the die-casting requires no machining after leaving the dies, this skin increases the wearing qualities of the casting.

The possibilities of die-casting are numerous. By this method of manufacturing it is possible and practical to cast pieces that could not possibly be machined. It is an every-day occurrence to make castings with inserted parts of another metal, as, for instance, a zinc wheel with a steel hub. It is also possible to make babbitt bearings that are harder and better than can be made in any other way. Often there are two or more parts of a device that have formerly been made separately, machined and assembled, that can be die-cast as one piece. In such cases the saving in production is very great. Figures and letters may be cast sunken or in relief on wheels for counting or printing, and of course ornamentation may be cast on pieces that require exterior finish. As to size, there is no reasonable limit to the work that can be cast. One job that is being done at the present time is a disk, 16 inches diameter with a round flange, 1 inch in diameter, around the rim.

"There is no great gain without some small loss," is just as true of a process like die-casting as it is of anything else. The limitations of this work are few, however, and they are here given so as to state the situation fairly. Generally speaking, a part should not be considered for die-casting if there are but few pieces required, because the cost of the dies would usually be prohibitive. Often, however, it happens that because of the large amount of accurate machine work being done on a machine part, it is economical to make a die for the comparatively small number of parts required and die-cast them. A case illustrating this phase of the matter recently occured in actual practice. In getting out an order of two hundred vending machines, it was decided to try die-casting on a part that was difficult to machine. The dies were expensive, costing $200, and as there were only 200 pieces to be cast, the die cost per piece was one dollar; but even with that initial handicap, it was found that on account of the difficult machin-

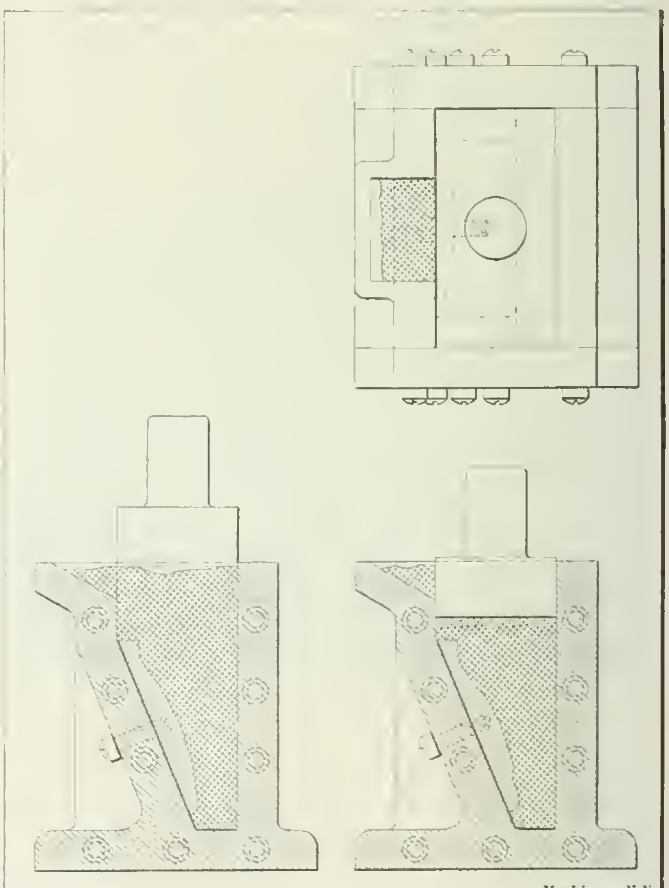

Fig. 4. An Early Experiment in Die-casting - Before Applying Pressure

Fig. 5. An Early Experiment in Die-casting — After Applying Pressure

ing that had formerly been required, the die-cast parts effected a large saving, and of course the results were superior.

A rough part that would require little or no machining should not be die-cast, because pound for pound, the die-casting metals cost more than cast iron or steel. The casting machine cannot make parts as rapidly or of as hard metals as the punch press or the automatic screw machine. For this latter reason a part that necessarily must be made of brass, iron or steel, cannot be die-cast, although mixtures approximately equal in strength to iron and brass are readily die-cast. To

give added strength to a die-cast part it is often advisable to add webs and ribs or to insert brass or iron pins at points that are weak or subject to hard wear. Roughly speaking, it is the part that has required a good deal of accurate machine operations that shows the greatest difference in cost when die-cast, and sometimes the saving is as great as 80 per cent.

The Metals Used in Die-casting

The metals that produce the best die-castings are alloys of lead, tin, zinc, antimony, aluminum and copper, and the bulk of the die-castings made at the present time are mixtures of the first four of these metals. From them, compositions may be made that will meet the requirements of nearly any part.

For parts that perform little or no actual work, save to "lend their weight", such as balance weights, novelties and ornaments for show windows, etc., a mixture consisting principally of lead, often stiffened with a little antimony, is used. There is but little strength to this metal, but it is used because of its weight and low cost. For parts that are subject to wear, such as phonograph, telephone, gas-meter and adding machine parts, an alloy composed of zinc, tin and a small amount of copper is used. This alloy may be plated or japanned, and is a good metal to use on general work.

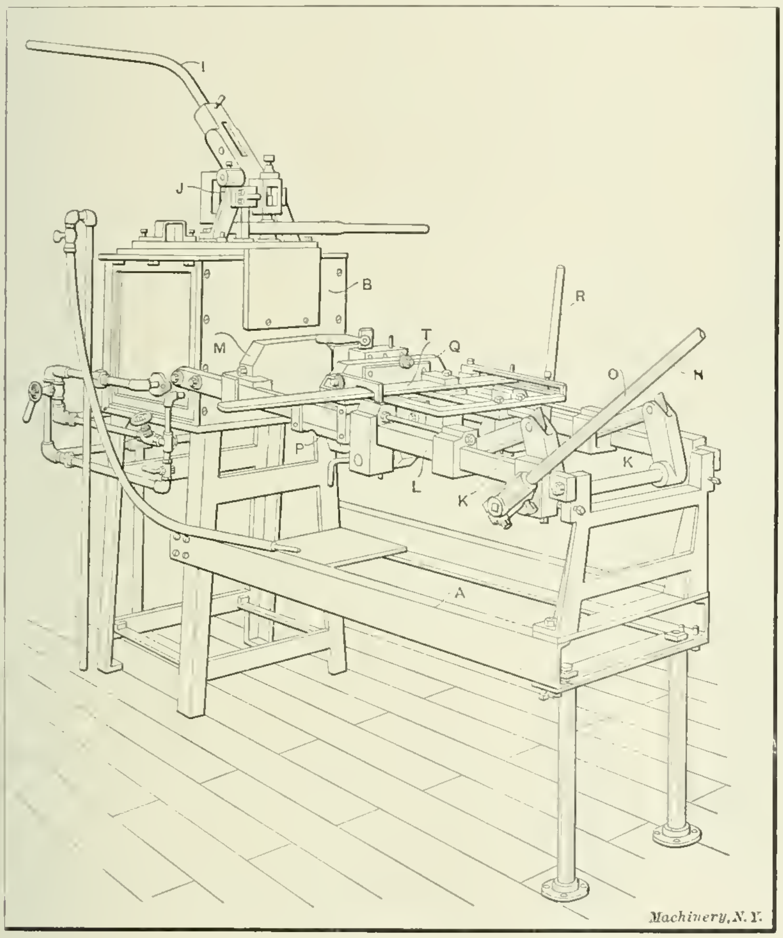

Fig. 6. Working Parts of the Soss Die-casting Machine

Another metal, used chiefly for casting pieces that have delicate points in their design but are not subjected to hard wear, consists principally of tin alloyed with lead and zinc to suit the requirements of the work. This mixture casts freely, and the finished castings come out exceptionally clean. Still another metal, used chiefly for casting pieces that have letters and figures for printing, is similar to the standard type metal: 5 parts lead and 1 part antimony; but if there are teeth cast on the sides of the printing wheel a harder mixture will be required to give longer life to the gears.

The following mixtures are typical of die-casting or "white brass" alloys: copper, 10 parts; zinc, 83 parts; aluminum, 2 parts; tin, 5 parts. Another is copper, 6 parts; zinc, 90 parts; aluminum, 3 parts; tin, 1 part. Another containing antimony is copper, 5 parts; zinc, 85 parts; tin, 5 parts; antimony, 5 parts. Shonberg's patented alloy is copper, 3 parts; zinc, 87 parts; tin, 10 parts. Alloys containing 15 to 40 per cent copper and 60 to 85 per cent zinc are brittle, having low strength and low ductility. An alloy of 8 per cent copper, 92 per cent zinc has greater resilience and strength but not the ductility of cast zinc.

Aluminum may be cast, but it is a difficult metal to run into thin walls and fine details; it plays, however, an important part in some good mixtures used for die-casting. Experiments are now being conducted for die-casting manganese bronze, and it is said that some very good castings have already been made. Its wearing qualities are so valuable that it is particularly desirable for making die-castings.

The Die-casting Machine

The three important requisites for good die-casting are the machine, the dies and the metal. The casting machine is fully as essential as either of the other requisites, and although there are a number of different styles of casting machines in use, each of which has its advantages over the others, especially in the eyes of their respective designers, the fundamental principles upon which they all operate are the same. In each there is the melting pot and the burner, the cylinder and the piston for forcing the metal into the dies, and the dies with the opening and closing device. In some machines pressure is applied to the metal by hand, in others power is used, and in still another class the metal is forced into the dies with compressed air. The provisions for opening and closing the dies vary in the different machines; there are various means employed for cutting the sprue, and the styles of heaters are numerous.

One or two of the largest firms in the die-casting industry have automatic casting machines for turning out duplicate work in large quantities very rapidly. These machines are complicated and are only profitable on large quantities of work, and for that reason their use is not extensive. In general, their operating principles are the same as in the case of the hand machines, but provision is made for automatically opening and closing the dies, compressing the metal, and ejecting the castings.

The Soss Die-casting Machine

The Soss die-casting machine, manufactured and sold by the Soss Manufacturing Co., Brooklyn, N. Y., is one of the latest of the die-casting machines, and is the first die-casting machine to be placed on the open market. This machine is shown in Figs. 1 and 6, and in section in Fig. 7. The Soss Manufacturing Co. originally manufactured invisible hinges exclusively. At the advent of the die-casting era, they commenced to make these hinges from die-castings, and placed orders with a leading die-casting concern amounting to thousands of dollars each year. After the die-cast hinges had been on the market for a short time, complaints commenced to come in, some to the effect that the hinges were breaking and others that the hinges were corroding. Either of these faults was serious enough to blast the reputation of the hinge, but the first trouble, breakage, was the more important. Examination of the broken hinges showed that the castings were porous and full of flaws, and as the makers of the castings could not produce castings sufficiently strong for the hinges, Mr. Soss started to experiment for himself. This experimenting led to the production of the Soss die-casting machine.

Referring to the illustrations Figs. 6 and 7, *A* is the base and frame of the machine, *B* is the heating chamber located at one end of the machine, and within this heating chamber is the tank *C*, shown in Fig. 7. This tank contains the metal from which the die-castings are made, and the metal is heated by the burners *D*. These burners are fed by air and gas through piping on the side of and beneath the furnace. To facilitate lighting the burners and inspecting their condition at any time, there is an opening (not shown) through the firebrick lining of the furnace and the outer iron wall, on a level with

the top of the burners. There is also another opening through the furnace wall to allow the gases due to the combustion to escape. Through the bottom of the tank, well to the inner side of the furnace, runs the cylinder *E*. Below the bottom of the tank, the cylinder makes a right-angle turn, extending through the furnace wall and terminating just outside of the wall. The orifice of this cylinder is controlled by gate *F*. In that part of the cylinder that extends upward into the tank, there is an opening *G* that allows the molten metal to run into the cylinder from the tank. Working in this cylinder, is the piston *H*, that is used in forcing the metal into the dies. The compression lever *I*, hinged over the inner furnace wall, is kept normally raised by spring pressure, and is connected to the piston by means of the link *J*.

At the opposite end of the machine from the furnace, is the mechanism for operating the dies. This mechanism consists of a pair of square rods *K*, upon which are mounted the sleeves *L*. These sleeves have a long bearing surface and are attached to the die-plate *M*. Lever *N* at the end of the operating mechanism controls the movement of these sleeves by means of links *O*. Upon these sleeves is mounted a secondary set of sleeves *P*, attached to the other die-plate *Q*, and whose movement is controlled by lever *R*, through links *S*. This second set of sleeves is free to travel with the first set, and in addition has an independent movement of its own on the primary sleeves. It is the function of lever *R* to bring die-plate *Q* up to die-plate *M* by means of links *S* and sleeves *P*; and it is the function of lever *N* to bring both of the die-plates up to the outlet of the cylinder by means of links *O* and sleeves *L*. This system of sleeve-mounting is one of the distinctive patented features of the Soss machine. The orifice of the cylinder *E* is conical in shape and exactly fits the cup-shaped opening in die-plate *M*, so that when the two are brought together, the joint is metal tight. At the center of this opening, and extending through the die-plate *M*, is an opening that leads to the dies mounted on the inner faces of the two die-plates, and a continuation of this opening extends through die-plate *Q* in which the sprue-cutter *U* works. Attached to the outer side of this die-plate are two slotted brackets. In the slot of one of these is pivoted the lever *T*, and in the slot in the opposite bracket are bolted two stops that limit the motion of the lever. This lever operates the sprue cutter *U*, that works through the opening in die-plate *Q*. The sprue-cutting mechanism is best shown in Figs. 6 and 7. At the left of Fig. 6 may be seen a rubber hose connected to the air piping. This hose is used for cleaning out the dies after each casting operation.

Operation of the Die-casting Machine

The metal for the die-casting machine is mixed in the proper proportions for the work in hand by means of a separate furnace, before being poured into the tank of the machine itself. The burners are lighted and the dies are set up on the two die-plates. As soon as the machine has "warmed up", so that the metal is in a thoroughly melted condition, the sprue-cutting lever *T* is thrown back, leaving a clear passageway to the die cavities. Lever *R* is pulled backward, thus bringing die-plate *Q* up to die-plate *M*, which operation closes the two halves of the die. Then lever *N* is thrown forward, thereby bringing the closed die up to the body of the machine, with the nozzle in close contact with the outlet of the cylinder. Next, the gate *F* is opened, and the man at the compression lever *I* gives the lever a quick, hard pull, forcing the metal in the cylinder downward and into the dies. The molten metal literally "squirts" into the dies. Gate *F* is now closed; lever *N* is pulled back to remove the dies from the cylinder outlet; and the sprue-cutting lever *T* is pushed forward, cutting off the sprue and pushing it out of the nozzle into the kettle placed beneath it. The lever *R* is pushed forward, and a finished casting is ejected from the dies.

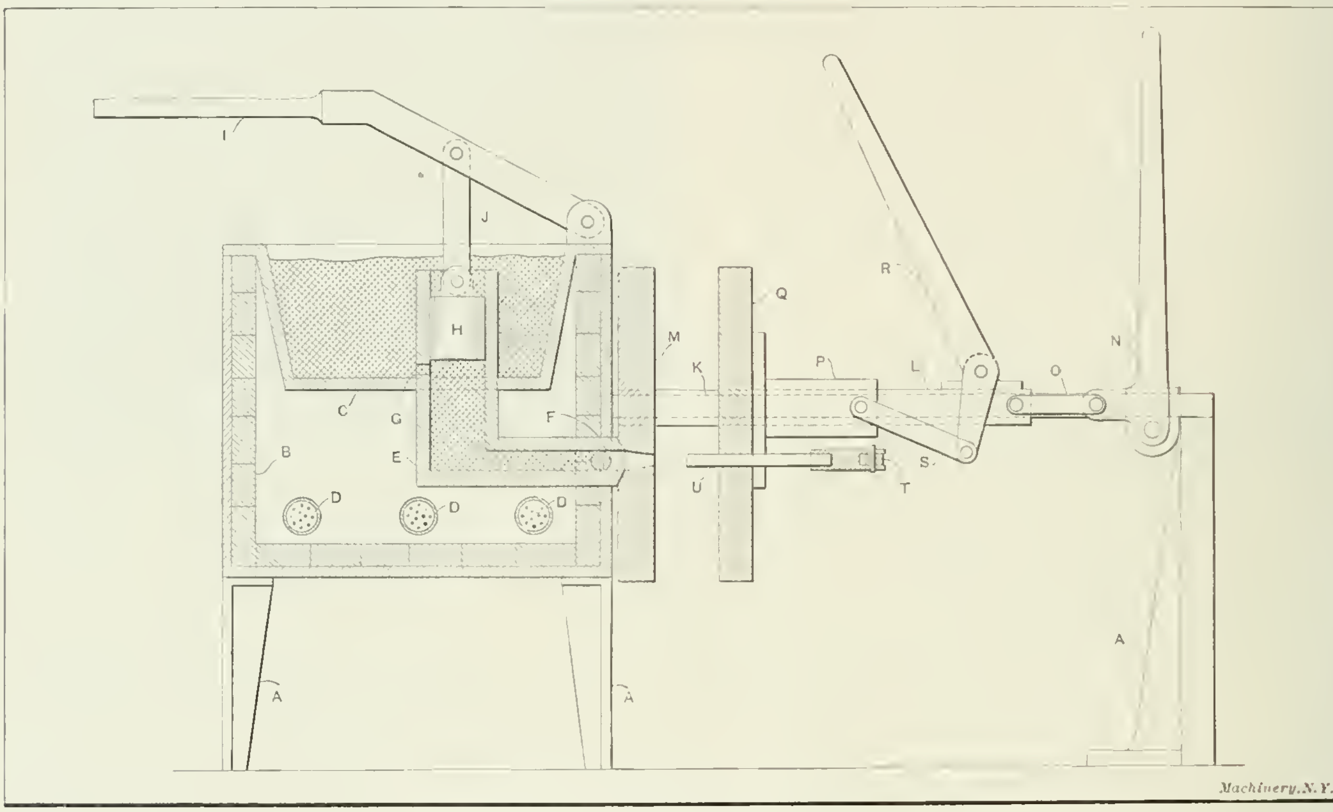

Fig. 7. Section of Soss Die-casting Machine

An important advantage that this machine has over other die-casting machines is the fact that the metal for the castings is taken from the *bottom* of the melting pot, whereas most other machines use metal from the top of the tank. At the bottom of the tank the metal is always the best, as it is free from impurities and dross; hence, there is little chance for the formation of blow-holes. A handful of rosin thrown into the melting tank occasionally helps to keep the metal clean, but the metal nearest the surface always contains more or less foreign matter.

While this description of the operation of the die-casting machine may convey the idea that the process is a slow one, as a matter of fact, the time required is, on the average, not over a minute and a half for turning out a finished casting. With the ejection of the casting from the dies, the product is completed, in theory; but in practice there are always a few small thin fins, caused by the air vents or by improperly fitted portions of the dies. It is, however, but the work of a few seconds to break off these fins, and unless there are many of them, or

they are excessively thick, they are detrimental neither to the quality nor the quantity of finished castings.

Points on the Operation of the Die-casting Machine

We have now taken up the description and general operation of the die-casting machine, but like every other machine, there are numerous little kinks and practices in its working the application of which makes the difference between good and poor die-casting. Some of these points are here given:

The casting machine is best operated by three men, one of whom attends to the compression lever and the metal supply in the tank. The other two men stand on each side of the die-end of the machine, and it is their duty to operate the sprue-cutter, open the dies and remove the finished casting, clean the dies with air and close them, throw back the die-plates to their casting position over the cylinder outlet, and do any other work incident to the operation of the machine. While it requires three men to operate a die-casting machine in the best manner, the man who attends to the compression lever has a good deal of spare time between strokes and if two or even three of the machines are conveniently placed, one man can easily pull levers for all three.

The metal should be kept just above the melting point and at a uniform temperature. If the metal is worked too cold, the result will manifest itself in castings that are full of seams and creases, and it will be difficult to "fill" the thin places in the dies. If, on the other hand the metal is allowed to get too hot, the die will throw excessively long fins, the castings will not cool as quickly in the die, and consequently they cannot be made as rapidly. On account of the importance of keeping the metal at a uniform heat, the fresh metal that is added to that in the tank from time to time, is kept heated in a separate furnace. Therefore, when the metal in the tank gets low, the new supply does not reduce the temperature of the metal being worked. Some casters use a thermometer to indicate the heat of the metal.

Casting-dies require lubrication frequently. Just how often they should be lubricated depends on the shape of the die, the composition of the casting metal, and the general performance of the dies. Bees-wax is the common lubricant, and the lubrication consists in merely rubbing the cake over the surfaces of the dies that come in contact with the casting metal. In die-casting large parts, the dies must be kept cool by some artificial means, for hot dies are conducive to slow work and poor castings. To reach this end, large dies are sometimes drilled and piped so that water may be circulated through them to keep them cool.

In the Soss machine, the burners are so placed that the metal in the cylinder is kept at a slightly higher heat than that in the tank proper. This condition is brought about by having the cylinder directly over the burners. The value of this feature lies in the fact that gas is not wasted in heating the entire tank full of metal to this higher heat, but still the metal under compression is at the required temperature. The gas consumption of the average die-casting machine is about 100 cubic feet per hour.

The speed at which die-castings may be produced varies with the size of the castings being made, the composition of the metal being cast, and the style of dies that must be employed. This latter restriction may involve separate brass or steel pieces that must be placed in the dies before each operation so that they will be inserted in and become a part of the finished casting. The dies may be difficult of operation on account of draft problems or pins and screws that must be inserted in the dies and removed from each casting before another can be made. These different types of dies will be more fully described in the next installment. Taken as a whole, from ten to sixty pieces per hour are the maximum limits for speed in die-casting, and with a well-working die, of simple construction, a speed of forty pieces per hour is considered good production. It is possible, however, when the castings to be produced are small in size and simple in shape, to gate a number of them together, or rather to construct the dies so that six or more castings may be made at once. By this means it is often possible to cast five or six thousand pieces per day of ten hours, on a hand die-casting machine.

SOME SUGGESTIONS FOR INDEXING BOOKS

By JOHN S MYERS*

As an experiment, the writer once asked several engineers for information which necessitated the consultation of a book and observed their methods of locating it. Almost invariably they leafed through the book entirely neglecting the index. Why? They *knew* of the information, had some recollection of how it was treated, of its location in the book or of the illustrations accompanying it, and hoped to catch a glimpse of one of these illustrations, thus locating the subject sought. The index provided was treated as a last resort. This suggested the idea that there was something fundamentally wrong with the index, the first point which suggested itself being that it was wrongly placed, at the back of the book, inside the covers, whereas it should have been on the exterior where it would have stared them in the face.

Fig. 1 represents an index applied to the exterior of a small dictionary. Note that the letters, instead of being inside the

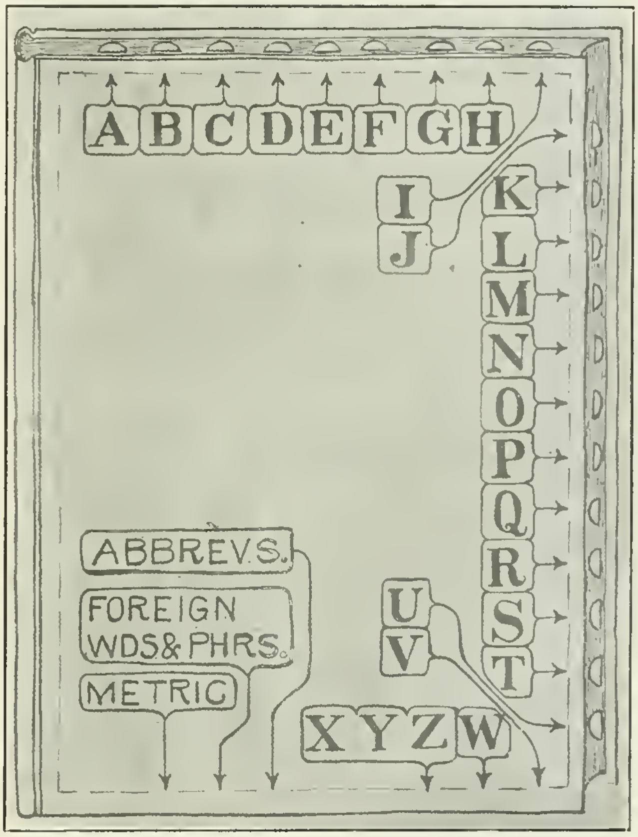

Fig. 1. Suggested Method of Indexing a Small Dictionary

thumb-holes, are on the cover where they are more readily seen. The distinctive feature, however, is the employment of lines and arrows directing the attention from a word or character to the thumb-notch it refers to. This makes it possible to utilize the entire face of the cover for the index. There are, however, points besides the location of an index which are at fault. Antiquarians tell us that away back in the ages hieroglyphic writing came into existence. Now why was this the first form of written language? The answer probably lies in the answer to the question, "Why are ideas most readily suggested to the mind by the medium of sight?" Suppose we moderns go back to first principles, back to the origin of written language. The lesson we learn is that a *picture* of an article is *more readily recognized* than the printed word. This principle is recognized in advertising and much ingenuity, not to mention money, is expended upon illustrating, but in the field of indexing we find it entirely ignored.

Some of the arguments in favor of the employment of pictures or symbolical designation in connection with an index are as follows: A picture more readily conveys an idea to the mind than the printed word, insomuch as it is perceived by a

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simpler mental process. There is more distinction between the appearance of two different pictures than two different words; thus, the location of the desired picture is seen at a glance, whereas the desired word can only be located by a search among all the words. In the case of a word index, the last word you find is the one you were looking for, whereas in the case of pictures, the first picture you see is the one you have your mind's eye open to perceive, *i. e.* the picture you are looking for.

The mind is enabled to perceive more readily by the aid of such pictures because it is aided by the very important faculty, *memory*. One cannot remember the precise word under which a subject is indexed, hence the necessity for cross-indexing with its attendant lengthiness, but with a picture index one would naturally, because of its novelty and prominent location upon the book, give the index itself some little thought; and, since each picture leaves a mental picture, memory directs the eye. This is in fact the mental process which causes one to ignore the present forms of index and thumb over the leaves in an attempt to locate a subject one has some recollection of.

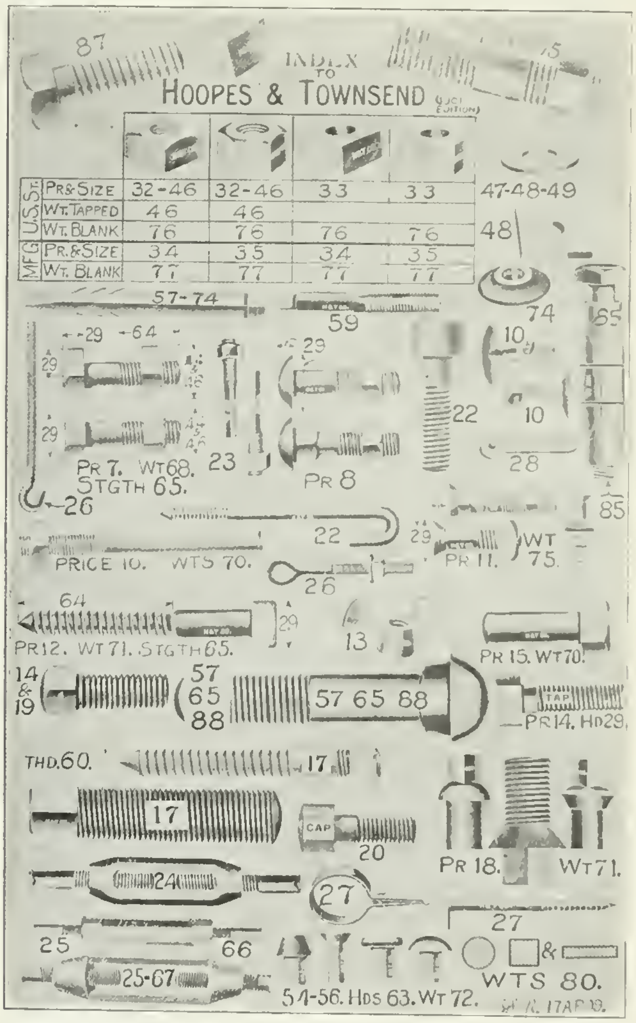


Fig. 2. Method Applied to a Catalogue of Screws, Bolts and Nuts, etc.

Granting the foregoing, it would seem easier and more natural to adapt the index to these mental tendencies than to attempt changing the make-up of the individual to suit the index. In other words, the present style of indexing is not natural—it has no psychological foundation. Again, one is frequently unfamiliar with the trade name or other proper designation of an object, but may easily be able to recognize its picture. This is especially true of small details listed in catalogues, for sometimes a part is known by several names.

The employment of pictures permits a logical arrangement of correlated subjects; for instance, in a trade catalogue, turnbuckles and sleeve-nuts, taps and dies, cap-screws and tap bolts, track bolts and fish-plates, constitute related details, and may be grouped by the proximity of their pictures. In an alphabetically arranged index their names are widely separated. The use of a picture index upon the exterior of a catalogue shows at a glance the subject matter within. It aids the customer to locate information, and consequently aids the advertiser. Fig. 2 is a rough attempt at preparing such an index for a catalogue. The method of preparing this illustration was to clip the pictures from the contents of the catalogue, arrange them upon a large sheet reduced by the camera to the size of

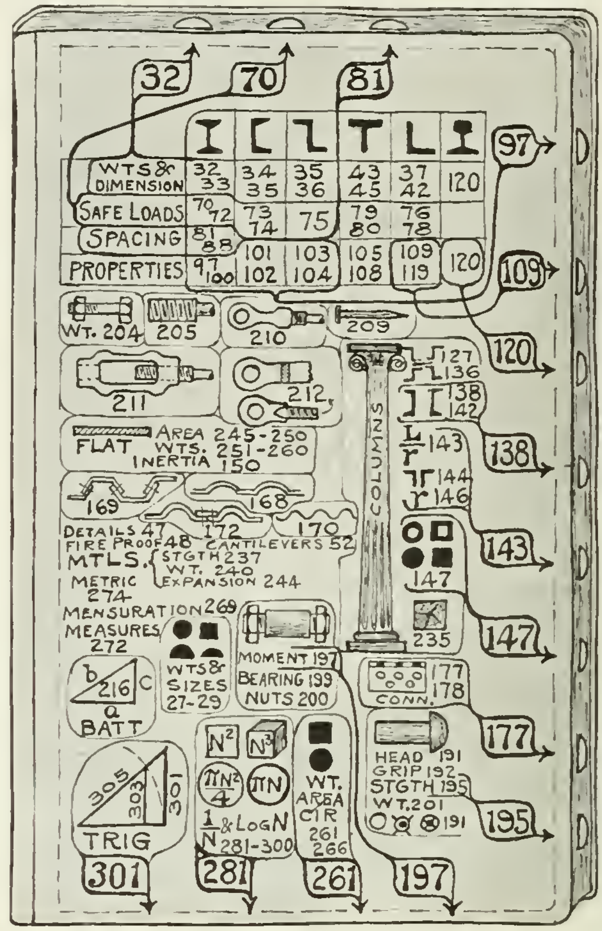


Fig. 3. Method Applied to Carnegie Steel Co.'s Hand-book

the cover; consequently, the relative size of the various pictures is precisely as they were in the catalogue, which gives undue prominence to certain subjects while others are rather small.

The precise manner in which such an index should be compiled would, of course, depend upon the nature of the book; for instance, a work on the anatomy of the eye might have one or more large sectional views of an eye on the exterior with

Fig. 4. Catalogue Cover which would lend itself to the Method of Indexing Proposed

page numbers and lines connecting the page numbers with the various parts, while if the subject was the general anatomy of the human body the pictures would be of the entire body, the numbers referring to the chapters relative to the various organs only. A hand-book on steam boiler construction might

have a picture of each general type of boiler with large page numbers for the beginning of each subject and smaller numbers for the details. Each book would have to be made the subject of special study—mere routine clerical compilation would not suffice. In some cases the index would be compiled with special regard to who constituted the largest users of the book.

In Fig. 3 is shown an index to the "Carnegie Steel Co.'s Hand-Book," especially compiled for structural draftsmen, the one class of men who continually use such a book. Note that the matter referred to in such a book is all indexed on the small cover; the matter most frequently used is provided with thumb notches. Fig. 4 is a reproduction (reduced) of an attractive cover, but it is ornamental only, not useful. By the addition of page numbers and the proper grouping of the contents it could be made an index.

Of course there are abstruse subjects such, for instance, as "The Psychic Life of Micro-organisms," to which this method of indexing would not be applicable. The scheme, however, could be applied to almost any subject in the line of mechanics, and suggests some ideas applicable to other than technical literature. The writer believes that one of the most salutary effects resulting from the use of such an index would be a more logical grouping of the contents of the book so indexed which is a much-needed reform in the case of the majority of hand-books and catalogues.

* * *

LEAVING TOOLS AROUND

A naval engineer has been reduced several numbers because he left a monkey wrench in one of the cylinders of the ship where he was employed. It was not because the wrench was of much value, and because his Uncle Samuel had to go out and purchase another, but because the wrench was in the way. It wasn't needed in the cylinder. It was foreign matter, not necessary to the running of the engine or to the speed of the boat. It added nothing to the fighting qualities of the craft, and that is what the Government is after principally. In fact, the wrench in the cylinder was a detriment and a hindrance to the smooth working qualities of the boat's machinery. There was no room for it in the cylinder, and when the great engine was started up something, of course, had to go. The monkey wrench being a hard nut to crack, it naturally followed that the cylinder did all the cracking. The cylinder came to grief, and in the common run of things naval the engineer followed the same course.

We are sorry for the engineer, but glad the naval board has meted out this just punishment. It makes us feel more at ease over the safety of our country not to have monkey wrenches in our cylinders and, to bring the lesson ashore, it will help some when we are undergoing repairs at the hands of the dentist or the surgeon who is using wrenches and scissors and chisels, etc., in the region of our own cylinders. It is a matter of common knowledge that all sorts of trinkets, such as lances, needles and shears, have been sewed up in the human system following a successful operation. Teeth have been found in the stomach long after a siege of extraction and distraction at the dentist's.

A pair of scissors left in a man's interior is of no more use to him than a monkey wrench left in a cylinder. The surgeon may not miss the scissors, but the patient misses the room he had before the scissors usurped it. Space in a cylinder or in a man's anatomy is valuable, and the engineer or surgeon who uses such space for cold storage for tools ought to be reduced, not only in numbers, but to a pulp.—*Boston Herald.*

* * *

The British Consul-General at Kobe, Japan, reports that the proportion of the imports of British electrical machinery has greatly increased over that of German and American goods, and states that British electrical machinery is highly appreciated by the Japanese, even though the British prices are sometimes higher. The cheap classes of machine tools are being produced in ever-increasing quantities by the Japanese themselves. The designs apparently are taken from foreign models.

EXTERNAL CUTTING TOOLS*—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The subject of external cutting tools is of wide scope, embracing all the tools which are used in removing material from the external diameters of the work. The most common tools used for external work are circular forming tools, box tools, hollow-mills, swing tools, taper-turning tools, angular cutting-off tools, shaving tools and other tools of special designs. All the tools mentioned, with the exception of circular form and cut-off tools, which were described in the March and April, 1910, issues of MACHINERY, will be described in this and subsequent articles. External cutting tools are made of different designs to suit the conditions of the work on which they are to be used; therefore a detailed description of the construction and use of each tool will be given.

As box-tools are used extensively on the automatic screw machines, and as they are the most common of all the tools used for external work, a detailed description will be given of their various parts, functions, and applications.

Preparing Work for Turning

Before reducing the diameter of the work by means of a box-tool or other external cutting tool of a similar type, it is necessary to chamfer the front end of the work to permit,

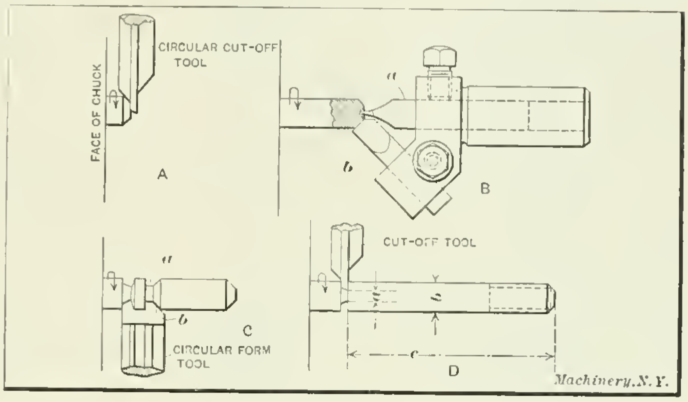


Fig. 1. Methods of Preparing Work for Turning

or rather to facilitate, the starting of the box-tool cutter on a light cut, until the supports are in position to steady the work. Pointing or chamfering the end of the work also facilitates the setting of a hollow-mill concentric with the work.

One method of pointing the end of the work is shown at *A* in Fig. 1. Here the circular cut-off tool has an angular projection on its face next to the chuck, which points the bar before it is fed out for the next piece. This method is generally used when the work is not very long, and runs practically true. When it is necessary to cut a thread on a piece, the beveled end of the bar is made small enough to facilitate the starting of the die.

It is sometimes found impossible to point the bar with the cut-off tool owing to various conditions, and in this case the bar is usually pointed by a combination centering and

* For additional information on this and kindred subjects published in MACHINERY, see: "Cutting Keyways in an Automatic Screw Machine," "Increasing the Product of Automatic Screw Machines," "Setting Screw Machine Stops," "Making a Large Stud on the No. 00 Brown & Sharpe Automatic Screw Machine, December, 1910; "Internal Cutting Tools," September and October, 1910; "Setting-up Tip for Screw Machines," October, 1910; "Measuring Screw Machine Cams," September, 1910; "Designing Screw Machine Tools and Cams," August, 1910; "Threading Operations," June and July, 1910; "A Formed Toolpost and Recessing Tool for Screw Machine Work," May, 1910; "Examples of Box-Tool Design," May, 1910; "Unusual Work Done on the Automatic Screw Machine," April, 1910; "Experiments with Automatic Screw Machine Feed Fingers," March, 1910; "Circular Form and Cut-off Tools," March and April, 1910; "Tool-holder Design," February, 1910; "A Formed Tool Problem," January, 1910; "Don'ts for Screw Machine Operators," November, 1909; "Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machine," April, 1909; "Knurls and Knurling Operations," June and July, 1909, engineering edition; "Attachments for Cutting Squares and Hexagons in Automatic Screw Machine," November, 1908, engineering edition; "Some Interesting Automatic Screw Machine Work," November, 1908; "Making Watch Parts in the Commercial Automatic Screw Machine," June, 1908; "Directions for Camming the Brown & Sharpe Automatic Screw Machine," September, 1903.

† Associate Editor of MACHINERY.

pointing tool as shown at *B*. This tool can be used when the bar does not project more than three and one-half times its diameter from the face of the chuck, and where the bar is unfinished or of irregular shape. The tool *a* is used for centering the work, thus preparing it for drilling a hole; and the tool *b* is used for pointing the end of the bar.

Another condition is that shown at *C*. Here the form tool precedes the box-tool, necking the bar at *a*. Now if the face *b* of the circular tool were left square and not chamfered, as shown, a ring or washer would be formed by the box-tool cutter, as there would be no resistance to the pressure of the cut and hence the thin ring would break off before all the superfluous material had been removed. This condition was clearly illustrated and described in the March, 1910, issue of MACHINERY and it will not be necessary here to go further into detail.

When it is necessary to turn down a portion of a long cylindrical piece of cold-drawn steel or other material which has a finished surface, and have the part turned concentric with the piece which has not been reduced, it is usually good practice to weaken the bar with the circular cut-off tool as shown at *D*. For this class of work the supporting bushing held in the box-tool should precede the turning tool so that the part turned will be concentric with the finished body of the work. Before turning, the bar is pointed with the circular cut-off tool as shown at *A*.

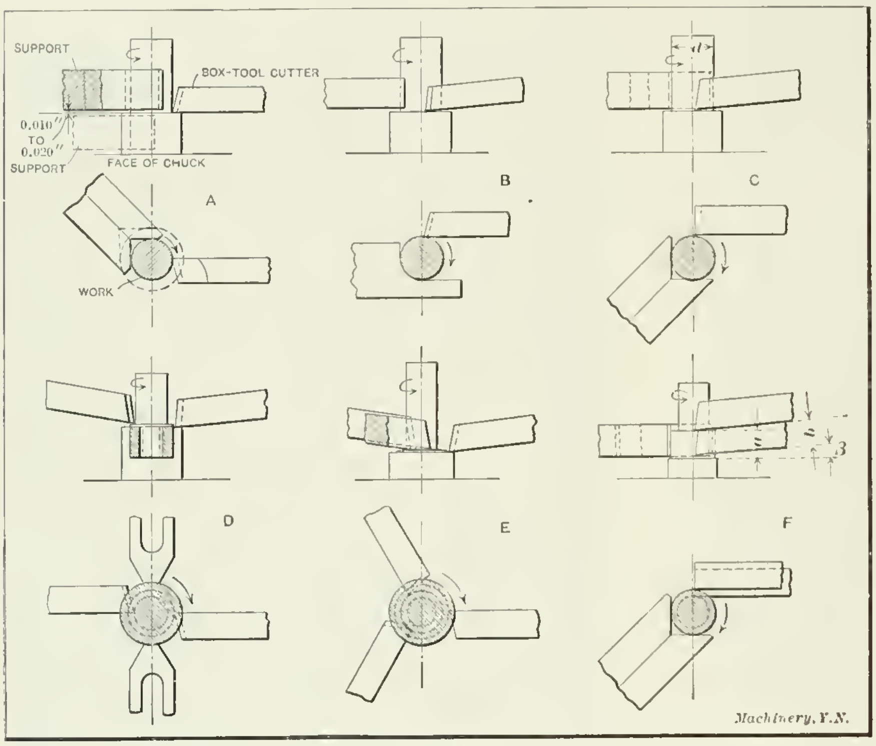


Fig. 2. Various Methods of Applying Box-tool Cutters to the Work

The diameter of the neck *a* should be small enough to allow the bar to be straightened with the box-tool support, so that it will run true. In the majority of cases the neck *a* may be made from 0.3 to 0.5 times *b*, but of course the length of the work *c*, the depth of the chip removed and the feed used will govern largely the diameter of the neck *a*. The material being turned will also affect the diameter of the neck *a* slightly, but in most cases this latter condition can be disregarded. Rods which have short bends in them should not be used, as it will be found impossible to produce a good surface on the part which is turned. The spring collet should also run perfectly true if good results are to be expected.

Application of Box-tool Cutters to the Work

Box-tool cutters are usually applied radially and tangentially to the work. The radial cutter is more commonly used for brass work, while the tangential cutter is used for all classes of steel work, but it is also sometimes used for brass work.

At *A* in Fig. 2 is shown what is termed a "radial cutter," and it can be seen that the cutting edge is set slightly above the horizontal center of the work. The amount that it is set above the center is usually about 0.02 times the smallest diameter of the work being turned. This is the preferable method of applying a turning tool for taking roughing cuts on brass rods. When the stock is rough or of an irregular shape, the cutter should precede the support by an amount equal to from 0.010 to 0.020 inch, but where the bar is cylindrical and has a finished surface, the support for roughing cuts should precede the turning tool, as is shown by the dotted lines.

At *B* is shown what is called a tangential cutter. Here the cutter is set to take a roughing cut from a bar which is not finished, or of irregular shape. Where the bar has a finished surface and is circular in shape, the support is set in advance of the turning tool as was mentioned regarding *A*. The support here shown will be described later.

A tangential cutter set for taking a finishing cut on steel work is shown at *C*. Here the turning tool is set slightly back of the center an amount equal to about 0.10 of the smallest diameter of the work being turned, or *d*. For cutting brass, the tangential cutter is set in line with the center, and, in some cases, a slight amount in advance of the center, especially where less clearance is necessary between the cutter and the periphery of the work.

A method of applying two turning tools for roughing down steel work is shown at *D*, and at *E* is shown a method of applying three turning tools for the same purpose. For taking roughing cuts on brass where an excessive amount of material is to be removed, a hollow-mill is generally used, but the method shown at *D* can sometimes be used to advantage. In the case shown at *E* no supports are used, as the tools support each other. These tools can either be set radially as shown, and a slight amount in advance of each other or can be set tangentially and at varying heights so as to distribute the cuts equally among each of the tools. For taking roughing cuts on steel, it is preferable to set the cutters tangentially to the work.

At *F* is shown a method of applying two tangential turning tools for turning down two diameters on a piece of work. This method is used when the distance *a* is not much greater than from ½ to ⅝ inch. If the distance *a* is much greater than this it is generally advisable to use two separate box-tools, that is, if there is sufficient room in the turret, although two turning tools can be set in the body of the holder, as will be explained later. When turning tools are used in this manner it is necessary to have the thickness of the first tool, or the distance *b*, such that the second tool when set tight up against the first one will turn the shoulder to the desired length.

To illustrate clearly how the distance *b* is obtained, we will take a practical example. Let $a = 0.375$ inch, $\beta = 10$ degrees; then $b = a \times \cos \beta = 0.375 \times 0.9848 = 0.3693$ inch. Where two turning tools are used in this manner they should be ground on all surfaces and should also be made a good fit in the square or oblong hole cut in the body of the holder to receive them.

Holding and Adjusting Box-tool Cutters

It is conducive to good results to have a box-tool cutter held rigidly in the holder, and not to project any further from the holder than is absolutely necessary to clear the largest diameter of the bar being turned. Means for adjusting the tool to cut different diameters should also be provided. At *A* in Fig. 3 is shown a method which is commonly used for holding a box-tool cutter for brass work. In this case a square hole is cut in the body of the holder to receive the cutter, the latter being held by a set-screw *a*. The cutter is adjusted for different diameters by the collar-head set-screw *b* which bears against the rear end of the tool. It is obvious

that this screw can only be used for adjusting the tool in, but by cutting a slot in the turning tool to fit the collar on the screw, this same screw may be used for adjusting the tool both in and out, thus making it more convenient.

The method of holding the turning tool shown at *B* is used particularly for brass work. In this case the turning tool is held in the block *c* by two set-screws *d*, the latter being adjusted in a slot along the body of the holder. The block or turning tool holder *c* has a projecting shank which passes through the body of the holder and is fastened to it by means of the nut and washer shown. It is evident that this method of holding the tool is very convenient for certain classes of work, especially when different diameters are required, as it is possible to have one or more blocks for holding the turning tools.

A method of adjusting and holding a tangential cutter is shown at *C*. Here, as can be seen, the cutter is set off at an angle from the face of the box-tool, and is held in the body This block has a groove in it which fits on a tongue formed on the box-tool body, thus holding the tool-holder rigidly.

At *G* is shown a method similar to that just described, but the turning tool is in this case held in the holder in a manner similar to that shown at *C*. This provides means so that the cutter may be set at a slight angle from the horizontal center line, thus giving it more clearance, as is sometimes necessary, especially when cutting steel, and it also permits for a slight adjustment of the tool, independently of the tool-holder.

It will be seen from a study of the various methods previously shown that the setting of the tool cannot be accurately known, so that a number of trial cuts have to be taken before the desired diameter is obtained. To obviate this tedious operation of setting the tool, a micrometer screw is used for setting the box-tool cutter to the correct diameter, as shown at *H* and *I*. This micrometer screw *k* has two shoulders on it and is screwed into the body of the holder, the body of the screw being made a good fit in the block

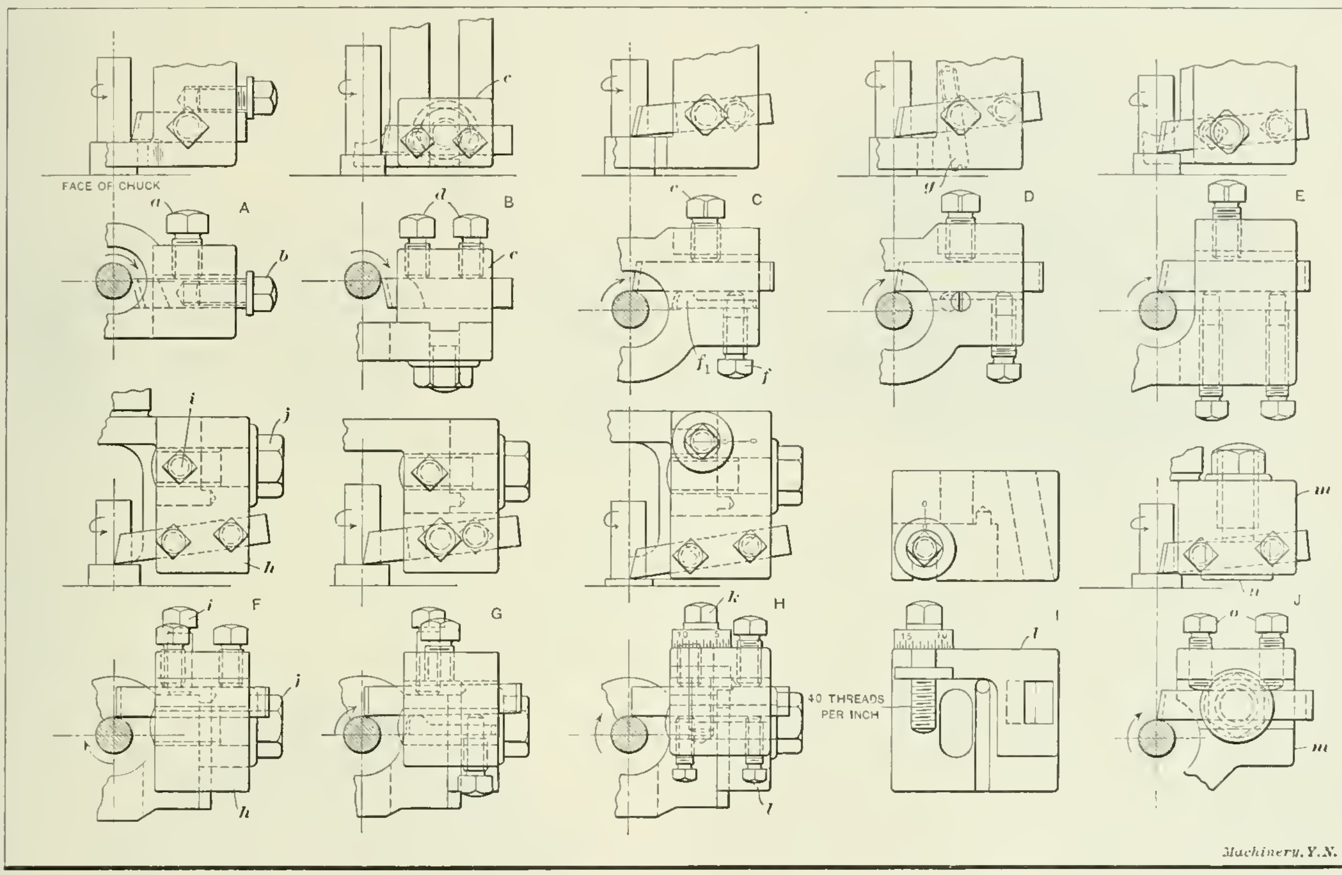


Fig. 3. Holding and Adjusting Box-tool Cutters for Various Conditions

of the holder by two set-screws *e* and *f*. The tool rests on a small block f_1, thus allowing it to be adjusted for turning different diameters, the two set-screws being used in connection with this block for adjusting. This method of adjusting and holding the turning tool is limited, very little adjustment being obtained by it.

A method of holding the turning tool somewhat similar to that just described is shown at *D*. Here the tool rests on the body of a screw *g* instead of a block. This screw is held in the holder as shown, and the tool is adjusted in a manner similar to that shown at *C*. The two previous methods of adjusting the tool are limited in their scope and, of course, can only be used for certain classes of work. A method which allows of more adjustment is shown at *E*. Here the tool is adjusted and held by three set-screws as shown, thus allowing the tool to be adjusted for various diameters, with the tool held in a plane parallel to the horizontal center line.

The methods shown at *C*, *D* and *E* are very seldom used for finishing box-tools, their use being principally for roughing box-tools. At *F* is shown a method of adjusting the turning tool holder which is usually applied to finishing box-tools. Here the tool is held in a block *h*, which is adjusted up and down on the body of the holder by means of the set-screw *i*, and is held when in the desired position by the cap-screw *j*. shown in detail at *I*. The hole in the block *l* through which the screw *k* passes is slotted out to the edge as shown, to facilitate assembling the screw in the block. A 40-pitch thread is cut on this screw, so that for one revolution of the screw the turning tool is moved up or down, as the case may be, a distance equal to 0.025 inch. By making this screw a good fit in the body of the holder and the block, it is possible to get the desired diameter without much trouble. The block is held to the body of the holder in the same manner as that shown at *F* and *G*.

A good method of holding two or more turning tools for roughing down work is shown at *J*, the holder, of course, being made with the desired amount of projecting lugs or tool-holders *m*. The tool in this case is held in a stud *n*, which has a square hole cut in it to receive the turning tool. This hole is cut at an angle with the face, so that the tool is set at the desired angle. Two set-screws *o*, are used to prevent the tool from turning against the cut, and also to permit of a slight adjustment of the tool. As can be seen, this tool is limited in its scope, the changes for diameter being accomplished by means of the set-screws *o*, and also by moving the turning tool in or out a slight amount. This method of holding a turning tool is used mostly for roughing work and is applied in a manner similar to that shown at *E*, Fig. 2.

THE FIELD FOR GRINDING*

By C. H. NORTON

Grinding in various forms has been known to man from the very beginning of history, yet it is doubtful if many engineers have a clear conception of the field for metal grinding. Experience (as a specialist) covering twenty-five years has taught me that the usual thought of grinding is that it is a slow, tedious, expensive, but sure method of obtaining accuracy, and that where great accuracy is not required grinding should not be done.

Webster defines abrasion as "the act of wearing or rubbing off; the wearing away by friction, as the abrasion of coins." Abrade, "to waste or wear away by friction, as to abrade rocks." He defines the word abraise as "rubbed smooth, as an abraised table," meaning a polished table. No doubt here is the connection between polishing and abrasion.

Some time within the last 75 to 100 years men discovered that a revolving polishing wheel enabled them to abrade work

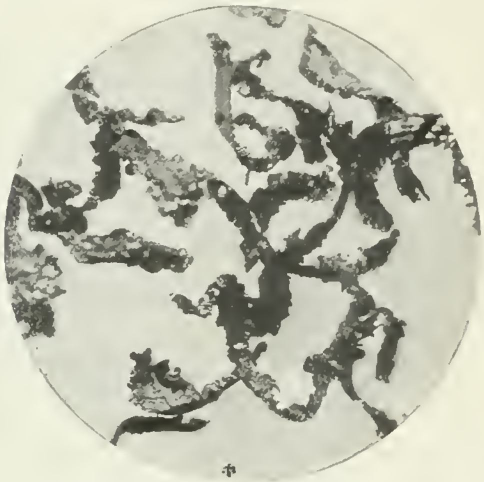


Fig. 1. Microphotograph of Chips from Modern Grinding Wheel, showing Resemblance of Fragments to Lathe Chips

in such a comparatively short time that so far as polishing was concerned it was no longer slow nor tedious. But as the original word for abrasive action was "grind," and grinding was slow, men still clung to the tradition in spite of the later discovery that polishing could be done quickly. When, within the recollection of the writer, mechanics made their own solid glue and emery wheels with which to grind small hardened tool work, it did not occur to them that they could do by grinding a certain part of the work that they were using steel tools for, because it was grinding, and was slow. Moreover, all nice work must, of necessity, take lots of time, because our older mechanics had said so. It did not occur to them that we could ever have better grinding wheels and better machines in which to use them. It was at this point in our reasoning that the majority of engineers rested and it is here that we find a large number now. All engineers admit the exactness of grinding, but most of them still believe it to be slow

Appleton's Cyclopedia of Applied Mechanics, published as late as 1893, says that emery wheels are employed mainly for producing cutting edges and for smoothing surfaces. Again, it says that in all cases of the employment of emery wheels in place of steel cutting tools, the operation is considerably slower, and it may be laid down as a rule that, save upon metal too hard to be operated upon with steel tools, the emery wheel cannot compete with the ordinary lathe, planer, milling tool, etc. My observations convince me that a great many American engineers hold the same views.

As a specialist for many years, I have seen a gradual but sure increase of knowledge of grinding and have noted the widening of the field as the result, but I am not aware that the intelligent study of grinding has been taken up by professional engineers or by any institute of technology. The intelligent use of grinding yields such large returns that it warrants careful study by the very best engineering and scientific minds and a place in the courses of our technical schools. The field is constantly broadening with each year's improvements in grinding wheels and grinding machines, and it is time that men of brains and education took a hand with us to help the world to a better knowledge of the science of grinding and grinding wheels.

The results thus far attained warrant a change of the world's idea of grinding and instead of using it as a synonym for slowness, tediousness and drudgery, it should be a synonym for rapidity, accuracy and economy.

The fact about grinding with the modern grinding machine and grinding wheel (not emery wheel) is that it enables us to size all round work cheaper than by turning and filing, that it takes the place of what we formerly called the finish cut of the lathe and all filing, giving us not a theoretically perfect cylinder or perfect finish, but a much nearer perfect cylinder and finish than we obtained with the lathe. It gives us diameters to such small limits as to be called exact, but whoever insists that none but exact work be ground loses the very pith of grinding, which is economy. Modern grinding means cheaper cost for all work, many grades of work to suit many requirements, and cheaper turning than is possible without the use of the grinding machine.

As a rule, the coarser the turning, the greater the economy by grinding. The greatest economy is obtained by the combination of cheaper turning and grinding. It is no longer necessary to turn work smooth, straight or correctly to size and the lathe is no longer necessary as a precision tool. If it has a carriage traverse of from four to ten threads per inch, has sufficient power to carry high-speed tool cuts at that feed and is well supplied with steadyrests to prevent springing of the work, it is ready for cooperation with the grinding machine. It is easier with modern grinding machines and wheels to grind off a given amount of metal when in the form of crude screw threads than in any other form, and with long work having several sizes, the grinding requires less time if 1/32 inch to 5/64 inch is left on the diameter for grinding than if the work is turned carefully to within 0.002 inch to 0.005 inch. In all cases, accurate turning increases the total cost of production and in some it makes the grinding very expensive.

The greatest economy is usually obtained by the combination of grinding with very rough turning. Yet there are

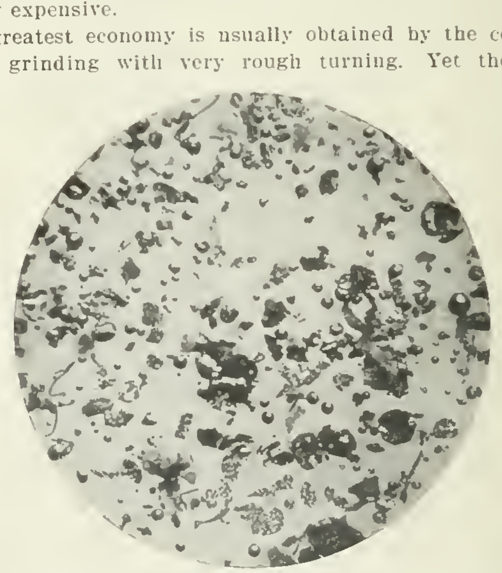


Fig 2. Microphotograph of Fragments from Emery Wheel, emphasizing the Great Heat generated, which melts Particles

cases where the least expensive way is to grind direct without turning, notably the greater part of crankshafts of automobiles and small gas engines and very long and slender work where turning is difficult.

It is not an easy matter to secure such rough turning as true economy requires in connection with grinding. Lack of knowledge of what is needed, coupled with the natural pride the workman takes in doing what tradition says is nice lathe work, prevents the grinding machine from doing what it is ready to do. Our industries are losing much while waiting for the engineer to assume the intelligent guidance of

* Abstract of article read before the annual meeting of the American Society of Mechanical Engineers, New York, December, 1910.

foremen and workmen who, through fear, doubt or prejudice now rob us of the great economies due to modern grinding machines. There is much yet to be learned by foremen and workmen about turning. High-speed steel makes possible much that has not as yet become common knowledge.

The lathe is a very old tool and foremen and workmen have known it for generations, yet I have been unable to find more than two instances where a careful study has been made of the combination of lathe work and grinding to effect the maximum saving. I have observed that lathe men have not tried to remove metal by increasing the number of cuts and using fast traverse. When urged to take coarse feeds to help the grinding machine to effect a total saving, they have invariably said that they were feeding all that the work would stand. It has been demonstrated that three cuts with a carriage traverse of 6 per cent have produced certain work in 9 minutes that required 13 minutes to turn in one cut, because the work was so frail that with one cut no faster feed than 32 per inch could be taken. The rough-ridged surface was readily ground by taking 1 minute more than when the turning was finer, the net saving for the job being 3 minutes. In many cases the ridged surface requires no additional time.

In another case where the work was quite firm and was being revolved at a very high speed with a view to getting everything possible from the high-speed tool, the turning required 5 minutes and the grinding 1 minute. A change was made in the feed of the lathe so that without revolving the work any slower it was turned in 1 minute, leaving a very crude, crooked and bad-looking piece of lathe work. The grinding then required 2 minutes, but the net time saved was 3 minutes. Did it matter how bad a looking lathe job it was if the finished work was perfect and 3 minutes was saved?

There is a rich field for engineers and managers in connection with the lathe and modern grinding. Recent lathe designs provide for high speed of revolution, with sufficient power, quick change to and from back-gears, and sufficient rigidity to utilize to the limit high-speed steel; but much work is not of sufficient rigidity to permit the maximum use of the tool at fast traverse and deep cuts. In addition, there are thousands of lathes of old design that will not be thrown away at once. There is, therefore, an opportunity to get much more out of present plants by cheaper turning, *because of grinding*.

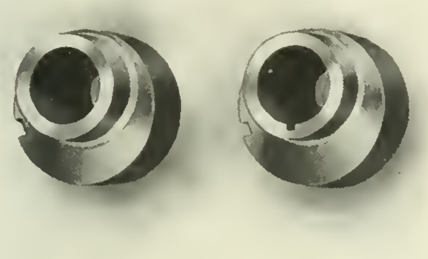
Developments warrant the conclusion that we should no longer assume that simply because a tool is a grinding wheel it cannot remove metal, and size and shape work as quickly as a steel tool. Rather, we should use the steel tool when it can be made to remove metal, size and shape work cheaper, and the grinding wheel when it excels. It is no longer to be taken as a matter of course that we can turn, plane and mill faster than we can grind. After all, the real reason we remove metal is to accomplish certain finished results, not simply to secure a certain number of pounds of chips in a given time. Before long I think all progressive engineers will understand that both the grinding wheel and the steel tool have their place for metal cutting. The old thought of abrasion must give way to the new thought of cutting.

While it is still true that poor wheels or good wheels poorly selected and wrongly used will still remove metal very slowly by abrasion, it is also true that the old-fashioned milling cutter, with fine teeth cut by hand with a file, hardened but never ground, and used in the old-time slender milling machine would very slowly abrade the surface. The modern grinding wheel, used in a modern machine by a modern man, is just as surely a milling cutter as if it were made of steel.

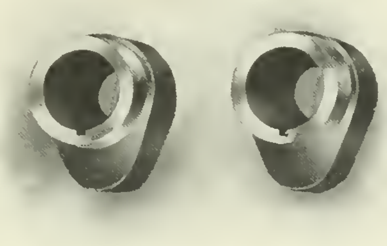
The microscope reveals the fact that such a wheel cuts off chips. Fig. 1 is from a microphotograph and clearly shows the chips that are as surely cut off as those made with a steel milling cutter. The grinding wheel used was a modern one made of crystalline aluminum oxide.

Fig. 2 is also from a microphotograph and shows the result of the old-fashioned abrasion described by Webster as "grinding to powder." Here we see the effect of great heat, the greater part of the powder being in the form of globules. This is magnified to the same extent as the other photograph and shows the vast difference between the old-time abrasion to powder and the present cutting of chips. A large part of the energy put into work was wasted in heat, as shown by the very small globules in Fig. 2. The wheel used for Fig. 2 was an emery wheel like those referred to in Appleton's cyclopedia of 1893.

The grinding wheel as now made is really a milling cutter with millions of cutting teeth. Although these teeth are not as large or as strong as the teeth of a steel cutter and therefore cannot cut as deeply, yet they are capable of cutting at much greater speed. Since there are so many more of them they are capable of much more work in a given time when the nature of the work is such that a large number of these cutting points can be used simultaneously. In some cases we can use as many as two billion cutting points per minute. Eight hundred million per minute is not uncommon and four hundred million per minute is very common.



Figs. 3 and 4. First Two Stages in the Grinding of an Automobile Cam



Figs. 5 and 6. Last Two Stages in the Grinding of an Automobile Cam

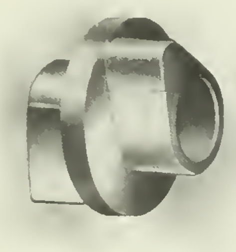


Fig. 7. Double Cam Ground from Rough Stock 2 inches in Diameter

The modern grinding wheel, mounted in a good machine, can be used at a cutting speed of 6000 or more surface feet per minute, and owing to this high speed it need not cut deeply relative to the rigidity of the work. Therefore it is able to remove metal from many forms of work more quickly than the milling cutter or the lathe tool.

The accompanying illustrations show a notable example. Figs. 3, 4, 5 and 6 show the process of making automobile cams. An order for a hundred of these cams was received and our shop superintendent began to provide means for producing them at the lowest possible cost. It is evident that drop forgings for so few would be out of the question, as the expense of dies would make the cost of the cams prohibitive. It was therefore necessary to devise means for producing them from the bar stock. This was done by providing an eccentric chuck for the automatic screw machine. To prevent the bar from turning in the chuck while feeding forward, the spline was made the full length and a mating key was placed in the chuck. Pieces like Fig. 3 were made in the automatic machine at the rate of 10 per hour. A keyway in the hole was made in the ordinary way, Fig. 4. These blanks were ground to rough shape, Fig. 5, at the rate of 10 per hour. The cams were then hardened and finish-ground, Fig. 6, at the rate of 40 per hour. It should be clear that such a cam could not be milled to shape from the blank in nearly so short a time with the milling cutter. When manufacturing such cams in large numbers, drop forgings would be used, and here again the grinding wheel is quicker than the milling cutter.

Another case where the grinding machine can accomplish the results desired in less time than the lathe is that of the pins and bearings of the automobile crankshaft. The results

desired are as follows: Five bearings, all round within 0.00025 inch, the axis of all, parallel and exactly in line; all of the right length within 0.004 inch; distance between bearings within 0.004 inch; accumulated error not over 0.008 inch. Four crankpins, all round within 0.00025 inch; the axis of all exactly parallel; all to length within 0.004 inch; all parallel with the bearings; all within 0.005 inch of the same plane; all of correct throw, within 0.010 inch; over-all length, accumulated error not over 0.008 inch; all fillets correct radius and exactly concentric with the bearings and pins; all bearings and pins straight within 0.00025 inch; and all a good, smooth surface.

In the case of cranks designed with clearance for the arms of the cranks, as shown in Fig. 8, the width of the wheel is identical with the required length of the pins and bearings, so that no measuring or setting of the tool is necessary for cutting to length. The act of grinding cuts the bearing or pin the right length and forms the fillets. The location of the pins and bearings within the small limits allowed is accomplished by a massive index bar, so that the workman does

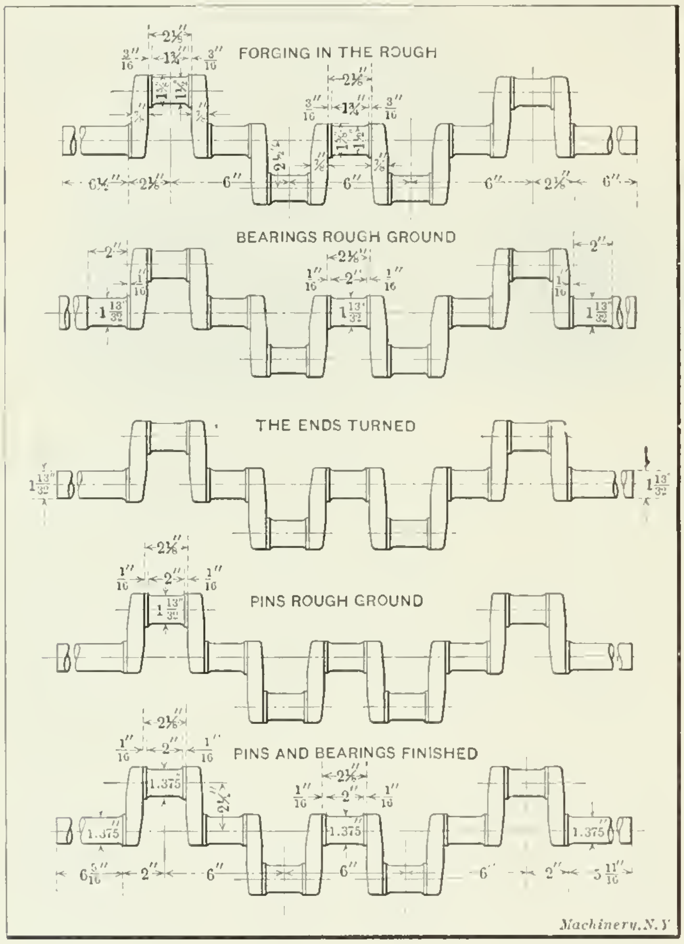


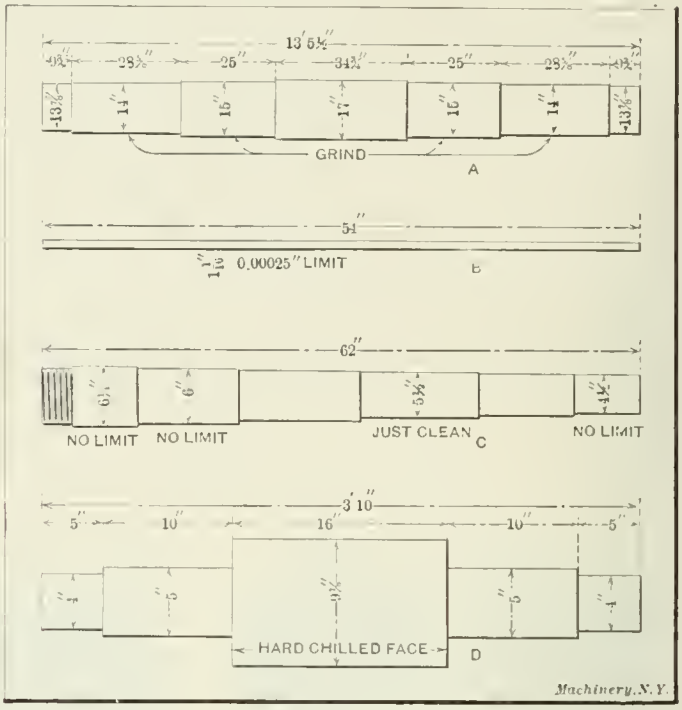
Fig. 8. Stages in the Grinding of an Automobile Crankshaft

no measuring whatever for location of bearings or pins. The entire time of handling and producing these five bearings and four pins from the rough forging to the nicely-sized and finished condition is 85 minutes. It is clear that when all the conditions of the finished work are considered the grinding wheel and machine have removed metal faster than the lathe. Again, it is not simply a case of removing pounds of metal per hour, but the removal of it in such a manner as to accomplish certain results in the least time.

The ends of these shafts beyond the bearings are turned before grinding. The entire list of operations to make a finished shaft from the forging is as follows:

Cut off ends and center	6 minutes
Rough-grind bearings	15 minutes
Turn ends	8 minutes
Rough-grind pins	20 minutes
Finish-grind pins	20 minutes
Finish-grind bearings and ends	25 minutes
Square ends	6 minutes
Total time	100 minutes

A little time could be saved if it were practical to secure forgings with pins and bearings 1⅝ inch in diameter over their entire length instead of with the depression to 1½ inch between shoulders, as the wheel can be forced more rapidly when the face has the same amount of work to do as the fillets. Here, again, tradition is strong and difficult to change



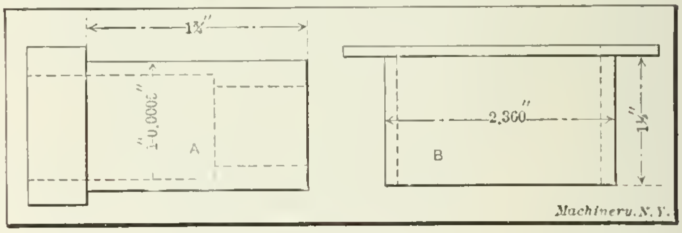
A.—Engine shaft, hammered forging. Weight 8000 pounds; stock removed, 0.025 inch; limit, 0.001 inch; time, 6 hours (8 hours including handling.)
B.—Shaft, 0.30 carbon steel. Stock removed, 1/16 inch; limit, as noted; time, 1 hour (including setting up.)
C.—Lathe spindle, crucible steel, hardened. Stock removed, 0.035 inch; limits, as noted; time, 1½ piece per hour.
D.—Chilled roll, chilled iron. Stock removed, ⅜ inch; time to roll face, 2½ hours; previous lathe time, 12 hours.

Fig. 9 Examples of Grinding on Long Work

at once, because the depression is better for those who turn the work. A little cooperation on dies would save time in grinding.

There are hundreds of other cases where the grinding wheel is used to remove metal in a more economical manner than with steel cutting tools, some of which are shown in Figs. 9 and 10.

Automatic grinding is a late development in the field. Certain work of which large numbers of pieces are made is ground by wholly automatic means. The work is conveyed to the machine by gravity in a hopper or chute and is chucked, ground and delivered to the receptacle. In a case where



A.—Bushing, cast iron. Stock removed, 0.010 inch; limit, as noted; time, 45 pieces per hour.
B.—Bushing, pressed steel. Stock removed, 0.025 inch; limit, 0.0005 inch; time, 60 pieces per hour.

Fig. 10. Rapid Production on Bushings

formerly, at piece work, 300 per day were ground, the automatic machine grinds 4 in a single minute—about 2300 per day.

When the knowledge of grinding becomes more common and the opposition to increased production on the part of the workmen shall have been more nearly overcome, the field will be still more extended. It is worthy of more systematic cooperation and if we get together we will be rewarded with success. The engineer is the one who by education and training is best fitted to take up the important question of the field for grinding.

PRECISION GRINDING*

By W. A. VIALL

Grinding is an art rather than an exact mechanical operation. It is an art of such recent growth that relatively little is known about it or its possibilities. In the development of the grinding machine from the beginning, as described in the historical article in MACHINERY of July, 1910, to the present well-known makes of universal and plain grinding machines, the successive steps that have been taken toward reaching stability and convenience in the machine form interesting chapters of mechanical history, since they show, as well as any class of machines, the tendency of the times.

In speaking of grinding as an art I mean that it contains elements in which the judgment and experience of the operator count for a great deal. While in a general way the manufacturer or the skilled operator is able to give instructions for the running of the machines, yet conditions arise which make it necessary to vary from these instructions in order to obtain the best results. To instruct an operator to use a given wheel and speed would make it possible for him to obtain any one of three results: When ground with a wheel surface that is not true a piece looks as though it had been gouged upon a grindstone, while with a wheel surface that is true it gives a dull finish and shows wheel marks. The latter is what we consider commercial grinding. When the same wheel has been run so that the points of the abrasive become somewhat dull, we obtain a highly-finished surface. All thes results are possible with the same wheel under different conditions.

TABLE I. GRINDING LIMITS FOR CYLINDRICAL PIECES

As adopted by Brown & Sharpe Mfg. Co.

RUNNING FITS—ORDINARY SPEED		
To ½-in. diameter, inc.	0.00025 to 0.00075	Small
To 1 -in. diameter, inc.	0.00075 to 0.0015	Small
To 2 -in. diameter, inc.	0.0015 to 0.0025	Small
To 3½-in. diameter, inc.	0.0025 to 0.0035	Small
To 6 -in. diameter, inc.	0.0035 to 0.005	Small
RUNNING FITS—HIGH SPEED, HEAVY PRESSURE AND ROCKER SHAFTS		
To ½-in. diameter, inc.	0.0005 to 0.001	Small
To 1 -in. diameter, inc.	0.001 to 0.002	Small
To 2 -in. diameter, inc.	0.002 to 0.003	Small
To 3½-in. diameter, inc.	0.003 to 0.0045	Small
To 6 -in. diameter, inc.	0.0045 to 0.0065	Small
SLIDING FITS		
To ½-in. diameter, inc.	0.00025 to 0.0005	Small
To 1 -in. diameter, inc.	0.0005 to 0.001	Small
To 2 -in. diameter, inc.	0.001 to 0.002	Small
To 3½-in. diameter, inc.	0.002 to 0.0035	Small
To 6 -in. diameter, inc.	0.003 to 0.005	Small
STANDARD FITS		
To ½-in. diameter, inc.	Standard to 0.00025	Small
To 1 -in. diameter, inc.	Standard to 0.0005	Small
To 2 -in. diameter, inc.	Standard to 0.001	Small
To 3½-in. diameter, inc.	Standard to 0.0015	Small
To 6 -in. diameter, inc.	Standard to 0.002	Small
DRIVING FITS—FOR SUCH PIECES AS ARE REQUIRED TO BE READILY TAKEN APART		
To ½-in. diameter, inc.	Standard to 0.00025	Large
To 1 -in. diameter, inc.	0.00025 to 0.0005	Large
To 2 -in. diameter, inc.	0.0005 to 0.00075	Large
To 3½-in. diameter, inc.	0.00075 to 0.001	Large
To 6 -in. diameter, inc.	0.001 to 0.0015	Large
To ½-in. diameter, inc.	0.0005 to 0.001	Large
DRIVING FITS		
To 1 -in. diameter, inc.	0.001 to 0.002	Large
To 2 -in. diameter, inc.	0.002 to 0.003	Large
To 3½-in. diameter, inc.	0.003 to 0.004	Large
To 6 -in. diameter, inc.	0.004 to 0.005	Large
To ½-in. diameter, inc.	0.00075 to 0.0015	Large
FORCING FITS		
To 1 -in. diameter, inc.	0.0015 to 0.0025	Large
To 2 -in. diameter, inc.	0.0025 to 0.004	Large
To 3½-in. diameter inc.	0.004 to 0.006	Large
To 6 -in. diameter, inc.	0.006 to 0.009	Large
To ½-in. diameter, inc.	0.00025 to 0.0005	Large
SHRINKING FITS—FOR PIECES TO TAKE HARDENED SHELLS ⅜-IN. THICK AND LESS		
To 1 -in. diameter, inc.	0.0005 to 0.001	Large
To 2 -in. diameter, inc.	0.001 to 0.0015	Large
To 3½-in. diameter, inc.	0.0015 to 0.002	Large
To 6 -in. diameter, inc.	0.002 to 0.003	Large
To ½-in. diameter inc.	0.0005 to 0.001	Large
SHRINKING FITS—FOR PIECES TO TAKE SHELLS, ETC., HAVING A THICKNESS OF MORE THAN ⅜-IN.		
To 1 -in. diameter, inc.	0.001 to 0.0025	Large
To 2 -in. diameter, inc.	0.0025 to 0.0035	Large
To 3½-in. diameter, inc.	0.0035 to 0.005	Large
To 6 -in. diameter, inc.	0.005 to 0.007	Large
To ½-in. diameter, inc.	Standard to 0.0005	Large
GRINDING LIMITS FOR HOLES		
To 1 -in. diameter, inc.	Standard to 0.00075	Large
To 2 -in. diameter, inc.	Standard to 0.001	Large
To 3½-in. diameter, inc.	Standard to 0.0015	Large
To 6 -in. diameter, inc.	Standard to 0.002	Large
To 12 -in. diameter, inc.	Standard to 0.0025	Large

* The limits given in the table can be recommended for use in the manufacture of machine parts to produce satisfactory commercial work. These limits should be followed under ordinary conditions. For special cases, it may be desirable to vary slightly from the tables.

Most of us are interested in two classes of grinding. One is the occasional grinding such as we find in the tool-room and in the shop where one or two pieces of a kind are made and where accurate fits are demanded. The second is the manufacturer's problem where not only must the nicest accuracy be obtained but where the rate of production is an important consideration. In the first case the question of cost does not enter so deeply into the problem, although it is always to be considered; and one machine, specially designed to do a certain class of work, is often compe'led to answer the necessities for work to which it is not well suited. In the second case, however, the best results as to efficiency and production are obtained by having a machine of the proper size. It must be understood from the first that whether the machine is large or small it must be sufficiently heavy and stable enough to do the work it is called upon to do and it must be so designed that it can readily be operated. This latter element of convenience must be provided for even more carefully than in many other classes of tools, because much of the work done in the grinding machine is of such a character that the operations of putting in and taking out consume almost as much time as the grinding. Moreover, a grinding machine must have sufficient rigidity to preserve its alignment, which must be of a high grade from the first. Unless the machine is capable of producing true work its value is lost, for the grinding machine must not only finish work but also rectify it to a degree of accuracy that we cannot, in reason, look to a lathe or other type of machine to furnish commercially.

TABLE II. LIMIT GAGES FOR LATHE WORK

Size	Not Go On	Go On	Size	Not Go On	Go On
	Inches			Inches	
3/8	0.383	0.387	1 1/4	1.258	1.262
7/16	0.4455	0.4495	1 5/16	1.3205	1.3245
1/2	0.508	0.512	1 3/8	1.383	1.387
9/16	0.5705	0.5745	1 7/16	1.4455	1.4495
5/8	0.633	0.637	1 1/2	1.508	1.512
11/16	0.6955	0.6995	1 9/16	1.5705	1.5745
3/4	0.758	0.762	1 5/8	1.633	1.637
13/16	0.8205	0.8245	1 11/16	1.6955	1.6995
7/8	0.883	0.887	1 3/4	1.758	1.762
15/16	0.9455	0.9495	1 13/16	1.8205	1.8245
1	1.008	1.012	1 7/8	1.883	1.887
1 1/16	1.0705	1.0745	1 15/16	1.9455	1.9495
1 1/8	1.133	1.137	2	2.008	2.012
1 3/16	1.1955	1.1995	...	......	......

For illustration see Fig. 1.

The principles of grinding, in the main, are not difficult to grasp, and the time that would be required of the ordinary chief operator in grasping them is not excessive. But the work does require such attention and knowledge of the results that can be obtained, coupled with the skill acquired by experience, as to class it with the arts. In the early days it seemed quite necessary that for every different piece of work we should have a different wheel. Later it was found that a given wheel would give satisfactory results on various kinds of work by varying the speed of the wheel, the speed at which the work was run, or the feed of the work, so that one wheel answered a great variety of purposes. There have been changes in abrasives and we are getting today a far better quality of wheel than was possible some years ago. The grading of wheels has very much improved, and although in the writer's opinion it is not possible to obtain an absolute grading, this element has been reduced to such a nicety that it need not be taken largely into account.

The first use of the grinding machine as we know it today was to correct slight errors that were impossible of eradication by means of the file and emery cloth. Today the

*Abstract of paper read before the annual meeting of the American Society of Mechanical Engineers, New York, December, 1910.

grinding machine rectifies these errors and in addition finishes work for appearance and fit in a relatively cheap manner.

After the proper machine has been selected, the choice of wheels requires some specialized knowledge which the makers of machines and wheels are in a position to furnish to an extent that many of the users of machine tools are probably not aware of. When the proper wheels and gradings are once established for a given line of work, their subsequent use is very easy.

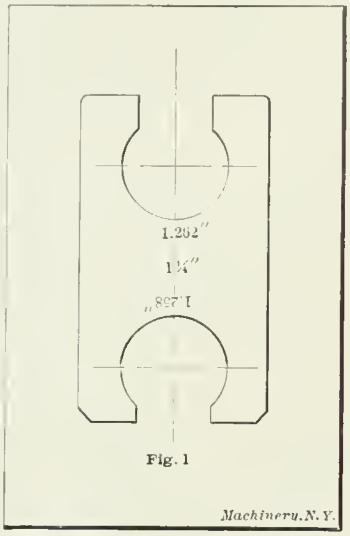
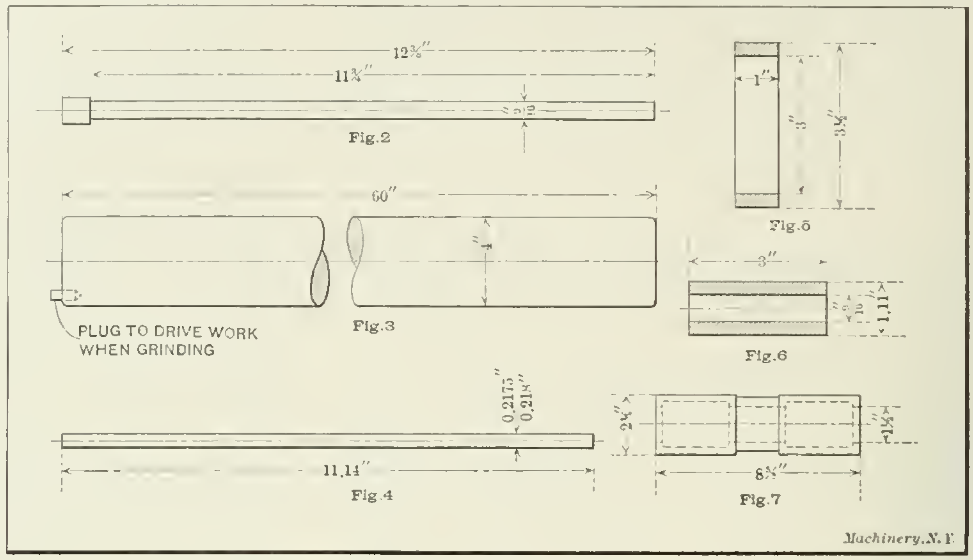


Fig. 1. Type of Limit Gage used. See Table II



Figs. 2 to 7. Some Varied Examples of Grinding Work detailed in the Table below

Fig. No.	2	3	4	5	6	7
Material	Soft machinery steel	Machinery steel	Machinery steel, casehardened	Machinery steel, casehardened	Cast iron	Bearing bronze
Part Ground	External	External	External	Internal	External	External
Machine Used	No. 11 Plain	No. 28 Plain	No. 11 Plain	No. 1 Universal (special)	No. 11 Plain	No. 14 Plain
Wheel Used	Monarch, 12 in. × 1 in. Corundum, No. 46, grade 2¼	Norton, 24 in. × 2 in. Alundum, No. 3846, grade K	Norton, 12 in. × ¼ in. Alundum, No. 36, grade 5, elastic	Norton, 2¼ in. × 2 in. Alundum, No. 5, grade 2½, elastic	American, 12 in. × 1 in. Corundum, No. 46, grade K	Abrasive, 18 in. × 1½ in. Corundum, No 60, grade L
Periphery Speed of Work, Ft. per Min.	35	35 roughing; 60 finishing	35	100	55	75
Travel of Work, In. per Min.	96	48 roughing; 30 finishing	13	By hand	37	30
Periphery Speed of Wheel, Ft. per Min.	7000	6000	5500 to 6000	5500	6500	6000
Amount of Stock Removed, Diameter	0.012 in. roughing, 0.005 in. finishing	0.025 in. roughing 0.005 in. finishing	0.005 in. roughing; 0.001 in. finishing	0.018 in. to 0.020 in. / 0.010 in. to 0.010 in.	0.020 in. to 0.025 in.	0.012 in. to 0.015 in.
Number of Pieces Completed per Hr.	13	3.5	15	16 / 20	54	32 1 man / 59 2 men*
Required Limit	Standard to 0.00025 in. small	Standard to 0.001 in. small	Standard to 0.0005 in. small	Standard to 0.0005 in. large	Standard to 0.0005 in. small	Standard to 0.0005 in. small
In Lots of	100	50	500	200	200	100
Remarks	21 roughed; 35 finished per hr. Handled twice	7 roughed; 7 finished per hr. Handled twice	Handled twice for roughing and twice for finishing			*A man operates the machine and a helper puts the work on and off the arbor.

The question of speeds and feeds is also the result of experience, and suggestions from the manufacturers will help users to a great extent in obtaining satisfactory results. The cutting operation of the wheel was well shown in an illustrated article by Messrs. Gribben and Warman in the *American Machinist*, July 2, 1903, where the microscopic photographs showed that the chips somewhat resembled those made by a lathe tool. It is only under proper conditions, however, that these results can be obtained. The wheels must be true and they must not be forced into the work to too great an extent, for this produces a torn effect upon the work, which is to be avoided.

In considering a piece of work to be done, first of all the question arises as to the size and the limits suitable for the purpose for which it is intended. Table I gives the limits used at the Brown & Sharpe Mfg. Co.'s works for varying conditions. There are special cases where it may be necessary to increase or to decrease these limits, and this table is not offered as the final word but as a guide towards selection.

The second necessity is that sizes should be established to

which the work should be rough turned ready for the grinding room. In our works, as in all factories, the aim is to produce the desired results as cheaply as possible. Our desired ends have been accuracy and nicety of finish where the parts ground are for fits, and nicety of finish where no fit is required. To do this work as cheaply as possible we believe that it is economical to turn the pieces to about the sizes indicated in Table II. It will be noted that we allow from 0.008 inch to 0.012 inch in diameter, an amount easily obtained by the ordinary class of lathe help. In order to make this work as easy as possible for the lathe department, we furnish the limit gage shown in Fig. 1. We are aware that practice varies on this point, and we have thoroughly endeavored to try out the plan of allowing correct limits, but we have found it fully practicable to hold the lathe to the limits given. By so doing we obtain the finished product free from all tool marks and at what we believe is the minimum cost.

Figs. 2 to 7 show some samples of commercial grinding taken from actual practice for the purpose of giving an idea of what can be done in a commercial way, as well as to give some definite data as to speeds, feeds, etc. While it is perhaps not possible to give a rule that will fit all work, these engravings should suggest ideas that will help in producing the work as well and as cheaply as this has been done in the cases shown. When enough pieces of any one kind are to be made it is possible to specialize to a higher degree than can be done in the general run of work, and better results may be obtained than are shown here.

The examples of commercial grinding given in Figs. 2 to 7 illustrate what is being done under actual working conditions in commercial work on the variety of pieces indicated, which are of various materials, both soft and hard. A reversal of the usual rule, where economy is gained by having one man operate more than one machine, is shown in Fig. 7, where the work is most economically produced by using two men to run one machine, that is, having one man to operate it and a helper to drive the work on and off the arbor. All other data are based on one man to a machine.

These pieces passed inspection within the limits given. The average loss from work of this class coming below the required limit or being otherwise spoiled is less than ¼ of 1 per cent in our grinding department.

* * *

REPAIRING JOURNAL OF A DIRECT-CONNECTED GENERATOR

By OBSERVER

While visiting a power house in one of the western mining regions the writer came across a very interesting repair job, which he considers will be of interest to some readers of

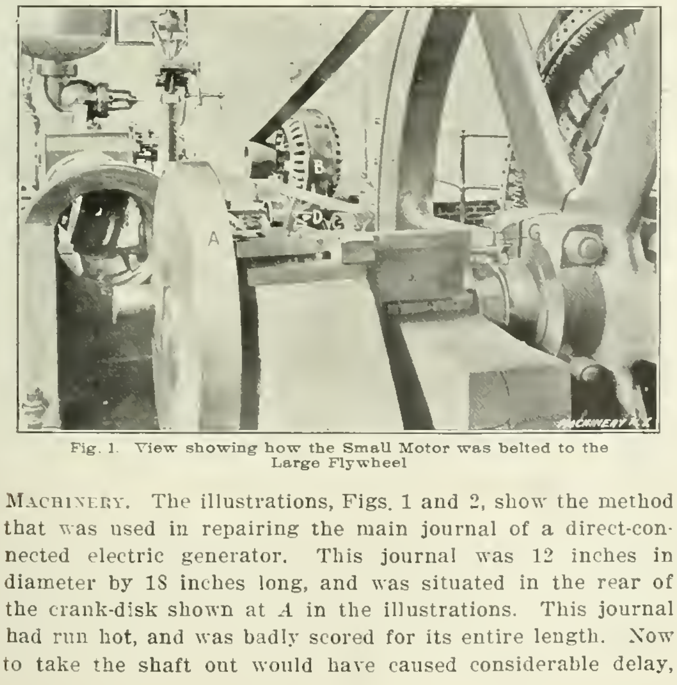


Fig. 1. View showing how the Small Motor was belted to the Large Flywheel

MACHINERY. The illustrations, Figs. 1 and 2, show the method that was used in repairing the main journal of a direct-connected electric generator. This journal was 12 inches in diameter by 18 inches long, and was situated in the rear of the crank-disk shown at A in the illustrations. This journal had run hot, and was badly scored for its entire length. Now to take the shaft out would have caused considerable delay, and there were also no facilities at hand for handling such a heavy job, so it was decided to true up the journal without removing it.

To true up the journal, a belt was run over the flywheel, and connected to a small motor B (Fig. 1) which was brought into service. An idler C, which can be seen close to the large flywheel, was used to overcome the small contact of the belt on the flywheel, and also to give the belt more pulling power. The manner in which the journal was turned is as follows: After disconnecting the main-rod, etc., the eccentric cams were removed and a piece of oak timber, which had previously been bored out, was babbitted and then rebored to the same radius as the journal. This support was then held tight up against the journal by means of other timbers

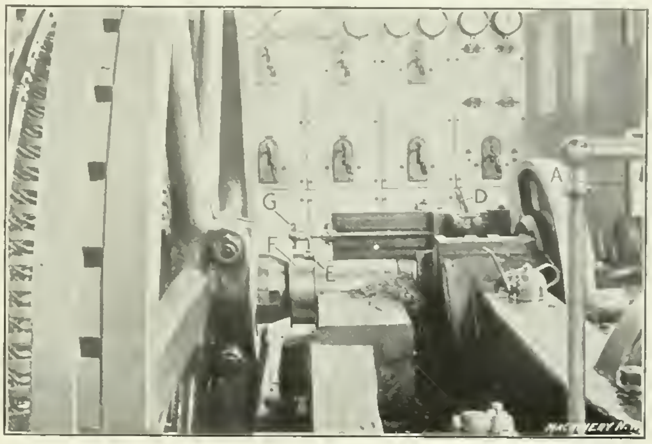


Fig. 2. View showing how Tool-head was utilized for Turning the Scored Journal

which were supported in various positions, and every precaution was taken to prevent any lateral movement of this "impoverished" journal. The pedestal, cap and other sections of the shaft bearing were removed, and a tool-head was then taken from a large planer, which with the addition of a few clamping devices was held in position as shown in Fig. 2. A one-inch square turning tool D was then fastened in the tool-rest and brought into a central position with the journal. A small finger E was then secured to the rim of the governor pulley, F, which operated a star wheel G, used in feeding the tool across the work. The journal which was turned is behind the bracket, and it is impossible to see it in the illustrations.

After turning the journal by the method shown, a lead lap was made and the journal was allowed to run in it for a period of about one hour. The cap and other parts of the bearing were then rebabbitted and bored out to fit the diameter to which the journal had been turned. This job was found to be very satisfactory, and, considering everything, comparatively little delay was caused. The writer has since learned that the engine in question has been running satisfactorily for several months.

* * *

SOFTENING RUST

A recent issue of the *Brass World* contained a simple method for removing rust from surfaces that were afterwards to be electro-plated, but the method might be applied equally well to other rusty surfaces. It consists in dipping the articles first into a strong hot potash bath for about half an hour, and then immersing in a cold muriatic acid pickling solution, composed of two parts of water to one of acid. This removed the rust in a few minutes, leaving the metal apparently attacked but very little. The previous soaking in the strong hot potash solution is responsible for this rapid pickling, as a test proved, for without the previous dipping, sixty-five minutes was required by the acid bath, against four minutes when previously treated in the potash bath. Apparently a chemical reaction is set up, changing the character of the rust, softening it and making it readily soluble. The appearance of the rust as it comes from the potash kettle testifies to this, as it is black and soft, and may almost be rubbed off with the hand. The pieces that have been treated in the potash bath have a smooth and glossy finish.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE DIE-CASTING ART

Although die-casting—the forming of shapes by casting in metal molds—is one of the old arts, having been employed for making type, bullets, etc., for many years, it is nevertheless one of the new arts as applied to the commercial production of parts that require cheap and accurate formation. The field of die casting is large and is growing. Parts of typewriters, adding and computing machines, cash registers, electrical apparatus, speedometers, etc., are die-cast in "white brass" at very low cost and true to pattern within one-thousandth inch or less.

The drawbacks to the process are the cost of dies, which usually makes the price prohibitive for a small number of parts, and the cost of the metal. The latter runs directly proportional to the number of parts, while the former is inversely proportional to the number, becoming so small for a large number as to be insignificant. The metal cost of small parts, however, is low when the high cost of machining cheaper metals that cannot be die-cast, is considered.

Die-casting is likely to become of much greater importance relatively to other means of shaping metal machine parts than now, especially if the more refractory metals can be die-cast. Cast-iron pipe and fittings are now successfully cast in metal molds, the molding in sand being, of course, eliminated, with consequent saving of labor. The possibility of very largely cutting out machine work on cast-iron parts is rather startling to those of us who regard the present order of procedure in manufacturing machinery as unalterably fixed. There seems to be little probability of any great change in the immediate future, but the possibility of revolutionary methods of this character being fully developed in the next twenty years is something to be considered by the builders of machine tools. If such development does take place, it will mean that the growth of the industry will not run parallel to the growth of general manufacturing, but will lag behind. The cheapening of machinery cost would tend, however, to stimulate manufacturing generally; and so, while machine tools might not be directly employed in the manufacture of machinery as much, relatively, as now, they would still be required in great numbers for mold making and other operations incident to the production of cast-iron parts. Of course, the machining of forged, drawn and rolled stock would not be affected by the change.

* * *

PROFITABLE EMPLOYMENT OF MACHINERY

The ideal condition in a manufacturing business is that in which the productive capacity is always at the highest point of efficiency consistent with a first-class product. Naturally those investments which apparently do not yield a constant income are looked upon with disfavor. For example, a machine that cannot be run every day is likely to become an eyesore if it cost several thousand dollars and stands in a conspicuous place. It may be that the character of work done on the machine is such that it could not be done on any other in the plant, nor could the work be done at a reasonable price elsewhere, but the stigma of unprofitable investment may nevertheless be set upon the idle tool, and someone responsible for its purchase is likely to be made uncomfortable by those interested solely in the financial side of the enterprise.

The theory that every machine should be worked all the time is sound, but its practice should not be allowed to deprive the plant of those machines which, though unprofitable, perhaps, in direct production, so facilitate the production that they are indirectly indispensable.

In the case of farm machinery, we probably have the extreme of idle or non-productive period in the year, as compared to the actual working time. The farmer's investment in agricultural tools is relatively large, and the period of actual use during the year is very short. For example, a harvester costing $150 may be used only ten or twelve days in the year; but, in that time it does the work of ten men working with the primitive hand implements in vogue before harvesting machinery was introduced. The returns on the investment are large, and though his machinery is in use so short a time, the farmer could not profitably plant and harvest his crops without it.

This extreme condition of long idle period but profitable investment, and that of actually unprofitable investment in a well-nigh indispensable machine are widely separated; so widely, in fact, that it may be set down as a principle that the well-nigh indispensable machine cannot be unprofitable in itself if the business as a whole is prosperous and its continuance depends upon the performance of that machinery.

* * *

THE STRENGTH OF MACHINE PARTS

Some mechanics think that a machine part which does not break when in use is amply strong. In many types of machinery, however, especially in machines performing operations requiring considerable precision—whether they are machine tools, printing presses, match-box machinery or other kinds—the mere fact that a machine detail does not break is not a sure indication that it has the required strength to serve its proper function. In most machinery of this type any springing action of the parts is almost as objectionable as actual breakage. If a part springs out of shape because it is not as strong as it should be, the work performed by the machine probably will be inaccurate, and the value of the whole machine will be affected merely on account of the lack of strength of a single detail. In fact, a machine detail which springs out of shape, while in action, is often more objectionable than one that actually breaks under the stress, because in the former case it may be very difficult to locate the cause of the trouble, whereas if the part breaks the weakness is at once located, and it can be effectually remedied with comparatively little trouble.

Another difficulty sometimes met with in the operation of machinery is that certain parts are out of proportion to others. Some parts may be excessively heavy and impose stresses on others which are unnecessary and could easily have been avoided. The latter parts may have ample strength

for the functions they were intended to perform, but, on account of the improper design of some other part, they cannot do their work properly. In one case that has come within the writer's experience, a machine table on which a slide was mounted was sprung out of shape so badly by attaching a heavy gear box to the overhanging end of the table, that the slide became locked in its ways and refused to move. With the gear-box supported from the column of the machine, the difficulty was wholly avoided. The greatest care should be taken to produce a harmonious design in which all parts are proportioned with reference to each other; and in particular should it be remembered that the parts must not only be strong enough to resist breakage, but of ample proportions so that no objectionable springing action will appear when the machine is in operation.

* * *

PRACTICAL COST REDUCTION BY RAILROADS

The discussion which followed the testimony of Mr. Brandeis and others before the Interstate Commerce Commission in regard to cost reduction by railroads, recalled a letter received some months ago from an authority in the trade; and some extracts, given below, possess peculiar interest at this time, although the letter was written previous to the hearing referred to.

"We presume if all sellers were disposed to follow the methods that the big railroad tool houses follow in selling, that the business would be somewhat better distributed; but it seems to us this is not the right way to go about correcting a condition that undermines the mechanical departments of the railroads from one end to another.

"The railroads who lump their business ignore or deny the elementary fact that there is a big difference in the producing power of different makes of machines. People who are in the tool business, know that anyone can produce a commonplace machine, just as anyone can play a commonplace game of chess, for instance; but they also know it is only when natural-born builders of certain kinds of machine tools get into the game, that things really begin to happen. When it comes to demonstrating the final saving through employing efficient machines, we find the most satisfactory way is to get the cost of the machines down to so much per unit of time. For purposes of comparison, "interest and depreciation" can be taken as representing the yearly cost of machines. If you put this at 15 per cent a year, which allows 5 per cent for the use of the money and 10 per cent for depreciation, you take care of both interest and principal, as 10 per cent depreciation will bring a machine's holding price down to about one-half price in five years; and machinery men know second-hand machines can be actually sold or traded for one-half price in that time, in most cases. It is a fact that the producing capacity of different machines will vary much more than that; but in this argument, we will put it at 20 per cent. The average wages of railroad boring-mill hands, say, from one end of the country to the other will probably be close to $100 a month. Say the more efficient machine costs $200 more. Interest and depreciation on this amount would be $2.50 a month, and if it lets the man get out 20 per cent more work, it will save $20 a month or eight times its cost; or to put it in another way, if a machine saves $20 a month, you can actually afford to pay for it, over the price of a less efficient type, $1600 ($20 × 12 ÷ 15). Make liberal allowances for differences between practical conditions and theoretical, and you will still have a showing making absolute proof that efficiency and not price is the all-important thing. It is certainly not exaggerating to say that railroads will have a hard time finding a place where they can invest their resources to yield bigger returns than these; also that when any railroad official from the top to the bottom trifles with his responsibilities, when it comes to buying machine tools, the salary he is paid will seem ridiculously small compared with what his methods actually cost his road.

"It is impossible for any one concern to get together a line that will give it the best machines in *every* department. The efficiency of every manufacturer is constantly fluctuating, and changing agencies is a slow matter. It follows then that if business is lumped, some of the machines gotten must be poor ones. Obviously, the proper way is to pick out the machines individually, giving the big houses such items as they are entitled to, only. The big combinations claim they can sell for less, on account of owning or controlling factories, but there is really not much in this claim, as it is self-evident that any investment, by whomever owned must yield a regular profit. The margins on machine tools are very small to anybody, so that any quantity discount that could be made, while possibly seeming big at first glance, would really amount to little in view of the bigger earnings of efficient machines.

"Lumping orders at headquarters naturally causes inferences by the shop men that tend to create a cynical and careless attitude throughout the whole organization. Another very important point, as we see it, is the fact that such a policy makes enemies of a great many salesmen. The training of these men makes them know how to talk, and they are constantly circulating among a large number of business men, and consequently cannot help but exert an important influence in molding public sentiment against the railroads. It seems to us that the purchasing department of a railroad is a place for an accomplished diplomat. The roads might just as well have a lot of salesmen boosting their cause as knocking it.

"Many of the most successful lines, such as the Harriman System, Burlington, Pennsylvania, Chicago & North Western, and others, are waking up to the importance of careful selections of tools, and it is high time that this plan should become more general. Shop payrolls on some systems will probably exceed a quarter million dollars a *month*, so the issue is big enough."

* * *

PHYSICAL INJURY FROM DRAFTING

By B. L. W.

In a large drawing-room employing one hundred draftsmen there was a frequent call for contributions for flowers as a last tribute to a poor fellow-workman who had gone on his last trip. One old man in the place noted that a number of these men previous to their death had complained of pains in the abdominal region where the pressure comes in leaning over the drawing-board. Recently a workman who complained of a pain in his left side at this point was taken to a physician and a thorough examination was made, to find out if possible if there was any internal injury due to his work. The physician found two painful spots similarly located in the right and left sides. The one in the left side, which was the most painful, was in the neighborhood of the low rib and directly in line with the heart. Further examination showed that the floating rib was out of place, being lapped under the rib above it. This derangement, which had evidently been brought about by pressing against the drawing-board when at work, was causing an undue pressure on the spleen and on one of the large intestines, as well as some of the nerves, with the result of hampering the spleen in its action, thus causing an impoverishment of the blood and its resulting debility. There was also a weakened digestion from the pressure on the intestines and nerves, a state of debility and lack of nerve tone, which condition being continuous would probably result in some chronic ailment. There was at this time no direct injury to the heart.

Another draftsman was examined and found to have the same trouble—deranged ribs—but the displacement in this case was not so much as in the first one. Allowing for all this, draftsmen need not feel that they are martyrs over or above all others, as most lines of work have their resulting physical ills, and the purpose of this article is not to commiserate the poor draftsmen on their unfortunate position, but rather to decide where the trouble lies and to find out how to alleviate it.

First, it is well to remember how the Chinese doctor, who, when a patient with a broken rib was brought in, first stripped the man, and then threw a pail of cold water over his back. The resulting gasp of the poor victim was excruciatingly painful, but the ribs were snapped into place and the doctor could then strap up his patient and bring him around in fine shape.

For the same reason the draftsmen should frequently during the day, straighten up and breathe deeply. Further, it will be of particular benefit to take regular morning and evening waist exercises and also it would be a good idea to cut out beer and an osteopathist can correct any injury already done.

Another thought is to discard the old flat board, and work as the artists do, with the vertical board. This can be done with entire satisfaction by using a straightedge which has a parallel motion instead of a T-square. In each case the draftsman must follow his own way of doing things, and look to himself that he makes the work a stepping stone to something higher.

* * *

Copper and its alloys are affected by rubber, and hence copper and rubber should never be used in combination.

MILLING SCREW MACHINE CAMS*

By WILLIAM W. JOHNSON†

William W. Johnson‡

There are several methods used for finishing plate cams. Most methods require that the outline be accurately laid out, after which the stock is removed, generally by drilling a series of holes around the outline and breaking away the outer part. The cam is then finished to the scribed lines by milling and filing. This method, however, is slow, and the highest accuracy is not obtainable in this way.

Another method which is applicable to all cams with a constant rise is illustrated in the half-tone Fig. 1. A diagrammatical view of the relative positions of the compound vertical milling attachment and the index head used in this method, is shown in Fig. 2. By this method constant-rise cams may be milled, so to speak, automatically, by placing the cam blank on the index head spindle, and gearing the head for spiral milling. An end-mill is held in the compound vertical milling attachment, which is adjustable to any angle in the vertical plane, as indicated in Figs. 1 and 2. The milling attachment and the spiral head are set at a certain angle with the table surface, this angle being determined by the rise of the cam and the forward feed of the milling machine table for one turn of the index head spindle; this forward feed is usually called the spiral lead for which the machine is geared. It will be clear even to persons unfamiliar with this method, that when the table is feeding forward, the slowly revolving cam blank is fed against the cutting edge of the end-mill, and as this latter is stationary, the radius of the cam will be constantly decreased. It is the object of this article to describe a method for finding the angle to which the spiral head is to be set, and the lead for which the spiral head is to be geared, so as to obtain very accurate results when milling constant-rise cams. The formulas given below and the tables in the accompanying Data Sheet Supplement, of leads obtainable on the Brown & Sharpe milling machines, and their logarithms, are used for facilitating the necessary calculations. In order to carry out the calculations by the method outlined, a table of logarithms of numbers (MACHINERY'S Reference Series No. 53) and a table of logarithms of angular functions (MACHINERY'S Reference Series No. 55) are required. In order to find the gears to be used for any spiral lead obtainable on the machine, a book entitled "Tables of Leads for Use with Universal Milling Machines," published by the Brown & Sharpe Mfg. Co., Providence, R. I., should be used.

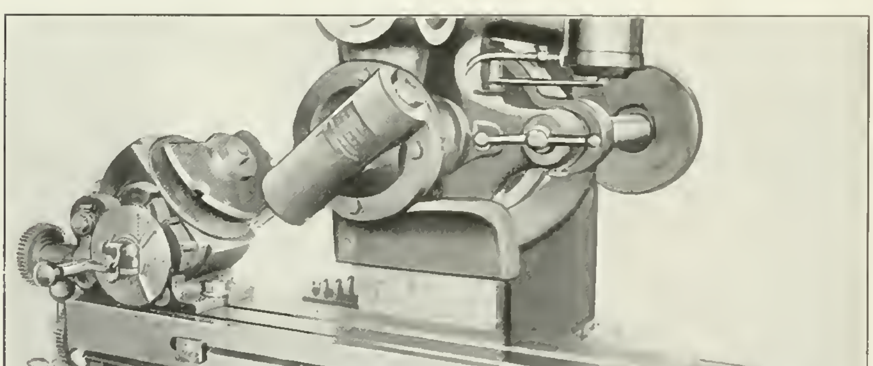

Fig. 1. Method of Milling Constant-rise Cams on the Milling Machine

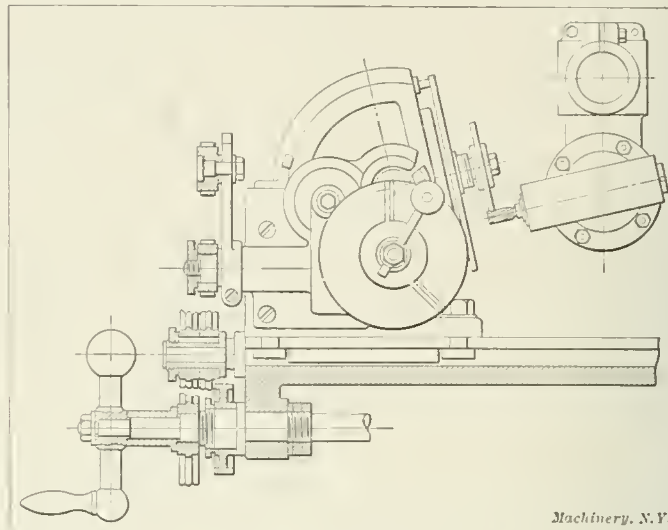

Fig 2. Diagrammatical View showing Method of Milling Cams on the Milling Machine

General Formulas for the Calculations

In the following formulas let

l = lead of the cam lobe to be milled; the lead of the cam lobe is the rise of the cam if the given rate of rise were continued for one whole revolution or 360 degrees,

R = rise of the cam in a given part N of the circumference,

N = the part of the circumference in which a given rise takes place; N is expressed as a decimal in hundredths of the cam circumference,

L = spiral lead for which the milling machine is geared,

a = angle to which the index head and milling attachment are to be set.

The finding of the angle a to which the index head is to be set for any specific case is most easily explained by reference to Fig. 3. In the right angle triangle shown, the hypotenuse L represents the distance that the milling machine table will be fed forward while the index head spindle makes one complete revolution, or, in other words, L is the spiral lead for which the machine is geared. The side l in the triangle represents the rise that the cam to be milled would have in 360 degrees, or in one complete revolution; hence, this side represents the lead of the cam. It is then clear that

$$\sin \quad = \frac{l}{L} \qquad (1)$$

But $l = \frac{R}{N}$, hence:

$$\sin a = \frac{R}{N \times L} \qquad (2)$$

It is apparent from Formula (2) that when R, N and L are known angle a can be determined. As it is not practicable, however, to set either the index head or the vertical

* With Data Sheet Supplement.

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milling attachment closer than to whole or half degrees, the lead L must be so selected that the angle a will be within 5 minutes either way of a whole or a half degree. Hence trial calculations must be made, and it is for the purpose of facilitating these calculations that the tables in the accompanying Data Sheet Supplement have been prepared.

Practical Use of Tables and Formulas

The practical use of the formulas given and of the tables in the Data Sheet Supplement can be best explained by means

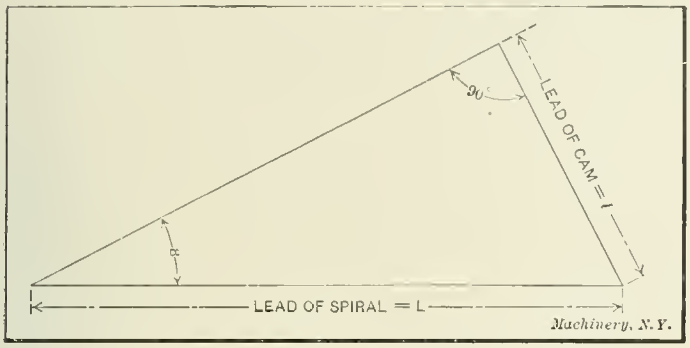


Fig. 3. Relation between Setting Angle of Index Head, Spiral Lead and Lead of Cam Lobe

of an example. Assume that a set of cams is designed and drawn as shown in Fig. 4, and that the toolmaker is to be given the necessary data for milling the lobes on these cams. The milling is to be done according to the methods illustrated in Figs. 1 and 2. The calculations should be made by the draftsman or whoever designs the cams, and it is recommended that the results of the calculations be tabulated as shown in the table. Referring to the cam drawings in Fig. 4, let us first take the first lobe on the front-slide cam. Here whole or half degree. In order to accomplish this result proceed as follows:

First find the logarithm of 0.6458:

$$\log 0.6458 = \bar{1}.81010$$

Now turn to the tables of leads in the accompanying Data Sheet Supplement. Beginning with any lead L that is *larger* than the numerator 0.6458, subtract the logarithms of the leads, as found in the tables, from the logarithm in the numerator 0.6458 until, by repeated trials, a remainder is obtained which is the logarithm of the sine of an angle which is within 5 minutes of a whole or a half degree. The angle thus found is the setting angle for the index head, and the lead giving this angle is the one for which the head is to be geared. Proceeding according to the directions given above we have:

$$\begin{array}{rl} & \log 0.6458 = \bar{1}.81010 \\ \text{(Subtract)} & \log 0.900 = \bar{1}.95424 \\ \hline & \log \sin a = \bar{1}.85586 \end{array}$$

From a table of logarithms of sines we find that $a = 45$ degrees 51 minutes. As this angle is not within 5 minutes of a whole or a half degree, try the next lead in Table II in the Supplement, as follows:

$$\begin{array}{rl} & \log 0.6458 = \bar{1}.81010 \\ \text{(Subtract)} & \log 0.930 = \bar{1}.96848 \\ \hline & \log \sin a = \bar{1}.84162 \end{array}$$

Hence $a = 43$ degrees 59 minutes.

This angle fills the requirements. No more trials are, therefore, required, and the index head and the compound vertical milling attachment are to be set to 44 degrees; the gears to use for gearing the spiral head for 0.930 inch lead are found from Brown & Sharpe Mfg. Co.'s book "Table of Leads for Use with Universal Milling Machines," as already mentioned.

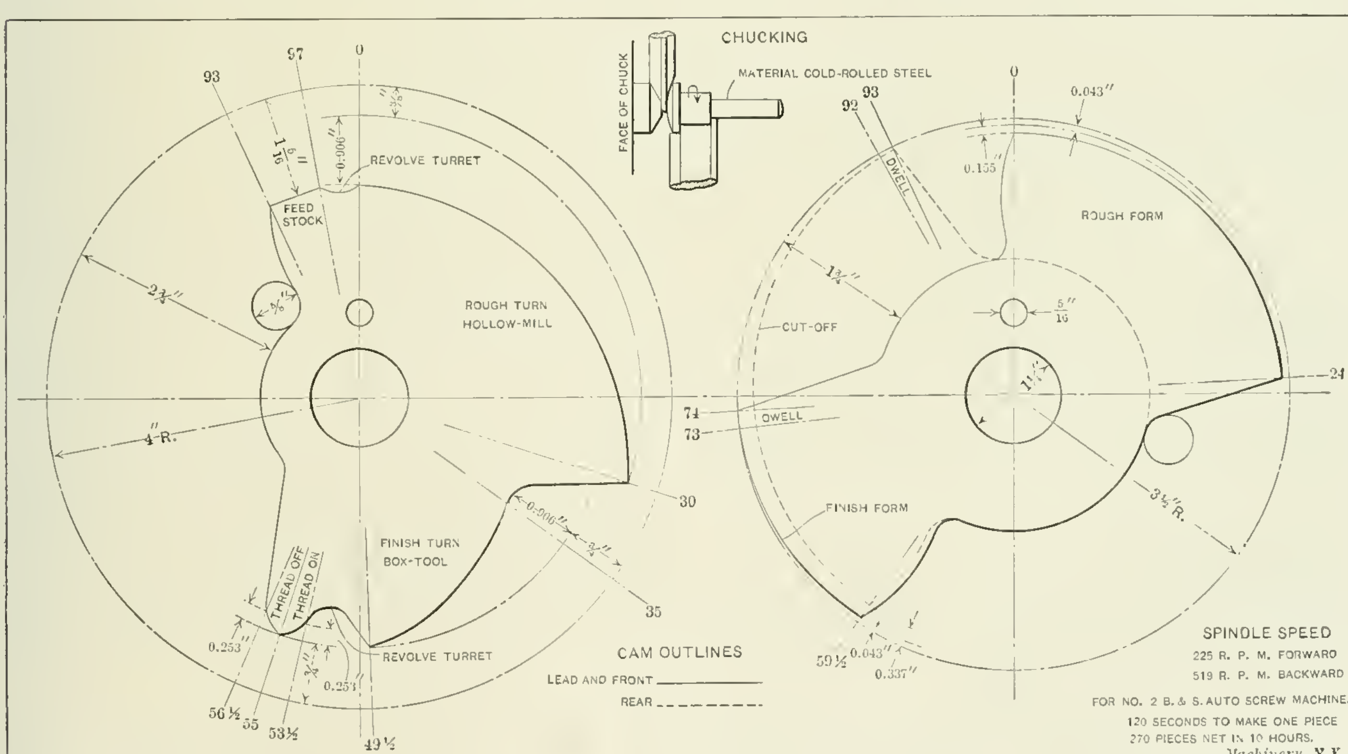


Fig. 4. Cams used as Examples in the Calculations

the rise $R = 0.155$ inch and this rise takes place in 0.24 of the whole cam circumference. Hence $N = 0.24$. We have further:

$$l = \frac{R}{N} = \frac{0.155}{0.24} = 0.6458$$

and, from Formula (1):

$$\sin a = \frac{l}{L} = \frac{0.6458}{L}$$

As already mentioned we must now find a lead L so selected that angle a will be within 5 minutes either way of a

In using this method, the following conditions must be taken into consideration:

If a spiral lead can be found in the tables in the Supplement which is exactly equal to the numerator l in the fraction giving $\sin a$ in Formula (1), then this lead is the lead for which the spiral head is to be geared. It will be seen that $\sin a$ in this case becomes equal to 1, which is the sine of 90 degrees. This indicates that the compound vertical milling attachment and the index head are to be set in a vertical position. The calculations required for this case then become very simple, as no further trials are necessary.

Especial attention should be given to the fact that the spiral leads L used in the trial calculations must be larger than the numerator l in the fraction giving $\sin a$ in Equation (1). If the number expressing the lead were not greater than the numerator, the value of the fraction would be greater than 1, but as the sines of all angles are smaller than 1, this would be an impossible condition.

In finding the lead corresponding to a suitable angle, a simple way is to write the logarithm of the lead L on the upper edge of a second sheet of paper and to hold this under the originally written value of the logarithm of the numerator l in Formula (1), putting the difference on the second sheet of paper until a logarithm of $\sin a$ is found, giving a suitable angle, as explained above. This saves repeating the writing down of the logarithm of the numerator l for each trial subtraction.

TABLE OF RESULTS OBTAINED BY THE CALCULATIONS FOR ANGLE AND LEAD

Piece No. 4-817
Computed by H. W. E.
Checked by W. W. J.
Date: Nov. 17, 1910

For Cam Chart D-904
(See Fig. 4)

Name of Cam	Rise on Cam in Inches	Number of Hundredths	Angle a in Degrees	Lead in Inches	Gear on Worm	First Gear on Stud	Second Gear on Stud	Gear on Screw
Lead cam	0.906	30	76	3.111	40	72	56	100
Lead cam	0.906	$14\frac{1}{2}$	80	6.343	100	44	24	86
Front cam	0.155	24	44	0.930	24	72	24	86
Front cam	0.043	$13\frac{1}{2}$	20	0.930	24	72	24	86
Rear cam	0.337	$32\frac{1}{2}$	82	1.047	24	64	24	86

As another example illustrating what has been said, we may calculate the first lobe on the lead cam. Here $L = 0.906$, $N = 0.30$. Hence $l = \dfrac{0.906}{0.30} = 3.02$. It is found by repeated trials, starting with $L = 3.03$, that no lead gives an angle a even approximately within the given requirements, before we come to the lead 3.111:

$$\begin{array}{rl} & \log 3.02 = 0.48001 \\ \text{(Subtract)} & \log 3.111 = 0.49290 \\ \hline & \log \sin a = \bar{1}.98711 \end{array}$$

Hence $a = 76$ degrees 6 minutes.

While the angle 76 degrees 6 minutes is not quite within the limits that we have specified, it is so nearly so that it is safe enough to assume the setting angle to be 76 degrees, the corresponding lead being 3.111. We can calculate the actual rise of the cam with this lead and angle and compute the error resulting in the rise. From Formula (2) we have:

$$R = \sin a \times N \times L \qquad (4)$$

Inserting $a = 76$ degrees, $N = 0.30$, and $L = 3.111$, we obtain $R = 0.9056$ inch.

The error in the rise thus is 0.0004 inch, which for all practical purposes can be disregarded. The same method is employed for the other lobes. With a little practice, the work can be carried on rapidly, and the method is very simple to remember.

While it is the best practice always to use a spiral lead which corresponds to an angle within 5 minutes of a whole or half degree, as stated, yet a considerable amount of time may be saved in milling cam lobes with several leads, when the greatest accuracy may not be required, by gearing the machine for the greatest lead of lobe and changing the setting angle of the head for the other leads.

* * *

Joseph Brucker, a German-American journalist, will attempt to eclipse Wellman next year. Brucker will make an attempt to cross the Atlantic from the Canary Islands to the West Indies with an airship 200 feet long, now nearing completion. This airship has a gas capacity of nearly 300,000 cubic feet, and is driven by two 200-horsepower motors. A motor-boat 35 feet long and 10 feet wide will serve as a car.

CAST-IRON BRACKET USED AS AN OBLIQUE CANTILEVER

By J. H. C.

A bracket similar to that shown in Fig. 1 had to be designed to carry a very heavy load. The conditions being quite different from those of an ordinary cantilever, whose neutral axis is at right angles to the vertical load line, led to an investigation of the stresses involved. For small brackets with light loads, one would probably hit safe proportions without calculating the strength, but for heavy loads with a long lever arm, for the sake of safety, a few figures do no harm. The result of the investigation spoken of above is here given, with the hope of being interesting to some who may have occasion to use this style of bracket.

In Fig. 1, by means of the triangle of forces, the downward force or load P may be resolved at point O into its components, which are two forces N and R, where N is in the direction of the neutral axis and R at right angles to it. Fig. 2 shows a part of a cantilever in which the forces N and R are taking the place of their resultant, the downward force or load P. The internal force n is resisting the compression due to the outward force N, and is distributed equally over the entire sectional area. The internal resisting forces B, which are compression stresses, and T, which are tensile stresses, are the greatest stresses in the beam due to R. The terms R, T and B are identical with those in the theory of beam flexure. We then have a cantilever of length L inches, loaded with R pounds at the end. In Fig. 1, if the section is symmetrical, the greatest unit stress will occur at point e, for unit compressions due to N and R are added at this point, while at point f, the unit tensile stress due to R is offset by the unit compressive stress due to N, the resisting stresses T and B (Fig. 2) being equal for this style of section.

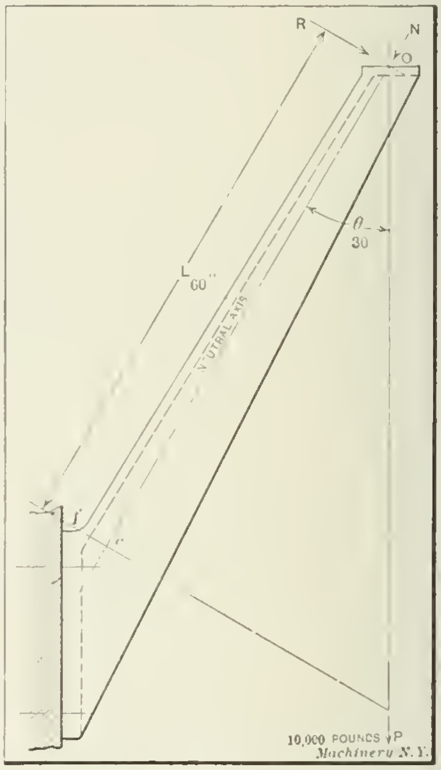


Fig. 1. Cast-iron Bracket used as an Oblique Cantilever

Let the greatest combined unit stress at e equal S; B = unit compressive stress due to R, and a = unit compressive stress due to N. Then $S = B + a$.

From the regular beam formula

$$B = \frac{RL}{Z}$$

where Z = section modulus.

We also have:

$$a = \frac{N}{A}, \text{ where } A = \text{area of section.}$$

$$\text{Then } S = \frac{RL}{Z} + \frac{N}{A}$$

But $R = P \sin \theta$, and $N = P \cos \theta$.

Therefore, by substituting:

$$S = \frac{P \sin\theta \times L}{Z} + \frac{P\cos\theta}{A} = P\left(\frac{L\sin\theta}{Z} + \frac{\cos\theta}{A}\right) \qquad (1)$$

For a section not symmetrical with respect to the neutral axis, the greatest stress might happen to occur at point f, in which case the unit stresses at both e and f must be questioned.

Let S_1 = the greatest combined unit stress at f,
T = the unit tensile stress due to R, and
a = the unit compressive stress due to N.

Then

$$S_1 = T - a,$$

$$T = \frac{R\,L}{Z}$$

where Z = section modulus of that part of the section under consideration. In sections symmetrical with respect to the neutral axis, values of Z are alike for both the tensile and compressive sections.

As before,

$$a = \frac{N}{A}$$

Then

$$S_1 = \frac{R\,L}{Z} - \frac{N}{A}$$

Substituting values of R and N:

$$S_1 = P\left(\frac{L \sin\theta}{Z} - \frac{\cos\theta}{A}\right) \qquad (2)$$

For example, in Fig. 1, let P = 10,000 pounds, L = 60 inches, and θ = 30 degrees, with section as shown in Fig. 3. The material is cast iron.

This section, not being symmetrical with respect to the neutral axis, the unit stresses at both e and f must be found, to make certain that either does not exceed the elastic limit of the material, which for cast iron is about 6000 pounds in tension and 18,000 pounds in compression. Use Formulas (1) and (2) to find the unit stresses at e and f. Here Z, the section modulus, equals $\frac{I}{C}$ or $\frac{I}{C_1}$, where I = the moment of inertia of the entire section in Fig. 3, and C and C_1 = the distance in inches from the neutral axis to the outermost fiber of section under consideration. In this case either the shaded section is in tension due to R, or the legs of the channel not shaded are in compression due to R. Any one of the handbooks (say, "Cambria") gives A, C and C_1, I and Z in terms of the dimensions of the section.

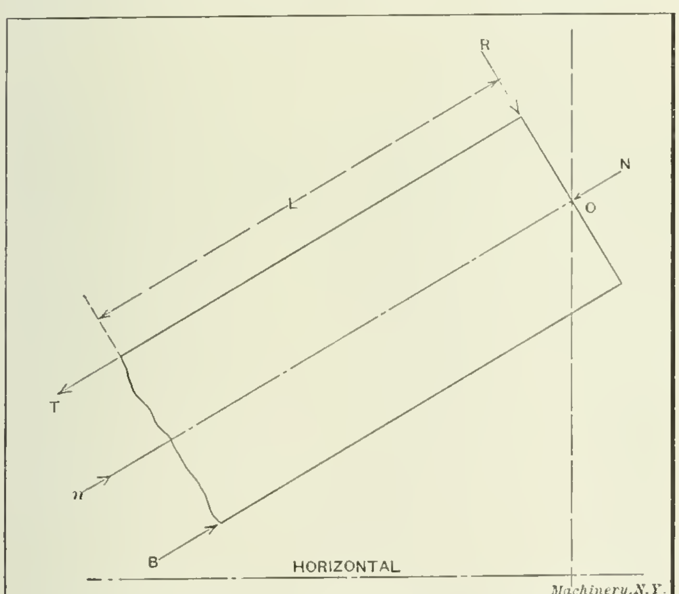


Fig. 2. Diagrammatical Sketch showing Stresses Produced

For section, Fig. 3:

$$A = b\,d - h\,(b - t) = (10 \times 16) - 14\,(10 - 1) = 34.$$

$$C = \frac{2\,b^2\,s + h\,t^2}{2\,A} = \frac{(2 \times 100 \times 1) + (14 \times 1)}{2 \times 34} = 3.15$$

(for shaded section)

$$C_1 = b - C = 10 - 3.15 = 6.85 \text{ (for lower section).}$$

$$I = \frac{2\,s\,b^3 + h\,t^3}{3} - A\,C^2 = \frac{(2 \times 1 \times 1000) + (14 \times 1)}{3} - (34 \times 3.15^2) = 334$$

$$Z \text{ for the shaded section} = \frac{I}{C} = \frac{334}{3.15} = 106$$

$$Z \text{ for the lower section} = \frac{I}{C_1} = \frac{334}{6.85} = 49$$

Using Formula (1) to find the unit stress at e,

$$S = P\left(\frac{L \sin\theta}{Z} + \frac{\cos\theta}{A}\right)$$

where P = 10,000,
L = 60,
$\sin\theta$ = 0.5,
$\cos\theta$ = 0.866,
Z = 49,
A = 34.

$$\text{Then } S = 10{,}000\left(\frac{60 \times 0.5}{49} + \frac{0.866}{34}\right)$$

or S = 6380 pounds unit compressive stress, which is well within the elastic limit of cast iron in compression.

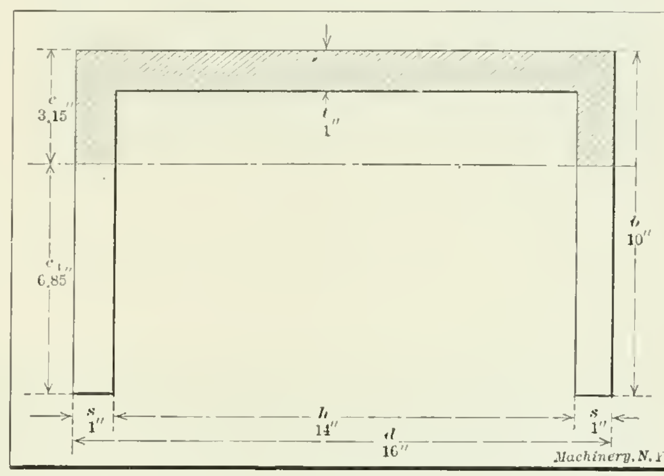


Fig. 3. Assumed Cross-section of Cantilever

Using Formula (2) to find unit stress of f,

$$S_1 = P\left(\frac{L \sin\theta}{Z} - \frac{\cos\theta}{A}\right)$$

The letter values are the same as in (1) excepting Z, which was found for this side of the section to be 106.

$$\text{Then } S_1 = 10{,}000\left(\frac{60 \times 0.5}{106} - \frac{0.866}{34}\right)$$

or S_1 = 2575 pounds unit tensile strength at f, which is well within the elastic limit of cast iron in tension.

* * *

AIR REQUIRED FOR PNEUMATIC HOISTS

The table below, taken from the *Industrial Engineering and Engineering Digest*, and compiled from curves in the 1910 catalogue of the Chicago Pneumatic Tool Co., gives the theoretical amount of free air used per foot when lifting maximum loads under various pressures for different sizes of hoists. In practice, 15 per cent should be added to the values given, in order to cover the losses.

CUBIC FEET OF AIR REQUIRED PER FOOT OF LIFT

Diam. of Hoist Cylinder, Inches	60 Pounds Pressure	80 Pounds Pressure	100 Pounds Pressure
4	0.5	0.6	0.75
6	1.0	1.25	1.60
8	1.75	2.25	2.75
10	2.75	3.50	4.25
12	4.00	5.00	6.00
14	5.30	6.80	8.40
16	7.00	9.00	10.80
20	11.00	14.00	17.00
24	16.00	20.25	24.50

METHOD OF HANDLING BOILER TUBES IN THE CANADIAN PACIFIC SHOPS

In the arrangement of one of the Canadian Pacific Railway repair plants, the tube shop is placed at a considerable distance from the erecting shop where the tubes are placed in the boiler. Owing to this location, considerable difficulty was experienced in handling the tubes and there was a loss of time in moving them from one shop to another. In order to remedy this difficulty the management decided to construct trucks for conveying the tubes and stands for supporting the trucks in a convenient position when removing tubes from a boiler. The material from which this equipment was made is mostly sheet metal and angle iron so that the construction is simple and durable. The trucks, in conjunction with the traveling cranes, greatly facilitate the handling of the tubes, which are systematically arranged so that those from a locomotive are kept together and handled as a unit.

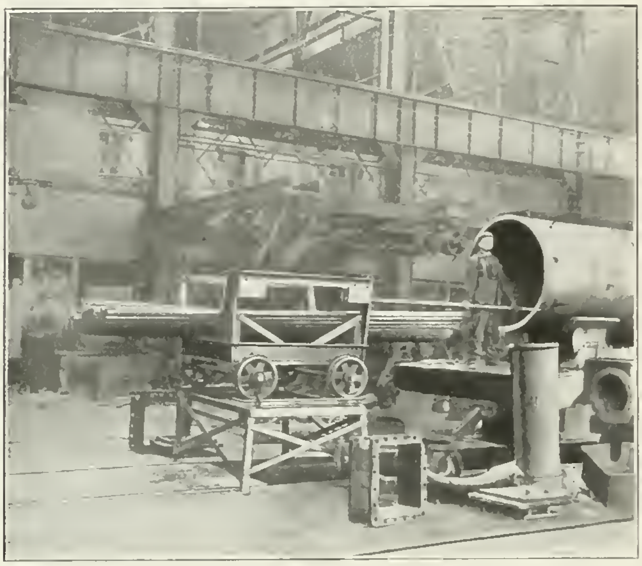


Fig. 1. Removing the Tubes and Placing them on an Elevated Truck

In Fig. 1, of the accompanying illustrations, the stripping gang is shown at work removing the tubes. These tubes are placed upon a truck that is mounted on a stand designed especially for that purpose, the truck being practically on the same level as the boiler. The shafting seen in the background of this illustration, while having no relationship to the subject of this description, is of interest as it operates two drills, two small planers for machining shoes and wedges, and a threading machine; there is also a blacksmith's forge. All of this apparatus is used for the erecting shop only.

Fig. 5 shows how the tubes are transferred from one of the trucks to the tube rumbler. The operation of this rumbler, which is made by Joseph T. Ryerson & Sons, Chicago, Ill., is very simple. The tubes, which are supported by two wide endless chains driven by sprocket wheels, are lowered by lengthening the chains into a pit or tank (seen beneath the truck) which contains water. When the tubes are immersed, they are rolled around by the operation of the chain loops and this continuous rolling movement removes the scale. One of the advantages of this rumbler, over the type commonly used, is in the elimination of practically all noise. This operation requires on an average of from 10 to 48 hours for cleaning about 300 tubes, the variation in time depending upon their condition.

Fig 2. Method of Storing Tubes

Fig. 3. The Tube Welding Department

Fig. 3 shows a general view of the shop. In the left foreground is the tube cutter, and to the right of this a mechanic may be seen working at a tube welding machine, which has a capacity of about 200 tubes per day when operated by an expert. At the right of the illustration can be seen the forges for heating the tubes. Fig. 4 shows the manner in which the tubes are placed so that they can be conveniently handled by the workmen. It will be noticed that a truck containing a

set of tubes has been lowered into a pit to bring the tubes to the most convenient level. The rumbler, which is enclosed in a box-like structure, may be seen in the background. Fig. 2 illustrates the method of storing the tubes. As the engraving shows the trucks are stacked one upon the other, thus enabling a large number of tubes to be stored in a comparatively small space. This illustration also shows a tube cutter.

Fig. 4. Another View of the Tube Department

All the consignments of tubes are closely inspected and a tube is selected at random from every hundred and subjected to the following physical tests:

A longitudinal section or strip 1/2 inch wide by 6 inches long is heated to a cherry red and plunged into a water bath having a temperature of 50 degrees Fahrenheit. The piece is

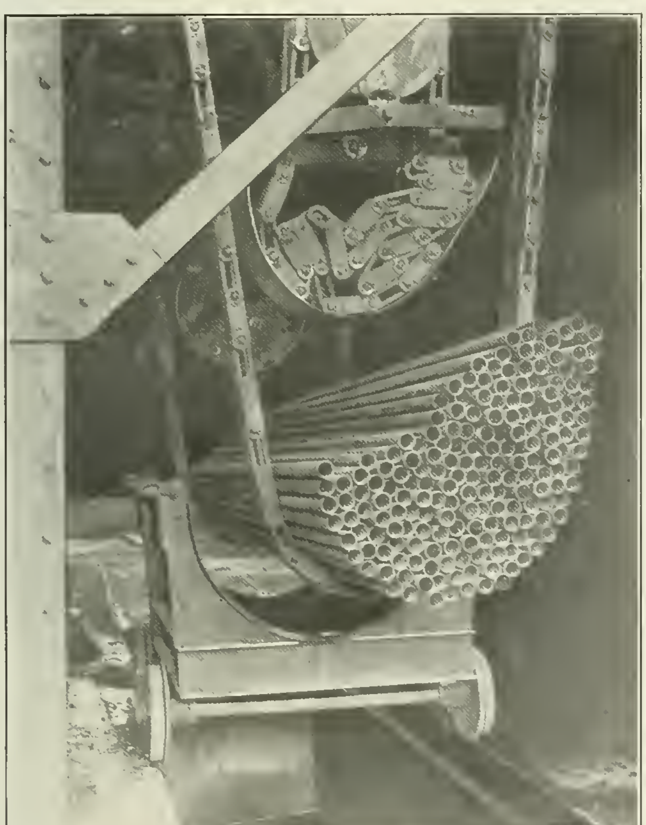


Fig. 5. Removing Tubes from the Rumbler

then doubled upon itself and hammered flat. This must be accomplished without cracking the material. The heating is for the purpose of checking the carbon content.

Another section of the tube having a length equal to one-half the diameter, is placed vertically on an anvil and subjected to a series of light blows. This piece must also crush flat without cracking. A section 6 inches long must not crack when flattened cold on itself, even though the weld forms one edge. A section having a length of 2 inches must not crack when a ⅜-inch flange is formed at right angles to the tube.

THE EFFECT OF KEYWAYS ON THE STRENGTH OF SHAFTS*

The strength and the proper proportioning of keys have been subjects of considerable study and of some experimentation, but the effect of the keyway on the torsional strength of the shaft has apparently been studied but little. Evidently, the keyway must weaken the shaft in which it is cut. In view of the very effective use of shafts with keyways, and the small amount of information available on the subject, the effect of keyways on the torsional strength of shafts has seemed to the author a problem worthy of some experimental study. The following is an account of an investigation carried on in the Laboratory of Applied Mechanics by the Engineering Experiment Station of the University of Illinois.

The mathematical analysis of the strength of a shaft with a keyway cut in it is a problem of great complexity. So far as the writer knows, there has been no successful attempt to develop the mathematical theory of the stress in a shaft with a keyway cut in it. However, as the range of sizes of shafts and keys in common use is not very great, it was thought that an experimental study of the effect of keyways on the strength of shafts might lead to formulas which may be safely used in nearly all the cases met with by the designer of shafts and keys. A considerable part of the experimental work was performed by F. E. Leidendeker, class of 1908, and O. Craig and J. C. Lund, class of 1909, senior students of the College of Engineering of the University of Illinois.

Adopting a nomenclature similar to that used by many writers on the strength of riveted joints, the ratio of the strength of a shaft with a keyway to the strength of a similar shaft without a keyway is hereafter spoken of as the *efficiency* of the shaft with keyway. The elastic limit of a shaft under torsion is taken as the measure of its strength.

The following notation is used:

d = actual diameter of shaft in inches,
w = width of keyway divided by diameter of shaft,
h = depth of keyway divided by diameter of shaft,
T = torsional (twisting) moment on shaft in inch-pounds,
M = bending moment on shaft in inch-pounds,
J = polar moment of inertia of cross-section of shaft $\left(\text{for circular shaft, } J = \dfrac{d^4}{10.2}\right)$
f = greatest fiber stress in shaft due to torsion,
a = angle of twist of shaft in degrees,
l = length of shaft in inches,
E_s = modulus of elasticity of material of shaft in shear (torsion),
e = efficiency of shaft with keyway,
k = ratio of angle of twist of shaft with keyway to angle of twist of similar uncut shaft,
H. P. = horsepower,
R. P. M. = number of revolutions per minute.

The following formulas are used:

$$T = \frac{2fJ}{d}$$

$$a = \frac{2fl}{E_s d} \times 57.3$$

$$T = 63{,}020 \frac{\text{H.P.}}{\text{R.P.M.}}$$

The first two formulas are based on the following assumptions: 1. That a plane section of the shaft remains plane during torsion; 2. That the fiber stress varies uniformly from zero at the axis of the shaft to a maximum at the outer fiber, *i. e.*, the modulus of elasticity for shear remains constant. The first assumption is not true for shafts which are not circular in cross-section.

* Abstract from Bulletin No. 42, of the Engineering Experiment Station, University of Illinois, Urbana, Ill. Herbert F. Moore, assistant professor of theoretical and applied mechanics, is the author of the bulletin.

Test Pieces, Tests, and Method of Testing

As nearly all shafting in common use is cold-rolled, the principal series of tests was made on specimens of cold-rolled steel shafting. The diameters of the test shafts of these series were 1 1/4, 1 9/16, 1 15/16, and 2 1/4 inches. Shafts were tested under simple torsion and under torsion combined with bending. The bending moment applied to the shaft was in one case equal to the torsional moment, aud in another equal to three-fifths of the torsional moment.

For transmitting power, it is common American practice to use a square key whose width and depth are each equal to about one-fourth the diameter of the shaft (Kent's Mechanical Engineer's Pocket-Book, pages 975 and 976). This means a keyway in the shaft in which $w = 0.25$ and $h = 0.125$. The depth of keyway is measured as shown in Fig. 1.

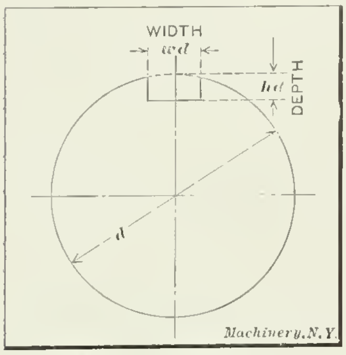


Fig. 1. "Square" Keyway

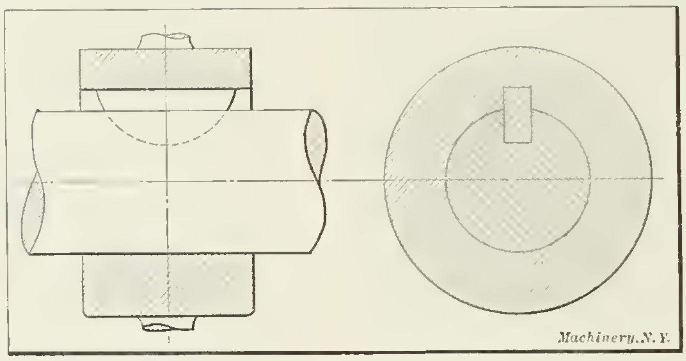


Fig. 2. Woodruff Key and Keyway

Shafts were also tested with keyways for the Woodruff system of keying. The outline of the Woodruff key and its keyway is shown in Fig. 2. In choosing the sizes of Woodruff keyways to be cut in the test shafts, the shearing strengths of various standard sizes of keys were calculated, and a standard size was chosen such that the shearing strength of two keys equaled, as nearly as possible, the torsional strength of the solid test shaft in question. The sizes of the Woodruff keys chosen are shown in Tables I and II.

In addition to the above tests for the effect of single keyways on the strength of cold-rolled shafting, tests were made which yielded data on the following subjects: ultimate strength of shafts with keyways; effect of two keyways at right angles; effect of length of keyway; effect of keyways on turned steel shafting. All keyways, except in the tests for studying the effect of length of keyways, were cut to a length equal to about four times the diameter of the shaft, no keyway being longer than eight inches.

All material for the test shafts was bought in the open market. Both the cold-rolled and the turned shafting were of ordinary soft steel. With a very few exceptions, all tests were made in duplicate. All shafts tested under simple twisting were tested in the 230,000-inch-pound Olsen torsion testing machine.

Data and Results

Table I shows the results of tests to breaking, of shafts with and without keyways. It seems that a shaft with a single keyway of common dimensions has about the same ultimate strength as a shaft without a keyway. In the torsional tests to destruction, after the elastic limit of the shaft had been passed, the keyways gradually closed up and at rupture they were entirely closed. The larger keyways and the two keyways 90 degrees apart lowered the ultimate strength somewhat. The variation in strength due to difference in material of the shafting seems to cause more variation in ultimate strength than is caused by different keyways. The elastic limit of a shaft is more significant than its ultimate strength.

While, as mentioned, the keyways in nearly all the shafts tested were cut to a total length of about four times the diameter of the shaft, no keyway being longer than eight inches, in several special shafts keyways were cut eighteen inches long. No difference between the *strength* of shafts with long keyways and that of similar shafts with the usual shorter keyways was observed.

One test was made of a shaft having two keyways 90 degrees apart cut in it, the two keyways being located in the same cross section of the shaft. While the result of this single test is by no means conclusive, it is of interest to note that the reduction in strength at the elastic limit of the shaft by these two keyways was nearly three times as great as the reduction in strength at the elastic limit of a similar shaft by one such keyway.

The tests made were mainly on cold-rolled shafting, but a few tests were made on test specimens of turned shafting. These results must be regarded as tentative. In these tests the effect of keyways on the strength of turned shafting at the elastic limit seemed to be about the same as the effect of keyways on the strength of cold-rolled shafting.

During the tests, the question arose as to the difference in strength of a shaft with an empty keyway and a shaft on which a pulley was keyed in place, the key nearly filling the keyway. It was judged best, however, to test shafts with empty keyways, as there is usually a part of the keyway at either end not filled by the key, and a perfect fit of the key in the keyway is by no means certain, especially after long service and, therefore, for purposes of design the empty keyway determines the strength of the shaft.

TABLE I. ULTIMATE STRENGTH OF SHAFTS WITH AND WITHOUT KEYWAYS

Values are the average results of two tests.

Diameter of Shaft	Keyway		Maximum Twisting Moment, Inch-pounds	Maximum Computed Fiber Stress (solid shaft) Pounds per Square Inch	H.P. 100 R. P. M.	Remarks
	Width, Inches	Depth, Inches				
1¼ inch, cold-rolled	0	0	27,400	70,550	43.4	Shaft without keyway
	¼	¼	27,600	71,000	43.8	
	⅜	¼	30,300	78,000	48.0	
	¼	⅜	24,400	63,000	38.7	
	¼	⅛	27,600	71,000	43.8	
	⅜	⅛	27,200	70,000	43.1	
	No. 10	No. 10	25,500	65,800	40.4	Keyway for No. 10 Woodruff
	No. 15	No. 15	26,200	67,600	41.6	Keyway for No. 15 Woodruff
	¼	¼	25,300	65,200	40.1	2 keyways 90 deg. apart
1¼ inch, turned	0	0	25,300	65,200	40.1	Shaft without keyway
	¼	¼	25,800	66,400	40.9	
	¼	⅜	25,500	65,700	40.4	
	No. 10	No. 10	23,700	61,000	37.6	Keyway for No. 10 Woodruff
	No. 15	No. 15	24,100	62,100	38.2	Keyway for No. 15 Woodruff
1⅝ inch, cold-rolled	0	0	54,700	65,000	86.8	Shaft without keyway
	11/32	11/64	56,400	67,000	89.6	
2 inches, cold rolled	0	0	103,700	66,000	164.5	Shaft without keyway
	7/16	7/32	102,100	65,000	162.0	
	7/16	7/16	101,500	64,600	161.1	
	7/16	9/16	94,200	60,000	149.1	
	9/16	7/32	104,500	66,500	165.7	
	No. 16	No. 16	105,300	67,000	167.0	Keyway for No. 16 Woodruff
	No. 21	No. 21	100,500	64,000	158.7	Keyway for No. 21 Woodruff
2 inches, turned	0	0	100,500	64,000	158.7	Shaft without keyway
	7/16	7/32	94,200	60,000	149.1	
	9/16	7/32	94,200	60,000	149.1	
	No. 16	No. 16	89,800	57,200	142.5	Keyway for No. 16 Woodruff
	No. 21	No. 21	85,000	54,100	134.8	Keyway for No. 21 Woodruff

The amount of twist in a shaft transmitting power is frequently of importance. Table III gives the ratio of angle of twist of shafts with keyways to angle of twist of shafts without keyways as computed from the data of the torsional tests for stresses within the elastic limit. The results are fairly well represented by the equation

$$k = 1.0 + 0.4\,w + 0.7\,h,$$

in which

k = ratio of angle of twist of shaft with keyway to angle of twist of similar shaft without keyway,

w = width of keyway divided by diameter of shaft,

h = depth of keyway divided by diameter of shaft.

Keyways for two Woodruff keys of shearing strength sufficient to develop the full twisting strength of shaft seemed to reduce the stiffness of the shaft somewhat less than did a keyway for a square key whose side measures one-fourth the diameter of the shaft. In considering the torsional stiffness of a shaft, it must be remembered that the keyways reduce the stiffness only over that portion of length which they actually occupy.

TABLE II. EFFICIENCY OF SHAFTS WITH KEYWAYS

$$\text{Efficiency} = \frac{\text{elastic strength of shaft with keyway}}{\text{elastic strength of shaft without keyway}}$$

Dimensions of Keyway	w = 0.50 h = 0.125	w = 0.25 h = 0.1875	w = 0.25 h = 0.125	Woodruff System*
Under simple torsion:				
Cold-rolled shaft, dia. $1\frac{1}{4}$ inch	0.762	0.760	0.820	0.840
Cold-rolled shaft, dia. $1\frac{9}{16}$ inch	0.803	0.846	0.900	0.860
	0.758	0.817	0.889	0.815
Cold-rolled shaft, dia. $1\frac{15}{16}$ inch	0.748	0.710	0.860	0.826
	0.764	0.750	0.824	0.835
Cold-rolled shaft, dia. $2\frac{1}{4}$ inch	0.848	0.775	0.839	0.943
	0.705	0.689	0.825	0.861
Under combined torsion and bending:				
1. Twisting moment = Bending moment	0.630	0.636	0.791	0.716
Cold-rolled shaft, dia. $1\frac{1}{4}$ inch	0.680	0.698	0.803	0.750
Cold-rolled shaft, dia. $1\frac{15}{16}$ inch	0.584	0.697	0.854	0.858
	0.671	0.775	.....	0.840
2. Twisting moment = $\frac{5}{8}$ Bending moment	0.895	0.670	0.940	0.930
Cold-rolled shaft, dia. $1\frac{1}{4}$ inch	0.870	0.735	0.888	0.880
Cold-rolled shaft, dia. $\frac{15}{16}$ inch	0.740	.....	0.832	0.856
	0.815	.....	0.840	0.810
General Average	0.752	0.735	0.850	0.845

* In $1\frac{1}{4}$-inch shafts keyways were cut for No. 15 Woodruff keys; $1\frac{9}{16}$-inch shafts keyways were cut for No. 25 Woodruff keys; $1\frac{15}{16}$-inch shafts keyways were cut for No. S Woodruff keys; $2\frac{1}{4}$-inch shafts keyways were cut for No. U Woodruff keys.

Efficiency of Shafts with Keyways

The efficiency of a shaft with keyway has already been defined as the ratio of strength at elastic limit of a shaft with keyway to the strength at elastic limit of a similar shaft without keyway. Table II shows the efficiency of the various test shafts. From this table it would appear that for a set of shafts of different sizes having the dimensions of the keyway kept proportional to the diameter of shaft, the efficiency does not depend, to any noticeable degree, on the size of shaft. The efficiency does not seem to be affected by the addition of a bending moment as great as the twisting moment. The efficiency of a shaft with two keyways cut in the same plane for two Woodruff keys, of such size that the strength of the solid shaft was equal to the shearing strength of the two Woodruff keys is about the same as the efficiency of a shaft with a keyway whose width equals one-fourth the diameter of the shaft and whose depth equals one-eighth the diameter of the shaft.

TABLE III. RATIO OF ANGLE OF TWIST OF SHAFT WITH KEYWAY TO ANGLE OF TWIST OF SIMILAR SHAFT WITHOUT KEYWAY

Diameter of Shaft, Inches	Dimensions of Keyway: w = 0.25 h = 0.125	w = 0.25 h = 0.1875	w = 0.50 h = 0.125	Woodruff System*
$1\frac{1}{4}$	1.24	1.25	1.27	1.11
$1\frac{9}{16}$	1.14	1.24	1.19	1.11
	1.18	1.21	1.36	1.18
$1\frac{15}{16}$	1.16	1.21	1.41	1.11
	1.29	1.48	1.54	1.12
$2\frac{1}{4}$	1.10	1.25	1.18	1.05
	1.10	1.28	1.37	1.10
Average	1.17	1.27	1.33	1.11

* See Table II for sizes of Woodruff keyways

The results of the foregoing tests are fairly well represented by the equation

$$e = 1.0 - 0.2\,w - 1.1\,h, \text{ in which}$$

e = efficiency of shaft with keyway,

w = width of keyway divided by diameter of shaft,

h = depth of keyway divided by diameter of shaft.

This equation gives efficiencies slightly lower than those observed for keyways of small width or depth, and efficiencies about the same as those observed for keyways in which $w = 0.50$ and $h = 0.125$; or $w = 0.25$ and $h = 0.1875$. As this equation is entirely dependent on the results of experiments, it should not be used for points much outside the limits of the experiments. The limits of the above series of tests were keyways having $w = 0.50$ and $h = 0.1875$.

Fig. 3 affords a convenient graphical method of applying the above formula, and is used as follows: To determine the efficiency of a shaft with a given (or proposed) keyway, locate on the diagram a point whose vertical distance from 0 equals the value of h, and whose horizontal distance from 0 equals the value of w. This point will, in general, fall between two lines representing values of efficiency, and the efficiency of the shaft in question may then be estimated with sufficient accuracy. The space within the triangle OAB represents the range covered by the tests actually performed, and covers the proportions of keyways commonly used in practice.

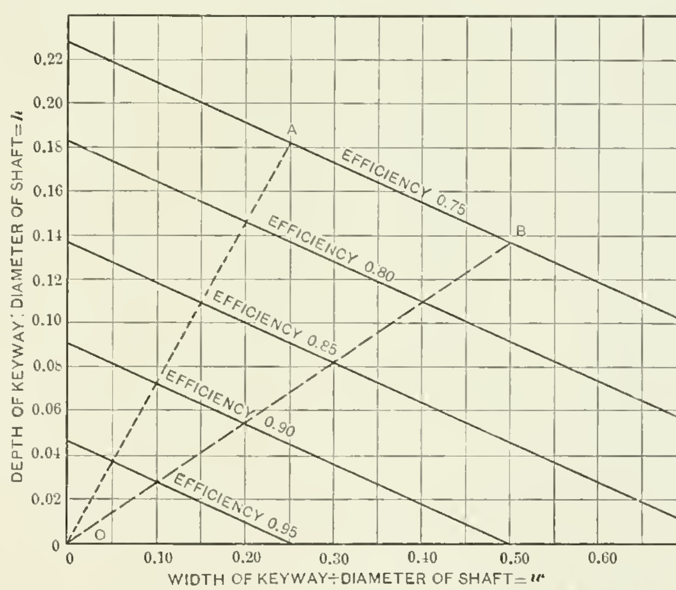


Fig. 3. Diagram for Determining "Efficiency" of Shaft with Keyway

Torsional Strength of Shafts with Keyways

The object of these tests was to determine ratios of strength and stiffness between shafts with keyways and shafts without keyways. The number of tests was not sufficient to give very much information as to the properties of cold-rolled steel shafting. However, as a matter of general interest, the values found in these tests for the modulus of elasticity in shear (torsion), and of the fiber stress at the elastic limit of the cold-rolled test shafts at sections without keyway, have been tabulated in Table IV.

Taking the fiber stress at the elastic limit of cold-rolled steel shafting at 37,500 pounds per square inch (a value slightly less than the average found in the tests), and the efficiency of shafts with keyways from the equation $e = 1.0 - 0.2\,w - 1.1\,h$, values for the twisting moments and the horsepower at 100 R.P.M., transmitted by cold-rolled shafts stressed to the elastic limit, have been computed for various sizes and tabulated in Table V. These values are for shafts with keyways for square keys whose side measures about one-fourth the diameter of the shaft. In the use of this table, a suitable factor of safety should be allowed.

TABLE IV. MODULUS OF ELASTICITY IN SHEAR (TORSION) AND ELASTIC LIMIT IN TORSION OF COLD-ROLLED STEEL SHAFTING

Diameter of Shaft, Inches	Modulus of Elasticity	Fiber Stress, Pounds per Square Inch
$1\frac{1}{4}$	12,900,000	43,300
$1\frac{9}{16}$	12,000,000	36,800
$1\frac{9}{16}$	12,490,000	38,500
$1\frac{15}{16}$	10,800,000	36,800
$1\frac{15}{16}$	12,660,000	40,500
$2\frac{1}{4}$	11,340,000	36,200
$2\frac{1}{4}$	11,710,000	40,500
Average	11,985,000	38,940

TABLE V. STRENGTH OF SHAFTS WITH KEYWAY

Diameter of Shaft, Inches	Side of Key, Inches	Twisting Moment, Inch-pounds	Horsepower at 100 R. P. M.
1	$\frac{1}{4}$	5,980	9.5
$1\frac{1}{16}$	$\frac{9}{32}$	7,080	11.2
$1\frac{1}{8}$	$\frac{9}{32}$	8,510	13.5
$1\frac{3}{16}$	$\frac{5}{16}$	9,980	15.7
$1\frac{1}{4}$	$\frac{5}{16}$	11,680	18.5
$1\frac{5}{16}$	$\frac{11}{32}$	13,390	21.3
$1\frac{3}{8}$	$\frac{11}{32}$	15,550	24.7
$1\frac{7}{16}$	$\frac{3}{8}$	17,590	27.9
$1\frac{1}{2}$	$\frac{3}{8}$	20,190	32.0
$1\frac{9}{16}$	$\frac{13}{32}$	22,600	35.9
$1\frac{5}{8}$	$\frac{13}{32}$	25,660	40.7
$1\frac{11}{16}$	$\frac{7}{16}$	28,500	45.2
$1\frac{3}{4}$	$\frac{7}{16}$	32,060	50.9
$1\frac{13}{16}$	$\frac{15}{32}$	35,350	56.1
$1\frac{7}{8}$	$\frac{15}{32}$	39,420	62.6
$1\frac{15}{16}$	$\frac{1}{2}$	43,180	68.5
2	$\frac{1}{2}$	47,860	75.9
$2\frac{1}{16}$	$\frac{17}{32}$	52,140	82.7
$2\frac{1}{8}$	$\frac{17}{32}$	57,900	91.1
$2\frac{3}{16}$	$\frac{9}{16}$	62,210	98.7
$2\frac{1}{4}$	$\frac{9}{16}$	68,160	108.2
$2\frac{5}{16}$	$\frac{19}{32}$	73,490	116.6
$2\frac{3}{8}$	$\frac{19}{32}$	80,120	127.1
$2\frac{7}{16}$	$\frac{5}{8}$	86,080	136.6
$2\frac{1}{2}$	$\frac{5}{8}$	93,470	148.3

* * *

An amateur's method of making an index wheel which produced a fair result was as follows: A series of holes was drilled in a flat brass strip, using a simple drilling jig containing two holes and indexing from the hole just drilled to the next. The method was really a stepping-off process, using the drill and jig instead of a pair of dividers. The spacing of the holes was made so as to secure the desired number of holes in a circle of the approximate circumference wanted. For example, suppose 50 holes were required in a circle of 25 inches circumference (about 8 inches diameter). Then the spacing was made about ½ inch, and 51 holes were drilled in line in the strip. When the holes were drilled the ends of the strip were beveled to match at an angle of 45 degrees and the strip was evenly bent around a suitable mandrel to a circle. The bevels at the ends were cut through the two end holes slightly beyond their centers, and the ends were brought together and the drill or a plug of the same diameter was placed in the hole thus formed to locate the ends exactly the right distance apart. They were secured by solder and the complete ring was mounted in a wooden chuck and bored out. The wheel on which the index ring was to be mounted was turned to fit and the ring mounted in place.

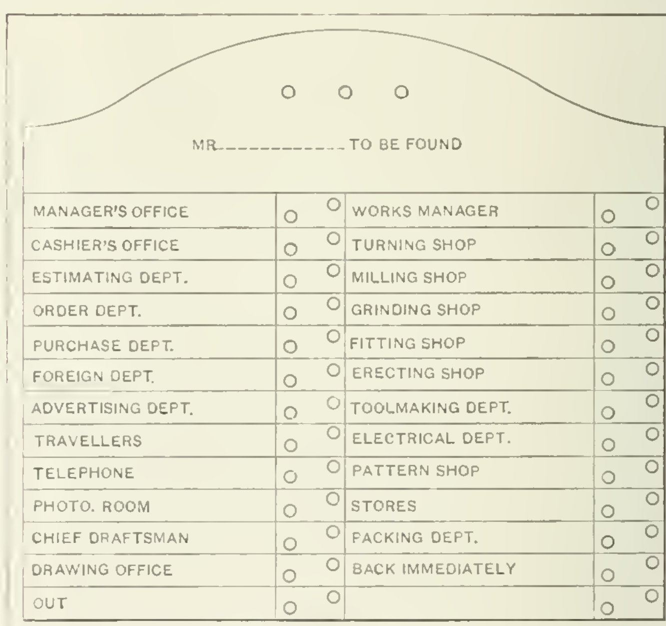
A SYSTEM FOR LOCATING HEADS OF DEPARTMENTS

By VICTOR WHITE

It is often the case in large offices and other departments of engineering works that a draftsman is called away to some portion of the shop to get particulars for his work, or is called upon to make his appearance before the various departments connected with the drawing office. The same remark holds good to a considerable extent with other sections of the works organization, such as the cost department, the ordering and purchasing offices and the stores. During the absence of the man in charge of a particular piece of work, he may be required by someone else in the firm, and the course usually adopted is to leave a note on the vacant desk, asking the occupier on returning to communicate with the writer.

The method described is somewhat cumbersome and wasteful of time, so that a little device which has been brought into operation by one of our foremost engineering firms may be considered with interest. This consists of a form, as shown in the accompanying illustration, which is drawn on tracing cloth, and from which any number of blueprints can be made. These blueprints are then mounted on stiff cardboard, and holes punched in the card in positions as indicated in the illustration. The cards are then filled in with the names of the departments, and other members of the firm who need to be consulted from time to time, and small pegs having flat tops are made to fit these holes. Two of these pegs are provided for each card, one being plain on the top, the other being marked with the name of the department, and they are then used as follows:

Supposing that the draftsman has to go into, say, the milling shop, to see how a particular piece of work is being carried out: He takes the blank peg from its hole in the top of the card and places it in the column opposite the word "milling shop." Anyone coming along later and wishing to find this man will then see from the index that Mr. So-and-So is to be found in the milling shop. The use of the index peg is as follows:



Card used in Locating Heads of Various Departments

Supposing that the man has left his post with the object of finding someone else: He takes with him the peg marked with the name of his department. Should the second person not be in his accustomed place, the first man puts the peg he has brought with him into one of the top holes of the card, and on the return of the second man he will find he is required by such-and-such a department. The rule is, then, that he must proceed at once to this department, carrying the peg back with him and must restore it to the man who has asked for him. In this way a perfectly simple and auto-

matic means for drawing the attention of one department to the requirements of another, is obtained.

In the case of head men or overseers whose duties involve a tour around the works, it is necessary to provide them with a series of pegs numbered consecutively. Before starting out from their office they then place the pegs in numerical order in the holes corresponding to the route which they intend to take. For example, the works manager may first of all wish to visit the drawing office, he may then proceed to the purchase department, to insure that goods are being ordered in accordance with drawings, then he may have something to say to the foreman of the pattern makers, and he may wind up his tour in the stores before returning to his own place. In this way he will put pegs numbered 1, 2, 3 and 4 opposite the various departments in their right order, so that any messenger boy who wishes to find him quickly will simply refer to the card and follow the same route. This system, although extremely simple, has been found to be of considerable timesaving value in cases where large numbers of departments have had to work together.

* * *

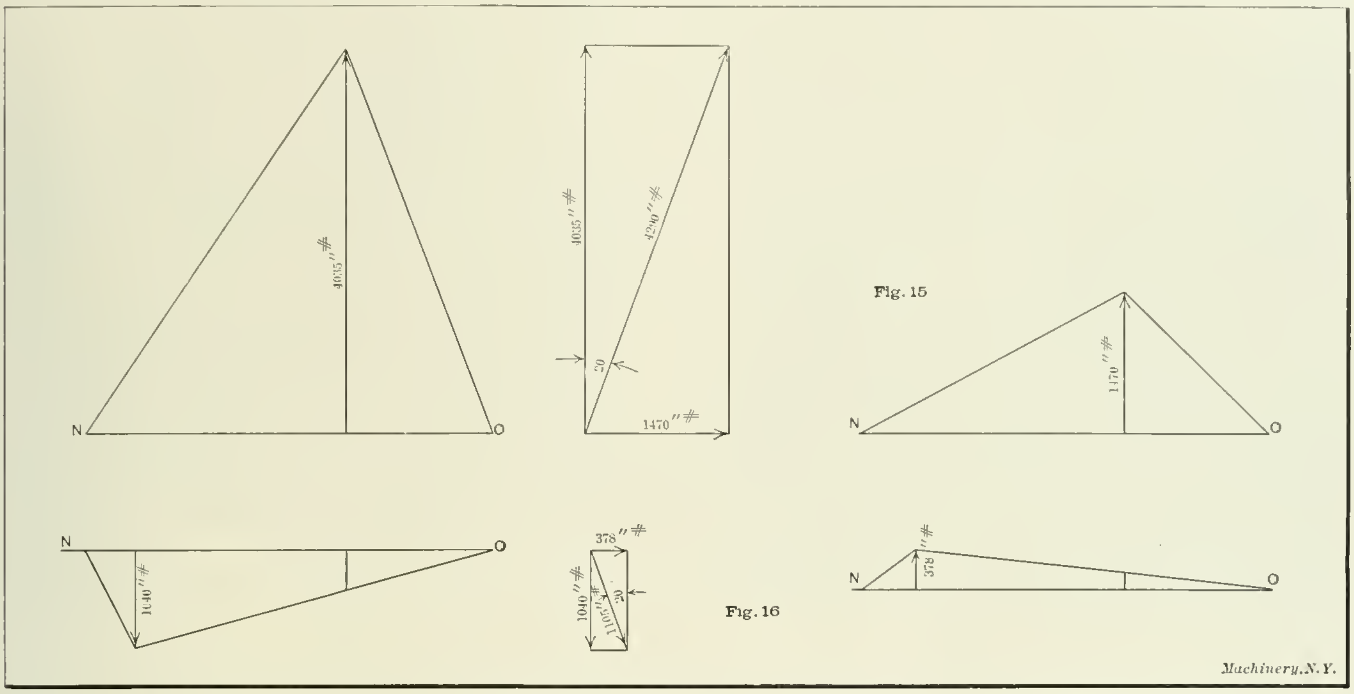
The tests carried out by the Stora Kopparoergs Bergslags Co. in Sweden with an experimental furnace for investigating the feasibility of electric iron smelting, have been successful, and a large electric smelting furnace is now being built. The company is planning to build ten of the new furnaces successively, each to have a capacity, at a low estimate, of 16,000 tons of pig iron a year. The power consumption will be about 40,000 horsepower, all the power required being generated at hydro-electric stations owned by the company.

DESIGN OF AUTOMOBILE TRANSMISSION GEARS*†—3

By M. TERRY‡

The preceding discussion of bearing pressures makes it clear that the secondary shaft is simultaneously subjected to two bending moments and a torque of 3080 inch-pounds. On intermediate, slow and reverse speeds, the torsional moment and one of the bending moments remain unchanged, while the second bending moment is determined by the speed. Since the greatest straining effort must be determined, it would first be necessary to solve three combinations of bending moments. The writer will limit his discussion to the slow speed, which, in the problem at hand, gives the greatest value of combined bending moments. The same method can be applied, of course, to the intermediate and reverse speeds. Since the distances between the bearings of the square and secondary shafts are the same, the bending moments on the two shafts at the center lines of gears D and H (Fig. 2) are the same, or 4290 inch-pounds (Table II). The second bending moment is equal to the reaction at N produced by pressure on gear B, multiplied by its distance from the center line of B, that is $1040 \times 1\ 1/16 = 1105$ inch-pounds. (See December issue, page 268.)

Since any bending moment is located in the plane of the



Figs. 15 and 16. Bending Moments on Secondary Shaft due to Contact of D and H, and A and B, respectively, Resolved into their Vertical and Horizontal Vectorial Components

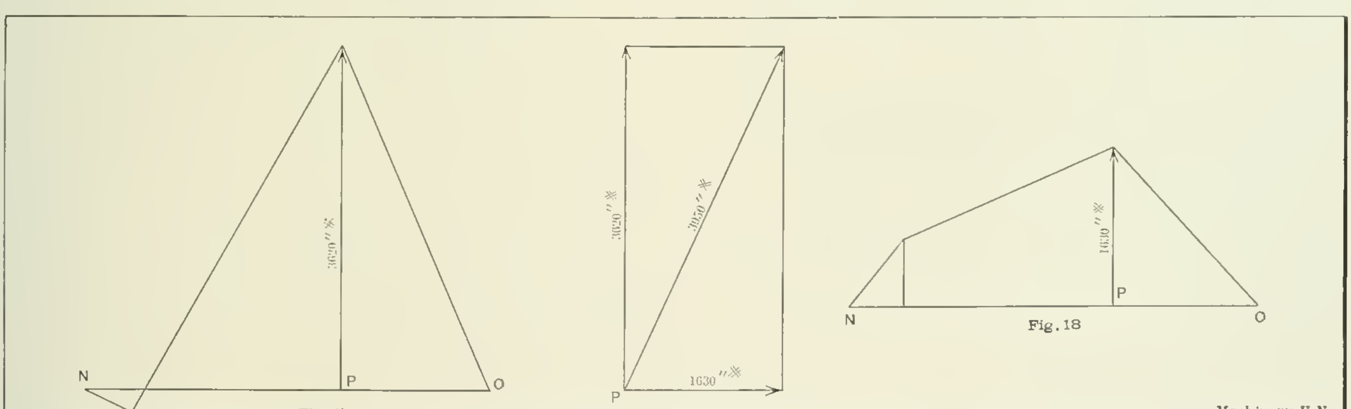


Fig. 17 Bending Moment Diagram for Combined Vertical Component Diagrams of Figs. 15 and 16. Fig. 18. Bending Moment Diagram for Combined Horizontal Component Diagrams of Figs. 15 and 16. Fig. 19. Maximum Vectorial Sum of Vertical and Horizontal Bending Moments

* This concludes the series of articles on this subject, previous installments of which appeared in the October and December numbers.

† An error appeared in the formula at the foot of the first column of the December installment of this article. Instead of

$$Te = zf = 0.200\, h^3$$

it should read

$$Te = zf = 0.200\, h^3 f.$$

‡ Address: 302 Williams St., Flint, Mich.

force producing it, it is clear at once, by referring to Fig. 10, that the said two moments are located in planes making an angle of 140 degrees with each other. The geometrical method for combining forces may also be applied to moments. This is shown in Figs. 15 and 16 where these two bending moments are resolved into vertical and horizontal components. Fig. 17 is the vectorial combination of the two vertical components shown in Figs. 15 and 16, while Fig. 18 is a similar combination of the horizontal components. These latter two figures are formed by adding vectorially the moments at any particular point on the shaft, the horizontal line representing that shaft. It will be noted that the vertical components are subtracted, while the horizontal ones are added. This is explained by the fact that the former act in opposite senses, while the latter act in the same sense. In reality, the moment diagrams of Figs. 17 and 18 are at an angle of 90 degrees with respect to each other. The resultant moment at any point on the secondary shaft can be represented by the hypotenuse of a right-angle triangle, whose legs are the moments at corresponding points of Figs. 17 and 18.

Those who are familiar with geometry can see at once that the maximum resultant moment is at P and is equal in extent to 3950 inch-pounds, as shown by Fig. 19. In some cases, however, it is impossible to determine at a glance where the maximum moment will occur and several triangles must, of necessity, be constructed before the location and magnitude of the maximum moment can be determined.

Combining the resultant bending moment of 3950 inch-pounds with the torsional moment of 3080 inch-pounds by the previously mentioned formula,

$$T_e = M_b + \sqrt{M^2_b + M^2_t}$$

$T_e = 3950 + \sqrt{3950^2 + 3080^2} = 8960$ inch-pounds = equivalent torsional moment.

To find the diameter of the secondary shaft, solve for D in the following equation:

$$T_e = 0.196\, f\, D^3$$

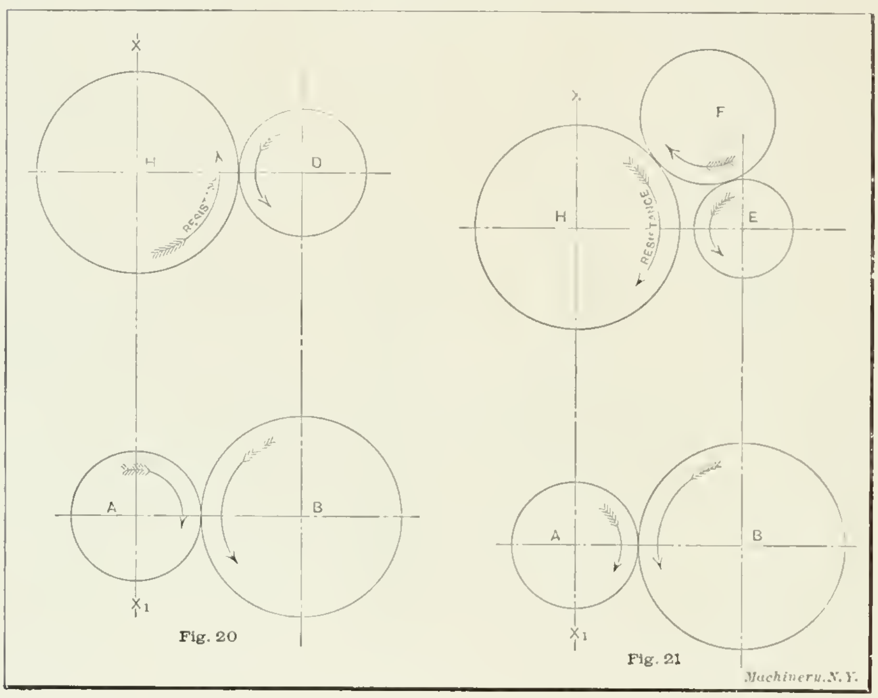
which applies for a solid shaft; and, finally the diameter may be determined for a hollow shaft by the following formula:

$$T_e = 0.196\, f\, \frac{D^4 - d^4}{D}$$

where in both cases

D = the outside diameter of the shaft,
d = inside diameter of the hollow shaft,
f = safe unit stress.

For the case of a hollow shaft it is merely necessary to assume a desired size of hole for the shaft.



Figs. 20 and 21. Directions in which Transmission Box tends to rotate with Forward and Reverse Drives, respectively

Support of Transmission Case

Any automobile transmission constitutes what is generally known as an "epicyclic train." At any given speed (direct drive excepted) the gears in active mesh form the "train" and the transmission box forms the "arm." By locking the arm, the forward and backward motion of the car becomes possible, for if the arm were not locked, that is in other words, if the transmission box were not laterally supported, the frictional resistance of the rear wheels resulting from contact with the ground, and the inertia of the car, would lock the last gear of the train (G or H) and spinning of the transmission box would be the result.

In Fig. 20, X-X, is the axis of longitudinal support. The driving torque of A tends to rotate the box clockwise about X-X, while the resisting torque of H produces a similar effect on the box in a counter-clockwise direction. The net effect on the box is the difference of the two on the slow speed. On the reverse, however, both the driving and resisting torques act in a clockwise manner with a net effect on the box of the sum of the two. This latter is shown in Fig. 21. From Table II we have the following:

On slow speed:
- Torque on H = 5650 inch-pounds, counter-clockwise
- Torque on A = 1680 inch-pounds, clockwise
- Net torque = 3970 inch-pounds, counter-clockwise.

On reverse:
- Torque on H = 7260 inch-pounds, clockwise
- Torque on A = 1680 inch-pounds, clockwise
- Net torque = 8940 inch-pounds, clockwise.

When the transmission is located next to the rear axle, as in E.M.F. and Overland cars, the transmission box is bolted to the bevel-gear housing, the bolts being usually located in a circle. Besides resisting the lateral torque of the box, these bolts are called upon to support the eccentric load caused by bearing pressures, and also to resist the moment of the torque tube. The same conditions, with the exception of the torque tube moment, exist in unit power plants. Where transmission constitutes an independent unit it is usually bolted to the frame or sub frame, and the bolts may then be either in tension or in shear. Various departures and modifications of the above methods of supporting transmissions are in use, and it is necessary that each case be analyzed by the designer; but no matter how the transmission box is to be supported, provisions must be made for the lateral torque of the box, which has its maximum value on the reverse.

* * *

Considerable comment is made in the report for the year on the operations of Lloyd's register of British and foreign shipping on the advent of the internal combustion engine for marine propulsion, as it is becoming a question of immediate and practical importance. The Diesel oil engine is being fitted to three fairly large vessels, built on the continent under the supervision of the surveyors of Lloyd's register. These are of a new two-cycle type, capable of reversing and are, therefore, direct-connected. Producer gas engines are also being installed on vessels under Lloyd's supervision. The internal combustion engine for marine service is apparently here to stay.

* * *

The first world's aerial exhibition held at the Crystal Palace, London, England, from December 1 to January 31, promises to be the most important aeronautical exhibition held thus far. It will be divided into sixteen sections and will deal with the history of aeroplanes, balloons, and dirigibles, as well as with the present types.

AEROPLANES AND AIRSHIP ENGINES*

In France and America some of the most successful light gasoline engines have been designed for aviation service. A novel form of French aeroplane and airship motor is shown in the accompanying half-tone illustration Fig. 1, and line engravings Figs. 3 and 4. This engine is designed and constructed by the Société Mors, of Paris, France. It is constructed with four cylinders, arranged in pairs, with the cranks 180 degrees apart, each pair of cylinders being arranged in the form of a "V." The carburetor will be seen at the right, and the magneto, geared to the main engine shaft, at the left in the illustration. This French four-cylinder engine weighs only 97 kilograms (213 pounds), and develops 45 horsepower when operating at a speed of 1700 revolutions per minute.

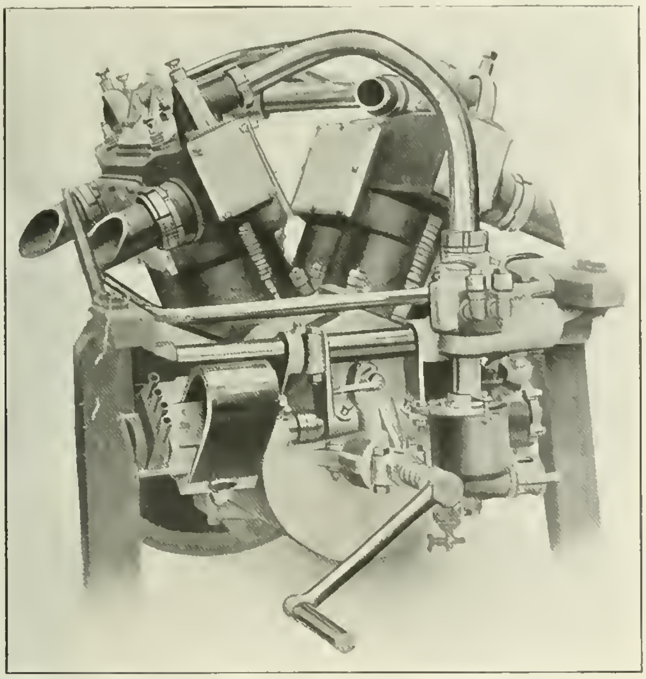


Fig. 1. Aeroplane Motor built by Societe Mors, Paris, France

An American motor for similar service is shown in Figs. 2 and 5. This is the Adams-Farwell gasoline engine, which was described in detail in MACHINERY, engineering edition, July, 1908. In this engine, gyroscopic force is utilized to steady the airship in its flight, the entire motor revolving around a stationary crankshaft. It is one of the lightest motors of its power ever constructed, weighing only 97¼ pounds and rated at 36 horsepower. It will be noted that this engine has no flywheel, no mufflers, and no cooling device, and the valves are closed by centrifugal force instead of by springs. There are ten valves actuated by a single cam, and the single-throw crankshaft weighs only 4½ pounds. For a more detailed description, reference should be made to the article previously published in MACHINERY, and mentioned above.

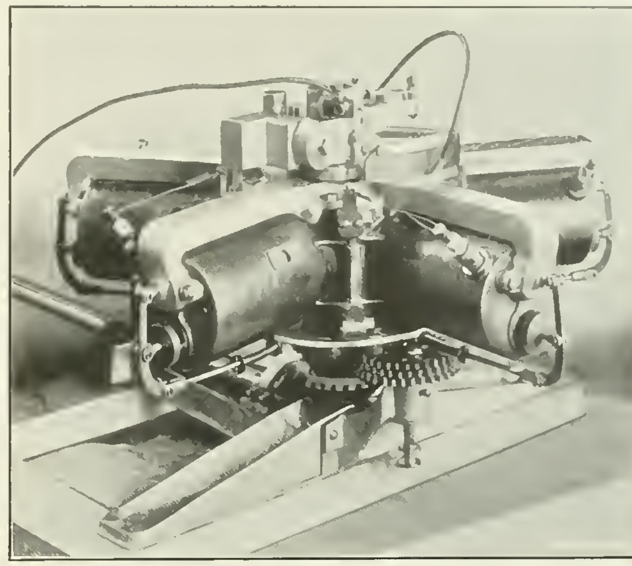


Fig. 2. The Adams-Farwell Aeroplane Motor

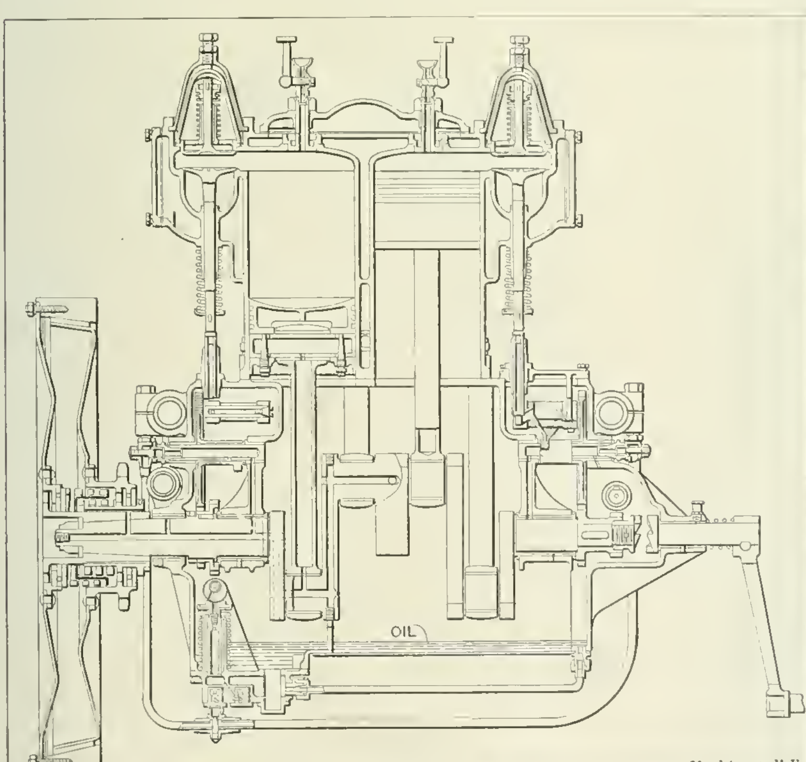


Fig. 3. Section of Mors Aviation Motor

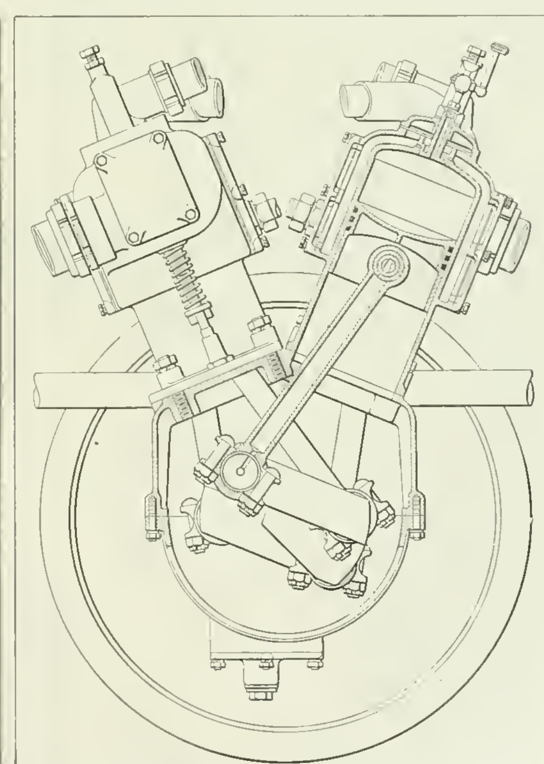


Fig. 4. End View and Section of Mors Aviation Motor

The principle advantage of this design is, of course, the feature of perfect air cooling, regardless of all external conditions, and independent of any auxiliary cooling devices. The revolving cylinders are, in effect, superior to a cooling fan, in that the radial cylinders act as blades of a centrifugal blower and discharge air in a direction tangent to their outer circle instead of parallel to their axis as would be the case

* For additional articles on this and kindred subjects, see MACHINERY, April, 1910, engineering edition, "Suggestions in the Design of Aeronautic Motors", "New Rotary Gas Engine for Aerial Navigation", "Light and Reliable Gas Engines"; November, 1909, engineering edition, "Light Aeronautic Motors"; October, 1909, engineering edition, "Glenn H. Curtiss—The Man, the Aeroplane and the Motor"; July, 1908, engineering edition, "Adams-Farwell Aeronautic Gasoline Motor."

with a fan. The air attains its highest velocity at the extreme outer end of the cylinders, which part requires the greatest cooling effect. The valves are located in the heads of the cylinders where they also receive the maximum cooling effect.

A novel eight-cylinder motor of the water-cooled "V"-type, of American construction, is shown in Fig. 6, the cylinders being 90 degrees apart and 45 degrees from the vertical. This aviation motor operates at a speed of 1200 revolutions per minute and weighs 275 pounds, including the magneto and oiler, ready for operation. The cylinders have special aluminum alloy heads, being cast with the shell in one piece with the cast-iron cylinder walls. Only one carburetor is used to supply all the eight cylinders, and the lubrication is provided for by a forced-feed oil-pump, located in the bottom of

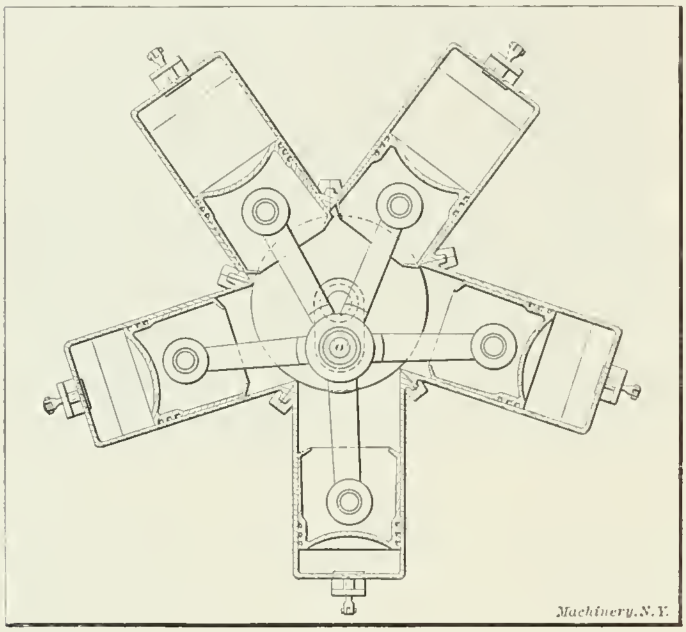


Fig. 5 Principle of Action of the Adams-Farwell Aeroplane Motor

the crank-case, operated by the crankshaft. The pistons are of gray cast iron, ground to size, while the crank-case is of a special aluminum alloy, fitted with bearings of phosphor-bronze. The valves are mechanically operated by one rod and overhead rocker-arms, with both valves in the head. The

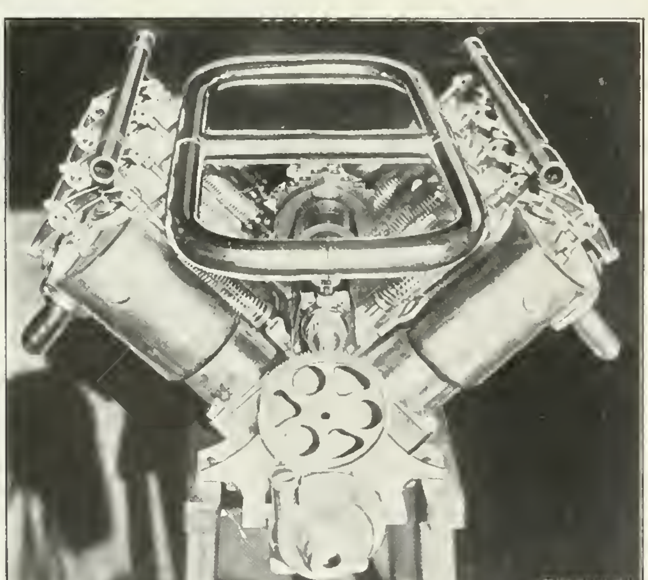


Fig. 6. Airship Motor made by the Easton Cordage Co., Easton, Pa.

crankshaft is 1½ inch in diameter, and made of chrome-nickel steel.

In examining the torque curves of four-, six- and eight-cylinder motors, it will be observed that the torque of a six-cylinder engine is considerably more than that of a four-cylinder, while the eight-cylinder shows none of the erratic qualities of the four-cylinder motor, and is far more steady than the six-cylinder. In fact, the pull all around the circle is about as perfect as can be obtained by the present gas engine. When eight cylinders are used, the power is not only more evenly divided, but considerable weight is saved, which could not possibly be dispensed with were a smaller number of cylinders employed. The eight separate cylinders of the

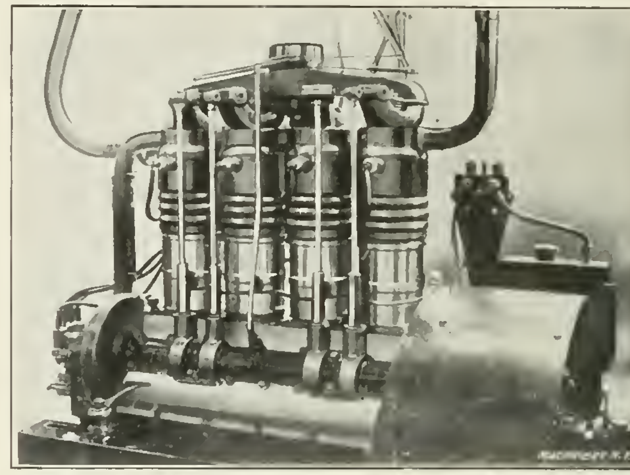


Fig. 7. Aerial Motor built by Panhard & Levassor, Paris, France

engine in Fig. 6 are arranged in two groups of four, on a common crank-case, the sets being at right angles to each other, and employing a four-throw crankshaft, each pin carrying the connecting-rods of a pair of opposite cylinders, which

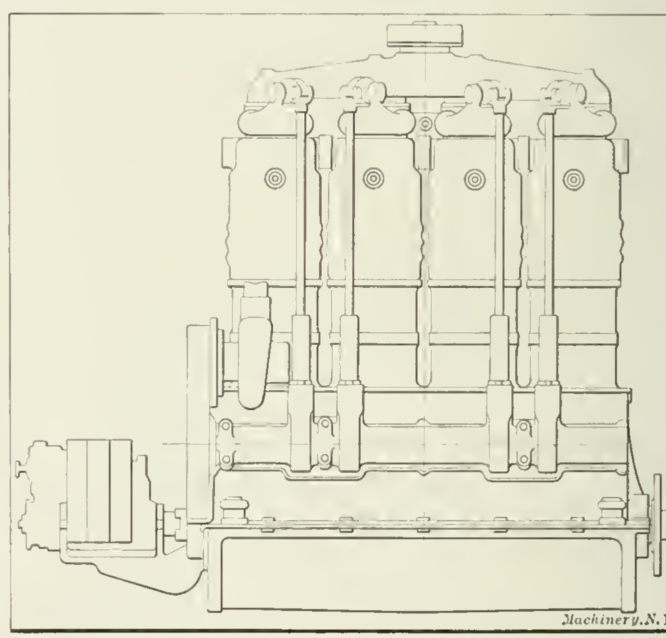


Fig. 8. Front Elevation of Motor shown in Fig. 7

are staggered in relation to one another. This engine is made by the Eastern Cordage Co., Easton, Pa.

A French water-cooled aviation motor is shown in the half-tone Fig. 7, and in the line engravings Figs. 8, 9, and 10, which latter indicate the design and construction of the engine. This type is designed by Panhard and Levassor, Paris, France. It measures 470 millimeters (18½ inches) in width at the base, and is 805 millimeters (31¾ inches) in height. The total length is 874 millimeters (34½ inches). This French gasoline engine has four cylinders 110 millimeters (4⅜ inches) in diameter with a stroke of 140 millimeters (5½ inches). It develops from 35 to 45 horsepower, and weighs, without the water utilized for cooling, about 95 kilograms (209 pounds). The arrangement of the valves, both exhaust and intake, as well as the ignition system, is clearly indicated in the illustrations.

Fig. 11 shows a recently brought out aerial engine of American design. This engine, built by David L. Herman, Detroit, Mich., is of the "V"-type, having eight cylinders. The reason that eight cylinders were decided on is that an engine with this number of cylinders gives continuous power with little

vibration. The hollow crankshaft which is made from Krupp's best grade of crucible chrome-nickel steel, has three line bearings of die-cast, cadmium-nickel bronze, which material is also used for the piston-pin bearings in the piston. One of the patented features, and one which makes this motor unique, is the single cam-shaft of one-piece construction, hardened and ground. This cam-shaft not only operates all the sixteen valves, but also drives the centrifugal pump, giving positive circulation. This construction eliminates thirty-six moving parts, and also eliminates all pins, etc., which are likely to work loose and cause trouble. The cam-shaft gear is of alloy steel, running into an intermediate fiber-filled gear,

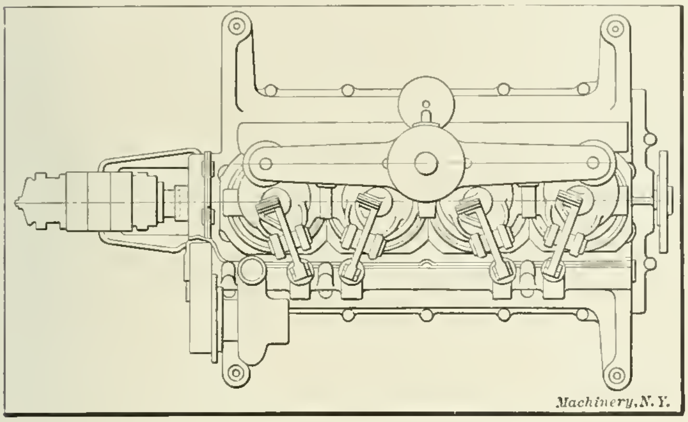


Fig. 9. View from Above of Motor shown in Fig. 7

thereby making a light, and at the same time a silent, train of gears. The valve tappets are hardened and ground, having fiber inserts. Another special feature is that the valves have gray cast-iron heads fused on steel stems, which not only makes it impossible for them to wear loose, but also gives a valve head of a material which has the same expansion as the iron of the cylinder, thereby eliminating the breaking of valves.

"Aerial metal," which is produced by the A. B. C. Castings Co., of Cleveland, Ohio, and which is fully fifteen per cent lighter than aluminum and 50 per cent stronger, is used not only for the crank-case, but also for the water jackets, pipes, gear housings, and in fact wherever a light alloy could be used without jeopardizing the serviceable properties of the motor. The crank-case has spacious hand-holes which make the connecting-rod bearings accessible. The water jacket being cast separate from the cylinder, makes it possible to thoroughly inspect the iron cylinder castings in a way that could not otherwise be attempted. These jackets are not shrunk on, but are bolted into position with chrome-nickel steel bolts in such a way that the difference of expansion between iron and "aerial metal" may be taken up in the bolt holes, so that, should a cylinder get hot, the water jacket does not crack. The oiling system is of the splash type, with force-feed oiler to the crank-case. The ignition system is of the high-tension type.

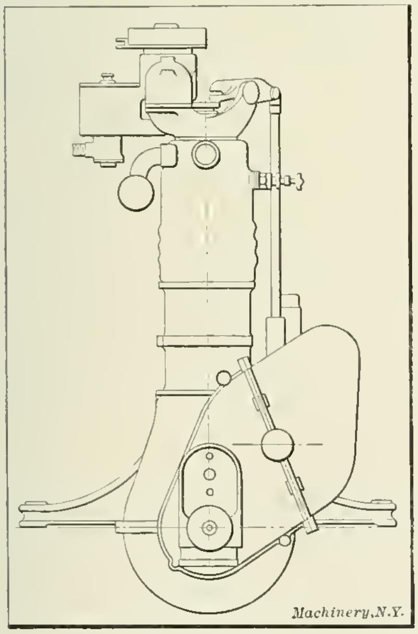


Fig. 10. End View of Panhard & Levassor Aerial Motor

The engines are built in two sizes; the smaller size has a stroke of 3⅜ inches, the bore being of the same dimension. It develops 45 horsepower at 1800 revolutions, and 34 horsepower at 1200 revolutions. Completely equipped, ready to run, it weighs 175 pounds. The hollow crankshaft is 1½ inch in diameter, the end bearings are 4½ inches long, and the center bearings 3 1/2 inches long. The pin bearings are 1 11/16 inch long, and the piston pin is ¾ inch in diameter. The valves are 1½ inch in diameter. This engine sells for $1750.

The large engine has a 4-inch bore and 4¾-inch stroke, and develops 70 horsepower at 1800 revolutions, and 56 horsepower at 1200 revolutions. When completely equipped and ready to run, it weighs 210 pounds. The hollow crankshaft is 1¾ inch in diameter, the end and center bearings are 4½ inches long, and the pin bearings, 2 inches long. The piston pin is hollow and ⅞ inch in diameter. The valves are 2 inches in diameter. This engine sells for $2500.

In order to prove the dependability of these engines, one of the smaller ones was mounted on an automobile truck and run over 5000 miles of rough roads. The truck was loaded with sand and pig iron. The engine required no repairs of any kind. The engine has been run under break tests for 72 hours without a stop, and at speeds as high as 4200 revolutions per minute.

Figs. 12 and 13 show an aeronautic engine made by the Aerial Navigation Co., Girard, Kan., known as the "Call aviation engine." Fig. 12 shows a two-cylinder and Fig. 13 a four-cylinder type. The engine is of the usual four-cycle type, water-cooled, 6 inches bore by 5¼ inches stroke; the two-cylinder engine develops 50 horsepower, and the four-cylinder engine, 100 horsepower, at 1750 revolutions per minute. The chief point of interest lies in the cylinder and cylinder head construction.

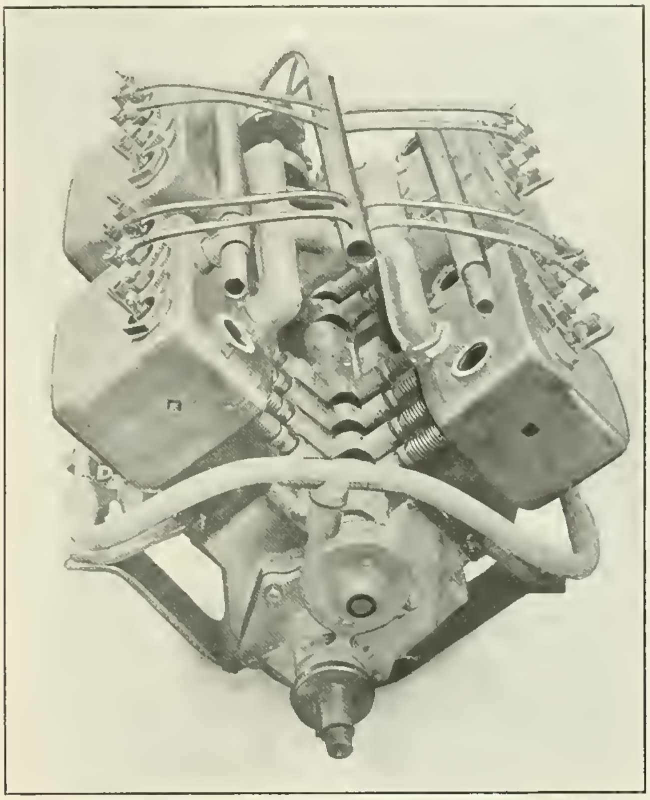


Fig. 11. An Aerial Motor of American Design

Even with the usual copper, or other sheet-metal, water jacket, adopted by most aeronautic engine manufacturers to lighten the weight of the cast-iron cylinders, the engine becomes unduly heavy. On the other hand, the employment of steel for cylinders, as has been attempted by certain manufacturers both in this country and in Europe, has not met with success. Engines of this construction, while giving satisfactory short runs, have failed in endurance tests. In the Call engine the cylinder walls, piston heads, valve cages, valve seats, and all other parts exposed to the heat of the explosion chamber, are constructed of vanadium gray iron, while the outer cylinders and cylinder heads, comprising also the water jacket, are constructed of an alloy of aluminum and magnesium, called magnalium.

Unlike other constructions in which the use of an outer cylinder of lighter metal with an inner cylinder or bushing of gray iron has been attempted, the iron inner bushing is surrounded throughout the entire explosion chamber length by the jacket water, without any intervening metal or joints, and no part of the lighter metal of which the outer cylinders and cylinder heads are composed, is exposed to the heat of the explosion chamber. With proper water circulation all danger of overheating the outer cylinders is thus avoided.

The gray iron bushings are machined to a fit, and are then pressed into the outer cylinder from the top. These bushings are of ample thickness throughout the length of the explosion chamber, and below that are considerably reduced in thickness. A shoulder upon the inner cylinder at the top is also machined to fit into a companion groove in the magnalium cylinder, in order to make a thoroughly water-tight connection, while the spiral partitions of the magnalium water jacket extend inward to the iron cylinder, thus greatly strengthening it. By the use of the lighter metal for the main outer cylinder, strength of construction results without undue weight.

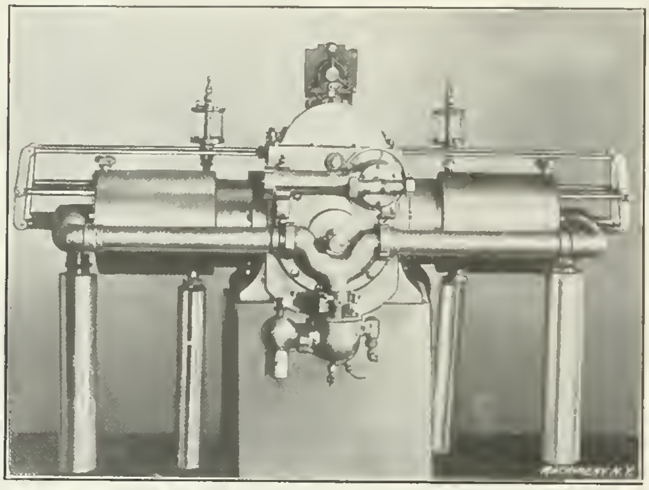


Fig. 12. Two-cylinder "Call" Engine

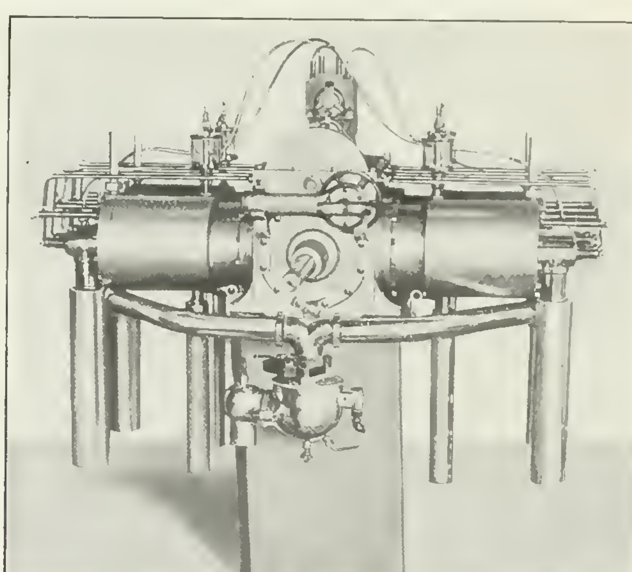


Fig. 13. Four-cylinder "Call" Aerial Motor

In order to further lighten the engine, the valve cages, which are also of vanadium gray iron, are air-cooled above the level of the cylinder heads, while below this, and around the valve seats, they are water-cooled. The crank-case and fittings not exposed to the heat of the explosion chamber are also made of magnalium, and the crank-case is thoroughly braced and ribbed so as to give great strength with minimum weight. Having thus secured lightness in the heavier engine parts, there has been no attempt made to secure lightness by the use of insufficient sizes in the construction of piston heads, connecting-rods, crankshaft, and other like parts. The connecting-rods are of vanadium phosphor-bronze, and the crankshaft is of vanadium steel, solid thoroughout.

Both the inlet and exhaust valves are 2 inches in diameter, and the valve lift is ⅜ inch. In addition to the main exhaust valves, a ¾-inch (inside diameter) auxiliary exhaust port, water-cooled, is placed on the bottom side of each cylinder. This exhaust port is allowed to open somewhat in advance of the main port, and thus draws the fire, furnishing an additional safeguard against the overheating of the main exhaust valve seats and bearings. Both the main and exhaust ports are silenced, not by means of the usual baffle or muffler plates which crowd the exhaust back into the explosion chamber, but by a silencer constructed of an inner casing of steel tubing, with V-slotted mouth, over which an outer casing of aluminum tubing of considerably larger proportions is then fitted by means of a vanadium gray iron ring or thimble containing a large number of holes around its circumference. The force of the exhaust pumps the cold air through these openings, and by this means the gases are so cooled and shrunk by the time they reach the mouth of the silencer as to greatly diminish the noise so common in aviation motors.

The water jacket partitions are spirally arranged in such a manner that the jacket water passes four times around the cylinder during each circuit, and then over the entire surface of the cylinder heads. The engine is equipped with a piston circulating pump instead of the usual centrifugal or gear-pump adopted on automobiles and commonly used on aviation engines. This piston pump is positive in its action, and in connection with the spiral cooling flanges, forces the jacket water four times around the cylinders during each fifteen seconds.

The prices of the above engines are $1000 for the 50 horsepower, and $2000 for the 100 horsepower. The 100-horsepower motor complete, including oil and water pumps, carburetor, mufflers, and force-feed oiling system, weighs 350 pounds. The 50-horsepower motor complete, including water and oil pumps, carburetor, mufflers, etc., weighs 175 pounds. The weight of the magneto is not included in either of these figures.

* * *

"HORSEPOWER REQUIRED TO COMPRESS AIR"—CORRECTION

In the December, 1910, number of MACHINERY, engineering edition, page 288, a formula in the article entitled "Horsepower Required to Compress Air" is given as follows:

$$\text{H.P.} = \frac{144 \times PV}{33{,}000}\left(1 + \text{Nap. log. } \frac{P}{P}\right)$$

It will be noted that in the Data Sheet Supplement accompanying the December issue, the formula is given as follows:

$$\text{H.P.} = \frac{144\, PV}{33{,}000}\left(\text{Nap. log. } \frac{P_3}{P}\right)$$

This latter form is the correct form, as given by the author, and the erroneous expression on page 288 is due to a typographical error.

* * *

The electrification of main lines is progressing steadily, if not rapidly, abroad. The Medi Railway of France is to electrify 70 miles of road on the Toulouse-Bayonne line. It is planned to electrify later the whole of this line, a distance of 200 miles. This is the largest scale upon which electrification has as yet been undertaken in France, and the results will be watched with no little interest throughout Europe. The experiments which have been carried on in Germany during the last three years have been so successful that it has been resolved to introduce electric traction on several main lines. The electrification of the first section of the railway connecting Magdeburg, Leipsic and Halle will shortly be finished, and during 1911 work will be begun on the electrification of a line in Silesia, running through a very mountainous region. The electrification of the Lapland railway in Sweden, which is one of the most ambitious undertakings in railway electrification, was treated in detail in the October, 1910, issue of MACHINERY.

INS AND OUTS OF GEAR HOBBING

By RALPH E. FLANDERS*

The hobbing machine has produced quite a little stir in the gear-cutting business in the past five years. It is, to all outward appearances, one of the most attractive of the gear-cutting machines, particularly in the matter of output. Some of its backers have also claimed for it that it produces work of a high grade of commercial accuracy. This has always been questioned, however, and the reputation of the hobbing process, and of various machines employing that process, have been rather fluctuating in this respect.

The writer has long had the intention of carrying out a series of experiments which, if properly conducted, should give some definite information as to the accuracy of the hobbing process of cutting gears, and the reasons for what inaccuracies there might be. A few weeks ago, through the kindness of three friends who furnished blanks, a hob and a hobbing machine respectively, these experiments were carried out. While the results were not so conclusive as had been hoped for, they nevertheless do show some things of interest great enough to warrant their being placed on record.

The machine used was one which, in the opinion of the writer, is the best designed and most generally satisfactory of all the hobbing machines. The hob was made by a firm

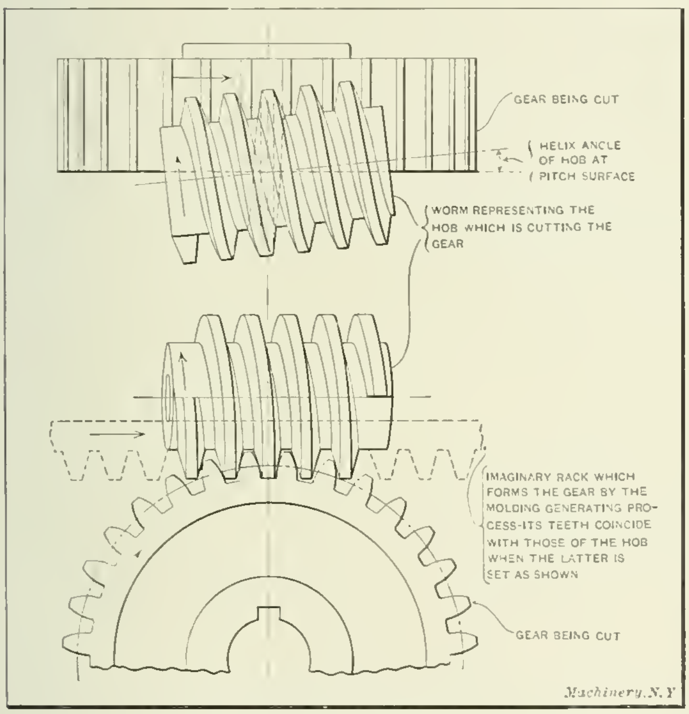


Fig. 1. Diagram illustrating the Principle of the Hobbing Process of Generating Spur Gears

with a high reputation for such work, and presumably represented the best in American practice. It is not necessary to give the name of the manufacturer of either the hobbing machine or the hob, since this article is a discussion of principles, and not a comparison of the work of individual manufacturers.

The Principle of the Hobbing Process

While the principle of the hobbing process is generally understood, it may be advisable to review it briefly. In Fig. 1 is shown an imaginary rack meshing with a gear. If the gear were made from a plastic blank, rolling it with the rack would generate in it teeth of proper outline to mesh with the rack, or with any gear of the interchangeable system to which the rack belongs. The rack teeth (in dotted lines) coincide with the teeth of the worm (in full lines) which has been set at such an angle as to make the teeth on its lower side parallel with the axis of the gear. In other words, it has been set at the angle of its helix, measured at the pitch line. The teeth of the worm, then, when set in this position, correspond with the teeth of the rack. If now the gear and the worm be rotated together in the ratio required by the number of teeth in the gear, this will cause the teeth of the worm to travel lengthwise in exactly the same way as the teeth of the imaginary rack when rolled with the gear. The worm then will serve as well as the rack for molding the teeth of the gear. In practice, the worm is gashed or fluted, and relieved; in other words, it is a hob. It is rotated in the required ratio with the work, and fed gradually through it from one side of the face to the other. When it has passed through once, the work is completed.

Description of Experiments

For carrying out the experiments, three sets of blanks were provided, each for a gear of 6 pitch, 21 teeth. They were arranged as shown in Fig. 2, with two wide-faced outside blanks

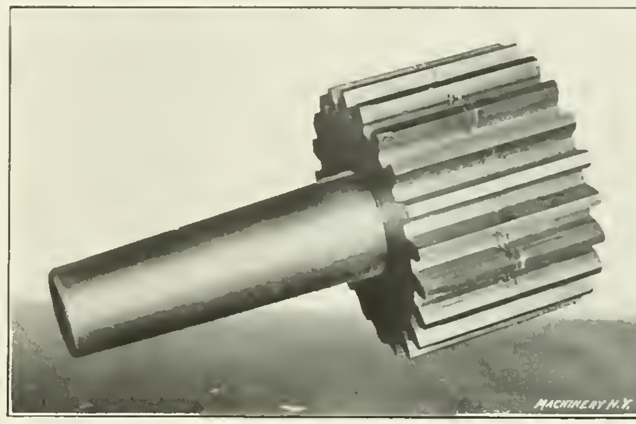


Fig. 2. Arrangement of Blanks used for Experiments on the Hobbing Machine

enclosing a pair of thin templets. The thick outside blanks allow the cutter to get right down to business before starting in on the templets; at the same time they are stiff enough to firmly support the templets, and were accurately faced so that the teeth of the templets showed practically no burrs whatever, leaving the sharp, clear outline of the cut. After each blank was cut, the templets were removed, one was reversed and matched up on the other, so as to compare the tooth outlines. By matching them up in this way in their reversed position, it was very easy to see whether or not the teeth were exactly the same shape on both sides. The prevention of "hooked" teeth is reported to be one of the difficult problems in gear hobbing.

To identify the blanks after being cut in the hobbing machine, each set was numbered, as shown in Fig. 3. The topmost blank was lettered *A*, the upper templet *B*, the lower

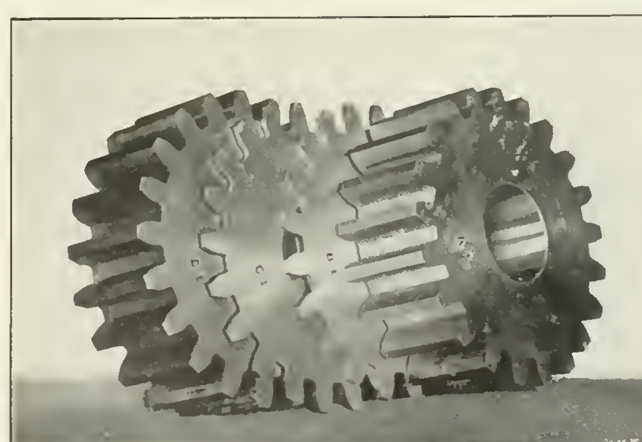


Fig. 3. The Blank separated into its Four Component Members, showing the System of Identification Employed

templet *C*, and the bottom blank *D*. The first set of blanks was numbered A_1, B_1, C_1, D_1, and the second set A_2, B_2, C_2, D_2, etc.

There are three theories propounded as to the cause of hooked teeth. One of these is that the difficulty is caused by not exactly centering one tooth or tooth space of the hob with the work. Manufacturers of hobbing machines provide indicators for making this setting very accurately. Another theory claims that hooked teeth are the result of the long and complicated mechanism, by means of which the movements

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of the hob and blank are connected. The various shafts, bearings, gears, etc., in this connection, all give chance for play and elasticity, and this elasticity produces torsional vibration between the hob and the work, resulting in an irregular movement of the former in relation to the latter. This, it is asserted, produces unsymmetrical teeth. The third theory lays the difficulty to the inaccuracies in the hob, due to hardening.

The three blanks were cut as follows:

1st blank:—Roughing and finishing cut. Finishing cut at fine feed. A tooth of the hob accurately centered. Blank made of brass.

2d blank:—Roughing and finishing cut. Finishing cut at fine feed. Hob tooth not centered. Blank made of brass.

3d blank:—Heavy feed taken at one cut. Tooth of hob centered. Blank made of steel.

By taking a very fine finishing feed in a soft material, we have reduced any possible trouble from torsional vibration to a minimum, with Blanks 1 and 2. As one blank is cut with a hob tooth centered, and the other with no tooth on center, a comparison of these two blanks should show the effect of the centering of the hob tooth.

Blanks 1 and 3 both have the same tooth of the hob set centrally, but one is made with a fine finishing cut in soft material, while the other is made with a single heavy cut in hard material. A comparison of these two blanks should therefore show what effect torsional vibration has on the question of cutting symmetrical, accurate teeth.

If neither the centering of the tooth nor the torsional vibration of the hob were shown by these previous experiments to have any particular effect on the shape of the teeth, it would be time to look for trouble in the hob itself.

Centering the Hob Tooth

The effect of centering a tooth of the hob, on the matter of the symmetrical shape of the tooth, is one that demands a little explanation. There is but one plausible explanation of any effect that this may have so far as the writer can discover.

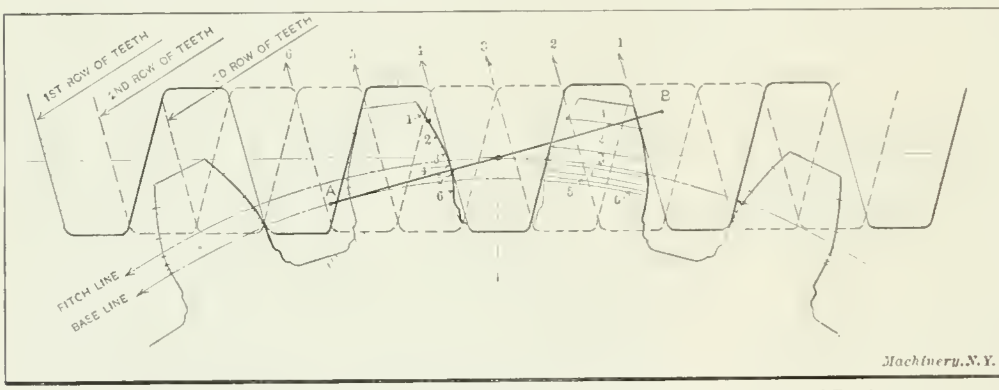

Fig. 4. Diagram showing the Action of a Hob having Three Flutes or Rows of Teeth; Flats are produced on the Teeth as shown

This explanation, as shown in Fig. 4, depends on the fact that a hob does not generate in the gear a theoretically perfect involute curve, but appoximates it by means of a series of flats.

In Fig. 4 we have a hob which, to make the action clear, is provided with three rows of teeth only. Each row of teeth, as it comes around into action, occupies the successive positions shown by the full and dotted outlines. These three successive positions each form a portion of the tooth outline, and each leaves a straight side, as indicated. This succession of straight sides approximates the curve of the involute.

If there were more rows of teeth in the hob, there would evidently be a greater number of flats, and the involute would be more closely approximated. If, instead of having teeth, the hob were a worm, ungashed, and made of emery or some other abrasive so as to be able to cut the work, there would be no flats whatever, theoretically, since the worm would cut over its entire surface. The more teeth, the finer the flats and the nearer to the true involute the work is produced.

It is interesting to note that these flats have been discovered recently by Mr. George D. Grant. He wrote an article about them in the *American Machinist* for June 23, 1910. Probably every gear man has known about them from the beginning. An English hobbing machine maker, Mr. Humpage, mentioned them in a paper read over two years ago; and these flats are identical with those long known to be produced in the hobbing of worm-wheels. This matter was discussed in connection with worm-wheels in an article by the writer, entitled "How Many Gashes should a Hob have?" in the January, 1909, number of MACHINERY. The same difficulties there mentioned as met with in the use of multiple-threaded hobs, apply to multiple-threaded spur-gear hobs also.

Now when a tooth of the hob is centered, as shown in Fig. 4, the flats on each side of the tooth are symmetrical, leaving a symmetrical tooth. If a tooth space is centered instead of a tooth, the flats are still symmetrical, though arranged some-

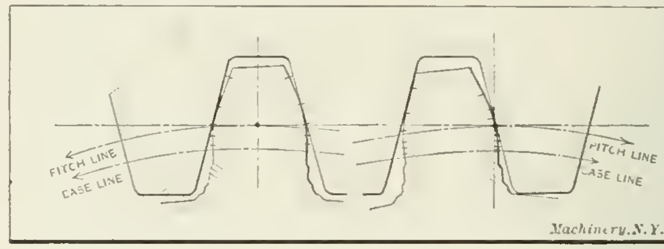

Fig. 5. Illustrating Distribution of Flats and Consequent Shape of Teeth—First with Tooth Space Centered, Second with Both Tooth and Space Off Center

what differently, as also shown at the left of Fig. 5. It is thus as satisfactory to center a tooth space as a tooth. If, however, neither a tooth nor a tooth space is centered, the flats, as may be seen at the right of Fig. 5, are unsymmetrically arranged, and the tooth is unsymmetrical.

The Importance of the "Flats"

Fig. 4 shows quite plainly how the number of flats on a hobbed gear tooth may be estimated. There will be as many flats on each tooth as there are separate positions of the cutting edge of the hob in the length of the line of action, *A-B*. In the case shown this line of action is limited at *B* by the outside diameter of the gear, and at *A* by the base line. In the length *A-B* there are six positions of the cutting edge, marked "1," "2," "3," "4," etc., which form the six flats correspondingly numbered.

The particular hob used in the experiments had sixteen flutes. These figures ought to give about twenty-eight flats in the length of each tooth. It will be seen, therefore, that it is extremely unlikely that any change in the distribution of flats as small as those could be detected at all. And it is therefore unlikely that the centering of the hob is of any use at all—at least so far as this matter is concerned. But more of this later.

Another point of interest in this connection is shown in Figs. 6 and 7. In the first case are shown the four successive positions taken by the teeth of a four-fluted hob. There are, it will be seen, four separate central positions for the hob teeth, in a distance equal to the circular pitch. These positions are numbered "1," "2," "3" and "4." In Fig. 7 is shown a similar diagram for a three-fluted hob, like that in Figs. 4 and 5. Here there are shown to be three positions in which a hob tooth is centered, and three other intermediate positions in which a tooth space is centered. The tooth spaces do not line up with the teeth as in the even-fluted hob. In a length equal to the circular pitch, there are, then, a number of central positions equal to the number of flutes for the even-fluted hob, and a number of positions equal to twice the number of flutes for the odd-fluted hob.

Since the number of flutes in the hob used in the experiments was even—sixteen—the distance to move it from a central position to a position half way between two central positions, or out of center, is found by dividing the circular pitch by twice the number of flutes. In this case we had:

$0.5236 \div (2 \times 16) = 0.016 + =$ amount of shift necessary.

Results of the Experiments

The blanks were cut as described. Then came the question of the various methods of comparing them. The simplest was the visual method of comparing the templets. The templets of the first blank, when reversed and matched together again in the manner previously described, showed a noticeable lack of symmetry. The teeth had a marked flat on one side at a point where they were well rounded on the other. There was also a slight shoulder at the base of the involute on each side, as might be expected, but this shoulder was considerably lower on one side than on the other. The templets of Blank 2 showed the same phenomenon, but to a considerably less degree. The teeth of the templets in Blank 3 were almost entirely symmetrical.

Another test that would naturally be applied by a gear man would be the rolling of the blanks together, either in the hands or on fixed centers set the proper distance apart. In either case the two outer wide-faced gears in Blank 1 rolled together very roughly, when both were the same side up as when they were cut. When one of them was reversed, they practically interlocked, so that movement was nearly impossible. This is what would be expected from unsymmetrical teeth. In fact, a good rough-and-ready test for symmetry can be made by rolling gears together before and after reversing one of them. If there is any difference in the action in the two cases, the teeth are unsymmetrical.

In Blank 2 the action was considerably better. The gears did not run so well when reversed, but they did not interlock. With Blank 3 the action was reasonably good, with comparatively little difference when the gears were reversed, although in no case was the action what would be expected of a high-grade gear.

A third test was applied with a special apparatus on the principle shown in Fig. 8. The gears were mounted so as to run, one on arbor *F*, and the other on a pivot on swinging arm *K*, being pressed into contact meanwhile by a not too heavy spring *N*. The dial indicator *M* reading to thousandths, was so mounted as to show the up-and-down movement of gear *H*, produced by irregularities in the tooth curves, as the gears were rotated. The results of this test with gears running the same side up and reversed, for all three blanks, are shown in the accompanying table, together with notations as to the smoothness of running of the gears as felt by the hand in rotating them.

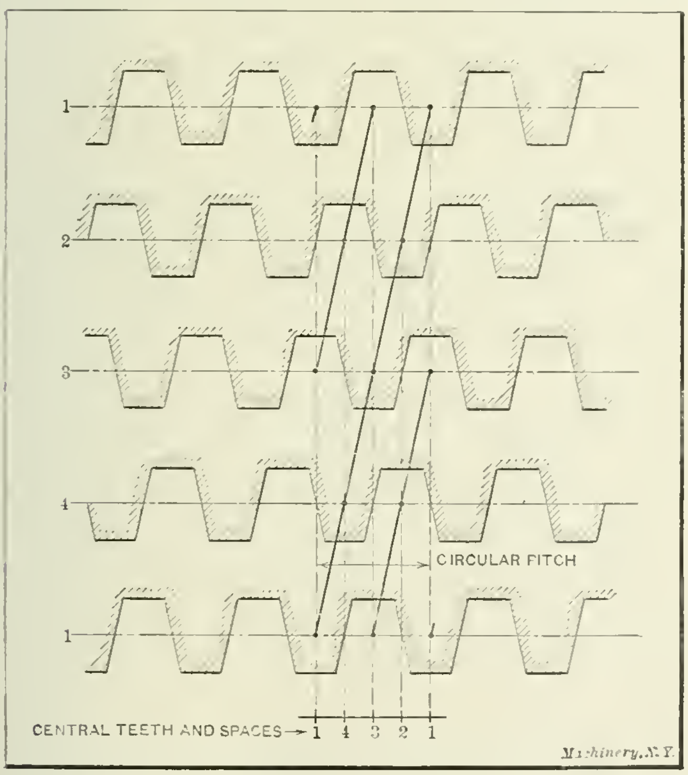

Fig. 6. Number and Location of Central Positions for Hob having an Even Number of Flutes

Now the question is—what do these experiments show? The table will do very well as a basis of comparison, as it agrees with the results of the two previous tests.

By comparing Blanks 1 and 2, it will be evident that centering the cutter did not improve the shape of the tooth produced; in fact, for some reason, it appeared to aggravate the error. So far as these experiments are concerned, then, the centering of the tooth appears to have little effect on the results. It should be noted that the hob had 16 teeth, a number sufficient to give so close an approach to the theoretical involute that the centering of the tooth should have little or no effect. Secondly, by comparing Blanks 1 and 3, it would appear that the torsional vibration of the machine has a mysterious effect. It would appear, in fact, that the more severe the strain on the driving mechanism, the better the gear. How is this?

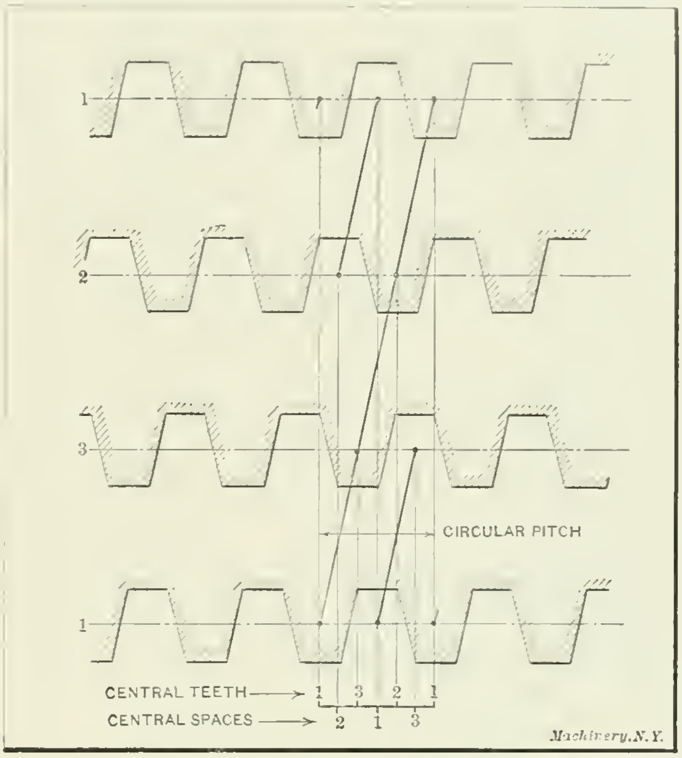

Fig. 7. Number and Location of Central Positions for Hob having an Odd Number of Flutes

Backlash and Spring in the Hobbing Machine

In explanation of this peculiar result, it should be stated that the particular hobbing machine used was so adjusted as to run freely in all its slides and bearings. It ran, in fact, rather more freely than it should have, in the judgment of the writer. He did not, however, go over the machine, tighten up the spindle and worm bearings, the gibs and other parts—first, for the reason that there was plenty of work for the machine, so that he did not feel justified in trespassing too long on the hospitality of the shop manager; and secondly, he did not at that time fully realize the importance of close adjustment in a gear-cutting machine.

The importance of this matter of adjustment he learned later by cutting two sets of similar gears on the Fellows gear shaper, one with the machine adjusted to the normal freedom of movement with which it is supposed to be used, and the other with adjustments loosened somewhat, particularly with the worms loosened in the worm-wheels which rotate the cutter and work spindles. A gear cut with a loose adjustment gave almost as poor results as the best of the hobbed gears, when tried in the apparatus shown in Fig. 8. A gear cut with the normal close adjustment, however, was far superior.

One conclusion, then, which can be drawn from these three experiments, is this—that the superiority of the shape of tooth in Blank 3 is caused by the fact that the machine was cutting under continuous strain, which took up all looseness, play and backlash in the driving mechanism, resulting in a generating action superior to that in the two preceding cases.

In this matter of looseness and play in the mechanism, the gear-hobbing machine is at a serious disadvantage. For one

thing, the rotating connection between the hob and the work must necessarily be long and complicated, owing to the adjustments of the machine. The spindle is mounted on a head which is adjustable to various angles, and is itself mounted on a slide which has a horizontal or vertical movement for the feed. This construction requires a complicated combination of bevel or spiral gears, spur gears, etc., of small diameter, with shafts having restricted bearings. At the same time, it requires a large overhang of the hob spindle beyond the face of the column.

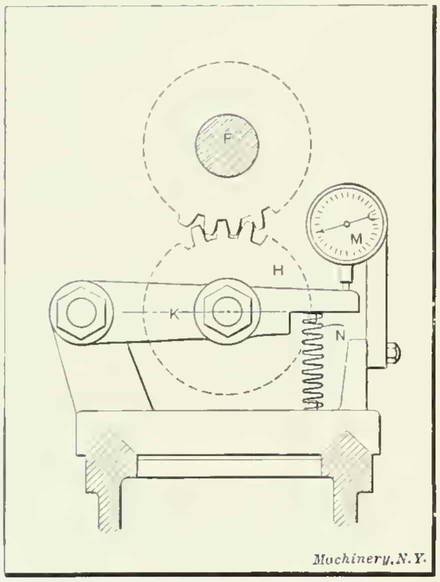

Fig. 8. A Testing Rig used for Comparing the Gears cut in the Hobbing Experiments

In the case of a hobbing machine arranged for cutting spiral gears, the chance for looseness and play is usually aggravated by passing the motion through a differential gearing, which gives a chance for looseness in itself, besides adding to the sum total of the looseness all that of the feed mechanism. The fact that we can obtain better spiral gears than spur gears from a hobbing machine is simply due to the inherent smoothness of action of the spiral gear, which tends to disguise poorness in design or workmanship by the smooth manner in which the teeth come into and out of action.

Hardening Troubles in the Hob

There comes next the question of why a gear cut with the teeth off center should be more accurate than one with the teeth accurately centered. The only suggestion that occurs in this connection is one offered by a firm which has experimented largely with the question of hobbing. They have found, for instance, that by setting one tooth of a hob central, the teeth will be hooked in one direction; by centering the next tooth to it, the teeth may be symmetrical, while by centering the next tooth, all the teeth may be hooked in the other direction. It is their custom, in fact, to test each new hob in actual gear cutting, centering one tooth and then another until a tooth is found which, when centered, will give symmetrical gears. This tooth is then marked, and the hob is always centered on that tooth.

COMPARISON OF GEARS BY TEST SHOWN IN FIG. 8.

Sample No.	One Gear Reversed		Both Gears Same Side up	
	R. H. Rotation	L. H. Rotation	R. H. Rotation	L. H. Rotation
1	0.015 Interlocked	0.015 Interlocked	0.004 Hitchy	0.004 Smooth
2	0.015 Hitchy	0.015 Hitchy	0.004 Hitchy	0.003 Smooth
3	0.012 Fair	0.010 Smooth	0.006 Hitchy	0.005 Smooth

The only possible explanation of action as eccentric as this is that the teeth of the hob in hardening are distorted, some of them one way and some another. By shifting the hob endwise, so that one tooth after another is centered, a position can be found in which these various inaccuracies tend to neutralize each other, and a more or less symmetrical tooth is produced. In all probability, then, in the case of Blank 1, the particular tooth centered was the one which should not have been centered. Perhaps if some other tooth had been tried, a more satisfactory result would have been obtained.

This question of keeping the hob in shape during the hardening process is one of the most serious the hobbing machine has to contend with. The difficulties met with in hardening the ordinary formed and relieved cutter are immensely magnified. One experimenter, who has gone extensively into this matter, claims that he has solved every problem except this one. Until some method for retaining the shape of the hob in the heat treatment process is devised, or until some scheme for grinding the hob after hardening is discovered, this man was content to ignore the hobbing process for good work. In this connection it may be noted that a hob ground after hardening has recently been advertised, but no particulars of its construction have been made public as yet.

A number of American firms have claimed to be able to buy much better hobs abroad than they can obtain at home. If the foreign hob is really superior, it may be due to some improved method of hardening which we have not yet found out; but its superiority may be due to another reason. In a batch of ten hobs, it is very likely that two or three would come out of the fire in very decent shape, not warped enough to do much harm. Is it possible that these two or three hobs would be sent to this country, while the poorer ones would be retained on the other side, where (as the writer has been given to understand) the hobbing machine is now generally used for roughing only? This, however, is mere surmise.

Details of Hob Design

Now there are other difficulties to be contended with in the hob itself, outside of those previously mentioned in connection with keeping the shape through the hardening process. If the hob is to cut standard 14½-degree gears, it must be so shaped that it will make the required corrections for "interference" on the flanks of the small pinions and on the points of all the gears from the smallest to the largest. The particular hob used appeared to have absolutely straight sides, without correction of any kind. As a result, the product showed a considerable undercut in the flank, reducing the length of the involute bearing surface a trifle. If this hob had been cutting a 12-tooth pinion, the flank would have been so undercut as to take away about half the bearing between the base line and the pitch line; in the 21-tooth gear, however, it does not undercut so badly. The hob should be corrected for this interference by relieving the points of the teeth, and filling in the flanks to the proper shape.

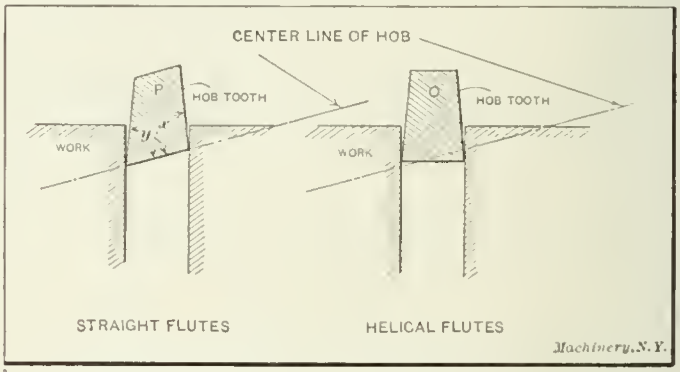

Fig. 9. A Comparison of the Cutting Action of the Teeth in Hobs cut with Straight and with Helical Flutes

Another slight criticism of the hob that might be made is that the corners of the teeth were left quite sharp. There seems to be no good reason why these corners should not be rounded down pretty nearly to the extent of the extra length of tooth added for clearance. This would serve two purposes. The corner of the tooth is the first part to suffer under heavy duty, and it will stand up much longer if it is rounded than if it comes to a sharp point. Besides this, the fillet at the base of the tooth of the gear, and the relieved portion of the flank, are generated by the point of the cutter, and a rounded point gives a smoother surface than is given by a sharp corner.

There is some question as to whether hobs should be made with straight or helical flutes. The helical flute has the disadvantage of requiring a special and rather complicated mechanism for grinding, as it has to be very accurately guided

with exactly the same twist it had when the flutes were milled and the teeth relieved. Except for this, however, the advantage is all with the helical fluted hob. Where the flute goes straight across, as shown at P in Fig. 9, one side of the tooth is left with an obtuse cutting angle x, while the other has an acute angle y. This results in crowding the hob lengthwise, and in a difference in finish on the two sides of the teeth. The helically-fluted tooth O avoids this trouble.

So far as the matter of the theoretical action of a straight- or helically-fluted hob is concerned, there is no difference, provided only that the tool, which forms and relieves the teeth, is properly set. For a straight-fluted hob, it should be designed to be used with its face in the same plane with the axis of the hob. For a helical-fluted hob, it should be designed to be set at the helix angle. The face of the relieving tool must match up with the face of the hob tooth it is cutting. If this precaution is observed, it makes no difference so far as the theoretical action is concerned, which way the hob is made.

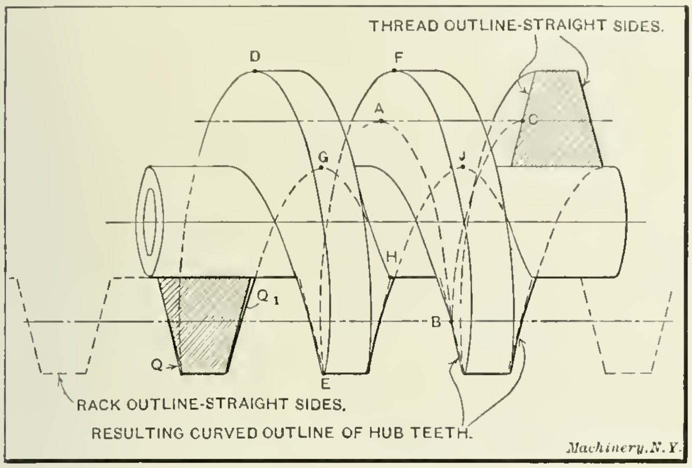

Fig 10. Diagram showing the Interference of Warped Surfaces in Relation to the Shape of Hobbed Teeth

The Interference of Warped Surfaces

There is another theoretical consideration in the design of the hob, which is worthy of mention. The actual effect on the gear is small in comparison with the other factors we have been describing. For a standard of workmanship as high as that met with in the best gear-generating processes, however, it should be considered. This point relates to the nature of the contact between warped surfaces. To illustrate: Suppose a worm, such as shown in Fig. 10, is set into a rack, as shown, at the proper helix angle as measured at the pitch line. If the worm were cut with a straight-sided tool of the same shape as the rack, it would be the natural impulse to say that it would fit exactly in the rack, making contact on the perpendicular plane passing through the center line of the worm. This is not the case, however, as is best seen at the lower dotted section, where the worm has been cut down to this central plane.

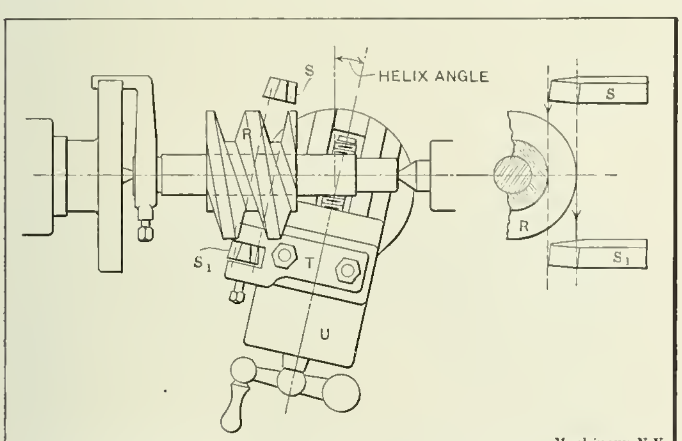

Fig. 11. Turning a Master Worm in which the Interference of Warped Surfaces is corrected

At Q and Q_1 we see that parts of the worm tooth beyond the central section project outside of the rack outline, at both the top and the bottom of the tooth. The reason for this should be evident. The worm is set at a helix angle calculated from the pitch diameter. This helix angle is right for the pitch diameter, but is too great for the outside diameter and too small for the bottom diameter of the worm. Consequently, in the lower view, the pitch-line A-B C comes to a sharp point at B, as it should; the outside line of the tooth loops, as shown at E; while the bottom line of the tooth curves in the opposite direction, as shown at H.

What is true of a worm, is true of a hob made from that worm. If made with a straight-sided tool, the hob will cut teeth which are of the proper thickness at the pitch line, but are thinned slightly at the point and at the root. In Fig. 11, of course, the error has been exaggerated by showing a worm of very coarse pitch in relation to its diameter. In any worm or hob met with in practice the error would be much less. But if the hob is to do work as accurate as that performed by other generating machines, such as the Bilgram and Gleason bevel-gear machines and the Fellows gear shaper, for instance, this would have to be remedied. A suggested remedy is shown in Figs. 11 and 12.

First rough out a tool-steel worm, of the dimensions desired for the hob. This worm is to be finished as shown in Fig. 11. At S is a tool of the exact shape of a rack tooth of the pitch desired. This is mounted in the special holder T, attached to the compound rest U, which is set to the required helix angle. The tool passes under the work R, and is fed from back to front along the dotted lines shown, being set at the proper height to finish the work to the proper diameter. Worm R is now of exactly the right shape to make accurate contact with the rack, instead of interfering as shown in Fig. 10.

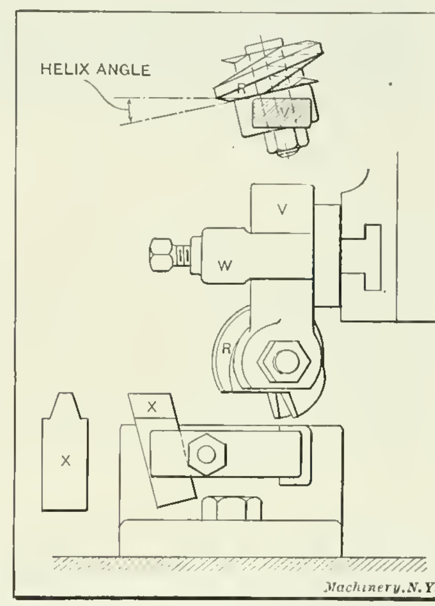

Fig. 12. Using a Section of the Master Worm of Fig. 11 as a Tool for Shaping the Forming and Relieving Tool used in making a Corrected Hob

In Fig. 12 a section of the same worm is shown at R. Here it is being used as a circular master tool for shaping the tool X, which is to perform the actual work of forming and relieving the hob. For this reason the worm of Fig. 11 has been gashed, hardened, sharpened and mounted in the holder V in the shaper toolpost W. This holder locates it at the same helix angle as that to which the rest was set in Fig. 11. The cutting edge of the circular form tool R is set to the same angle as that desired for the rake of the relieving tool X. The latter is held on a knee, clamped to the shaper table, as may be seen.

This somewhat roundabout procedure would give a relieving tool X which would produce a hob with interference errors eliminated. If the hob were made on the "stub-tooth" or other similar system, in which no correction of the involute has to be made, the resulting hob from a straight sided tool S should be of exactly the desired shape—before hardening, at least.

Feed and Finish

Besides the various other factors which were foreseen in the experiments we have described, there was one of great interest which was new to the writer. Its nature is shown in Fig. 13, which illustrates a section of steel blank No. 3 of the experiments, which was cut with a heavy feed. To be exact, the feed was 1/8 inch per revolution of the work. The hob was single-thread, and revolved at 43 revolutions per minute. This, with a 21-tooth gear, gives about 5 1/4 inches per minute, reduced to the usual basis of comparison with the

orthodox milling type of automatic gear cutter. This is "going some" for 6 pitch in steel, it must be admitted. The machine stood it without the slightest difficulty, but the hob was dulled by one passage through the blank.

The point to be noted is the finish. There is a shallow, spiral groove, 1/8 inch wide, around and around the gear from top to bottom. This shows on the sides of the teeth as well as on the bottom, and would be thoroughly objectionable in a finished gear, as compared with work produced at a similarly lively pace in the milling type of machine or on the gear-shaper. The question is, can the high output claimed for the hobbing machine be attained without sacrificing finish? And when a good commercial finish is obtained, will not the output be below that of other commercial methods? It will be interesting to hear from others on this point.

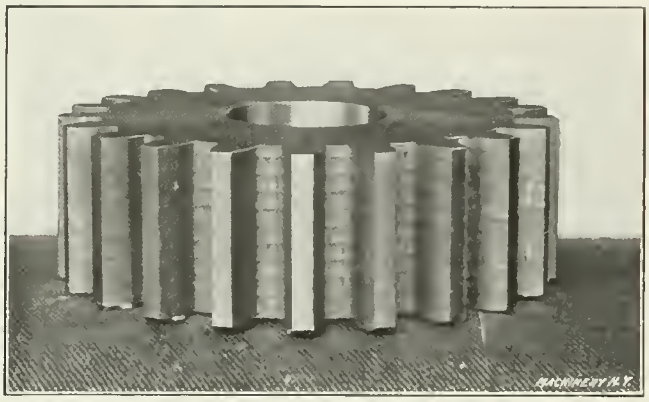

Fig. 13. Feed Marke produced on a Gear which was hobbed with a Heavy Feed

In Fig. 14 is shown the effect which a variation in diameter of the hob has on these feed marks. With hob teeth of the same size, so that there are twice as many in a hob of twice the diameter, the large hob will feed twice as far per revolution when taking the same chip per tooth. As it will take only half the number of revolutions per minute to keep the same surface speed, the rate of output will remain the same. Feeding twice as far, with a hob of twice the diameter, will give feed marks twice as wide and deep, as shown. The difficulty is thus magnified in the case of inserted tooth hobs, which must of necessity be larger in diameter than the ordinary solid ones.

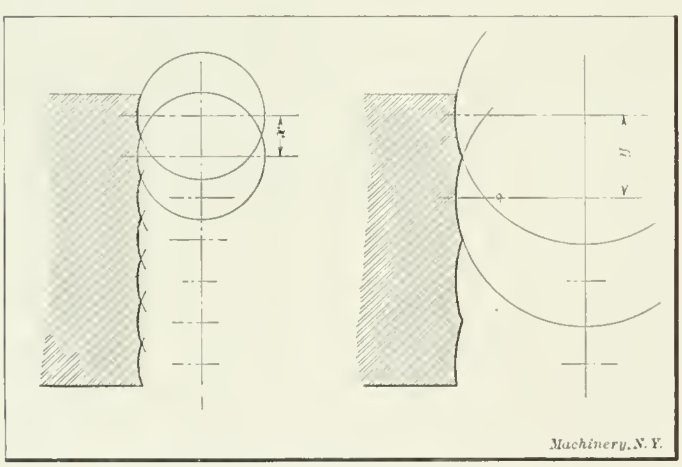

Fig. 14. Comparisou of Feed Marks Produced by Large and Small Hobs at the Same Thickness of Chip per Tooth

Summary

The writer, then, comes to the following conclusions in regard to the hobbing process:

There is no advantage in centering a tooth of the hob, except to center any one particular tooth which may chance to equalize the errors of hardening.

There is a great advantage in reducing backlash and spring throughout the whole machine.

In the latter connection, the machine is handicapped in its fundamental design, and a premium is put on unusual inventive skill in getting around the long, limber drives, and the numerous joints and overhangs required.

The hob is a very difficult hardening proposition; and inserted tooth hobs, which might be ground after hardening, would be so large as to give coarse feed marks, as well as increase the difficulties of overhang and weakness in the drive.

The hob, for really good work, should be corrected for interference of the kind shown in Fig. 10. For 14½-degree standard gears, it should also be corrected for interference with the flanks of the teeth of small gears.

The hob should be spiral fluted, and have the corners of the teeth rounded.

When all the other practical and theoretical difficulties of the hob and machine have been remedied, there may still remain the unsatisfactory nature of the finish, in any case where an attempt is made at high output.

* * *

SPECIFICATIONS OF THE U. S. NAVY DEPARTMENT FOR HIGH-SPEED STEEL

Specifications for high-speed tool steel have recently been issued by the United States Navy department. According to these specifications each bar up to and including a sectional area of 2¼ square inches shall be delivered with a test piece on one end equal in length to about one and one-half times the diameter. This test piece should be nicked on each side while the bar is hot, so that it may be easily broken off. The test piece is preheated slowly and thoroughly in a preheating furnace to a uniform temperature of about 1550 degrees F. When thoroughly heated, it is quickly transferred to a high-heat furnace and rapidly heated to a temperature just below the melting point, when it is quickly removed from the furnace and cooled in a heavy air blast. Each test piece is then ground off on one end with a wet emery grinder an amount equal to one-half the thickness of the test piece, leaving the end after grinding of a V shape. This V-end must test "file hard." Each bar failing in this test is rejected, and another bar furnished in its stead by the makers. If 10 per cent of the bars of any lot fail to meet the test, the whole lot may be rejected.

From each lot of tool steel one or more tools are forged and heat-treated. The tools are ground to a uniform standard shape for lathe tools, and are then given a 20-minute test on a steel forging of open-hearth steel, either nickel or carbon, which has been annealed. The minimum tensile strength of the forging on which the tool is used is to be 80,000 pounds per square inch, the minimum elastic limit 50,000 pounds per square inch, the minimum elongation in two inches 25 per cent, and the maximum contents of phosphorus 0.06 per cent, and of sulphur 0.04 per cent. A lathe tool known as ¾-inch standard must be able to take a cut 3/16 inch deep with 1/16 inch feed and a surface speed of 60 feet per minute for twenty minutes without regrinding.

* * *

A simple method of arriving at a commercial estimate of the relative values of different tool steels, is described by the *Zeitschrift des Oesterreichischen Ingenieur und Architekten-Vereins*. The tools are tested by cutting or turning a disk of steel 20 inches in diameter and 2 inches thick, which is held in a lathe. At the center the disk has a hole 4 inches in diameter. The various tools to be tested are used one after the other on the disk, the disk being revolved at a suitable cutting speed. The cutting is started at the center and continued until each tool becomes blunt, each tool, of course, taking a cut of specified depth. The better the steel the greater will be the diameter at which the tool fails. To obtain a commercial estimate of the value of various grades and qualities of tool steel, the prices per pound of the steels are divided by the diameter at which they failed. The quotients thus obtained may be taken as indicators of the value of the steel, the smallest figure, indicating the relatively cheapest steel. In one test undertaken with the seven steels it was found that the relatively best results were obtained with the steel next cheapest in price per pound, while the most expensive steel which, in fact, was nearly 30 per cent higher in price, was relatively about 25 per cent less efficient.

PNEUMATIC PRESS FOR REMOVING SPRING BANDS

By S. WHEAL*

The accompanying illustrations show a pneumatic machine for removing spring bands, recently designed and built in the Wabash shops at Springfield, Ill. Since its installation it has proved to be a valuable asset, not only in the amount of work it can do, but also in the saving of labor as compared with the old, cumbersome method of removing the bands.

Reference to Fig. 1 will give an idea of its construction. This crosshead is integral with the piston-rod of a 16 by 18 inch air cylinder *J*, supported in V-shaped grooves *K* in which it may oscillate. Beneath the vertical guides *B* and attached to the frames *A* by cross pieces, is a pocket *L* made from an old steel axle. The back of this pocket has gripping teeth, as shown at *M*, the use of which will be explained later.

The manner of operation is as follows: The spring which is to have its band removed is placed in the pocket *L*, as shown in Fig. 3, with a supporting grip-block *N* resting on the previously-mentioned tooth-face *M*. This grip-block *N* is so adjusted that the rounded faces of levers *G* just come over the

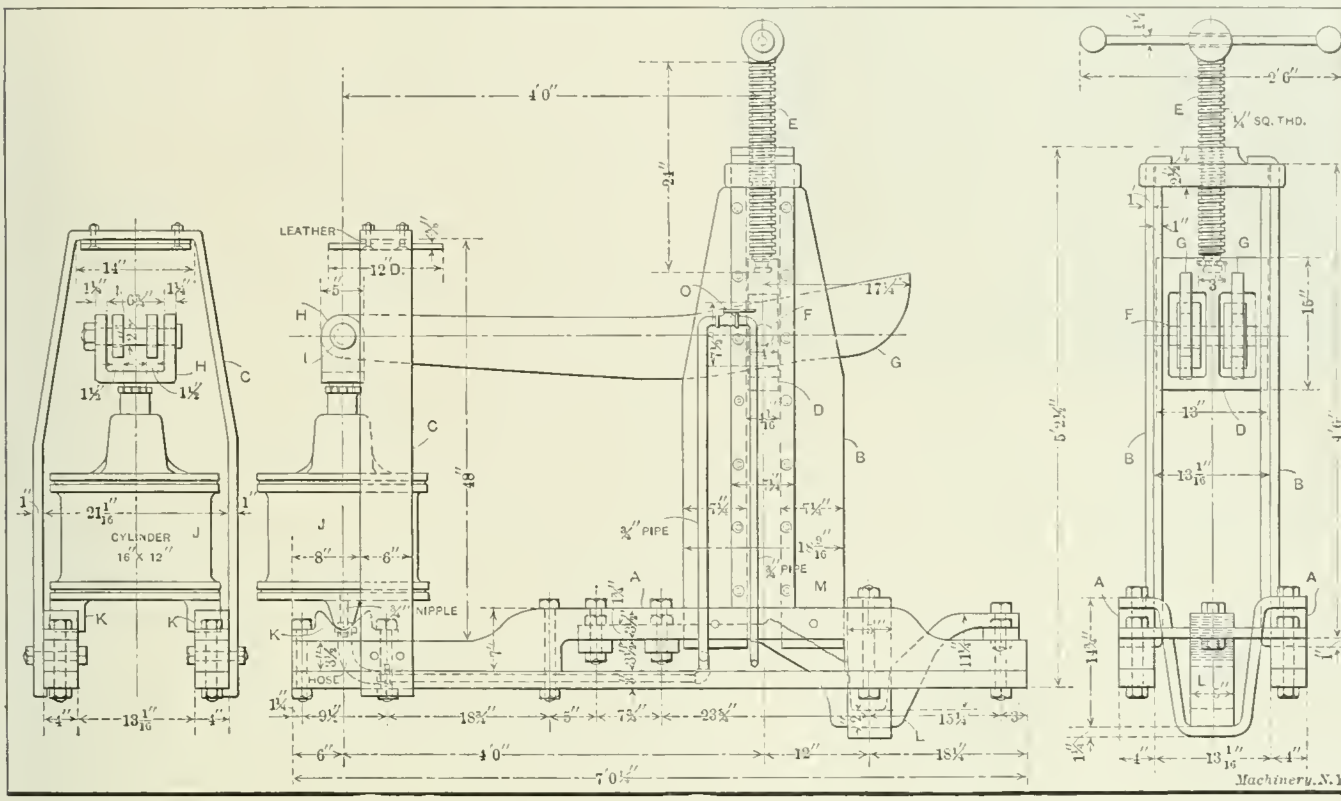

Fig. 1. Detail Views of the Pneumatic Press for Removing Spring Bands

The frame of the machine consists of two parts *A* to which are bolted guides *B* near the front end of the machine, and a frame *C* at the rear end. These base frames *A*, are composed of old front engine frames, with two discarded side rods bolted below; but where desired these frames might just as readily be made from channel iron. Each of the guides *B* is composed of three pieces riveted together as shown, in such a manner as to form guides for the crosshead *D*, which moves vertically in these crosshead ways and is controlled in

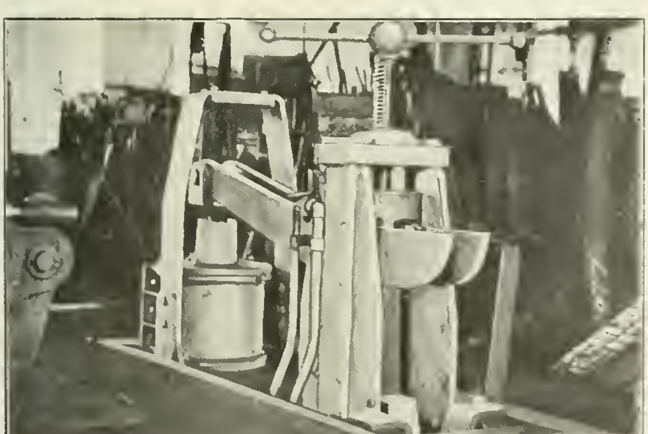

Fig. 2. The Pneumatic Press

its movement by a coarse-pitch square-thread screw *E*, passing down through the top connecting piece.

In the crosshead *D* there is a wrist-pin *F* on which are two levers *G* which pass to the back of the machine and are attached to a rear crosshead *H* through another wrist-pin *I*.

center of the spring band. Adjustment of the screw *E* brings levers *G* on top of the spring band and then by manipulating the air valve *O* air pressure in the cylinder *J* raises the rear

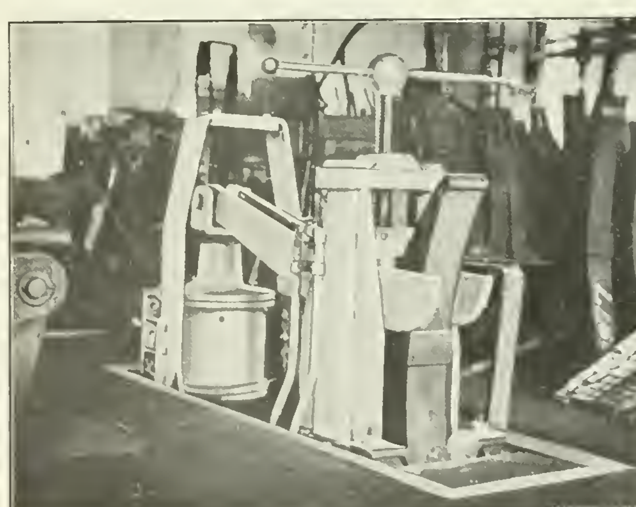

Fig. 3. Press with Spring in Position to be removed

end of the levers *G*, (pin *F* acting as a fulcrum) forcing down the spring band. Releasing the air valve and bringing *H* back to its original position and again screwing the levers *G* down on the new position of the spring band by means of the screw *E*, the operation may be repeated until the spring band is completely removed.

The action of the grip-block *N* is quite apparent, for otherwise, when pressure is brought to bear on the levers *G*, the spring would tend to bend, but the grip-block *N* holds it rigidly in position. Different sizes of grip blocks are provided

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for the various types of springs to be operated upon. Figs. 3, 4 and 5 are photographs of this mechanism showing its general appearance, ready for use, and finally with the spring band removed. It will be noticed in Fig. 5 how far down the screw E has been depressed.

With regard to the expeditious manner in which spring bands may be handled, it might be mentioned that for pressing off the band of an eight-leaf tank spring the average time required is one minute; for a twenty-leaf driving spring, two

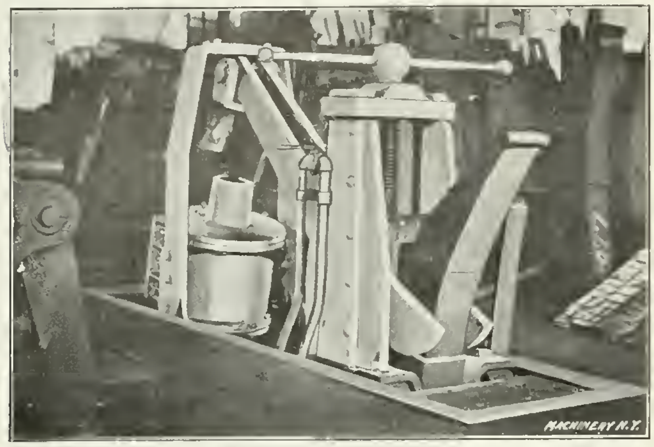

Fig 4. Preee at Completion of the Spring Removal Operation

minutes; and for an engine truck spring, two minutes. These figures merely give the actual operating time after the spring has been placed in position in the machine. For the complete operation, the capacity of the machine may be judged from the

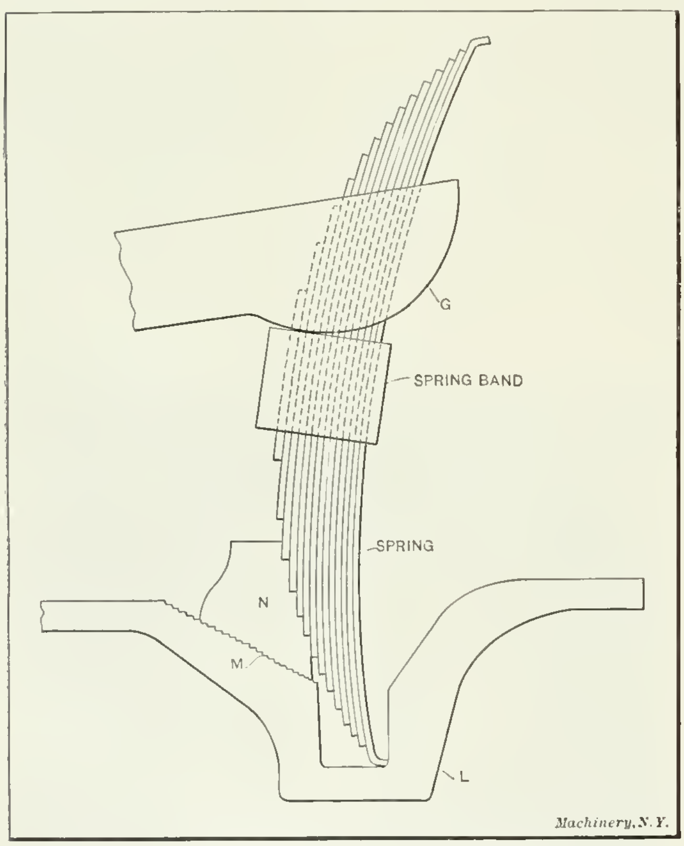

Fig. 5. Heavy Spring in Position to have Band removed, showing the Use of the Grip Block

fact that it only required twenty-three minutes for one helper to remove the bands from twelve eight-leaf tank truck springs.

* * *

An electric railway system is being installed at the "Hill Shops" of the United States Armory at Springfield, Mass. This will be connected with the local street railway and through that with the steam railroad, thus improving the facilities for handling materials to and from the transportation companies as well as between the "Hill" and "Water Shops."

THE AIR BRAKE AS RELATED TO PROGRESS IN LOCOMOTION

A lecture was delivered before the Franklin Institute of Philadelphia on the evening of November 17, by Mr. Walter V. Turner, chief engineer of the Westinghouse Air Brake Co. of Pittsburg, Pa., on the general subject of "Air Brakes." The paper, in connection with the stereopticon views which accompanied it, embraced the development of the art of braking from the earliest and most primitive forms of brakes for road vehicles through the early stages of the art as related to the primitive forms of railway wagons used on the first steam railroads, down through the various stages of progress in steam railroading, to the most improved types of apparatus as used at the present time. The discussion of the various forms of brake apparatus developed from time to time was accompanied in each case by an exposition of the service conditions which required the development of more efficient types of brakes.

Past and present conditions under which railroads are forced to handle the traffic of this country were contrasted in order to illustrate the fact that facilities for controlling railroad trains have not advanced relatively to the requirements, and that, as a matter of fact, the brake has not kept pace with the developments in locomotion. That is to say, even the most efficient brake of today is, at its best, not able to control and stop a train in as short a distance as when the weight and length of the train was less than one-fourth of what it now is. That the stopping distances of modern heavy high-speed trains are not longer than they are, is a source of gratification when it is considered that the length of the train and the volume of air to be handled in controlling the train have rendered the problem vastly more difficult so far as service control is concerned, and the increase in weight and speeds are such as would require at least twice the distance in which to stop modern high-speed passenger trains, if the old type of brake had to be used.

It is difficult for one who has not given the subject careful thought to realize the great changes in railroad equipment and operative requirements which have taken place since the introduction of the air brake. For example, in one of the earliest brake trials in the history of continuous brake, made on the Midland Railroad near Newark, England, in 1875, a stop was made from 53 miles per hour (the highest that could be obtained) in 18 seconds. This corresponds to 15.5 foot-tons of work per brake shoe per second. To stop a modern train of heavy Pullman cars from a speed of, say, 75 miles per hour (which can be obtained under favorable conditions) in the same time, namely, 18 seconds, would require about 4½ times as much work per brake shoe per second as in the case of the Midland Railway train. The tremendous significance of this increase in power demanded is but one aspect of the question and is mentioned simply to indicate the nature of the problem which must be solved.

As the capacity of a chain cannot exceed the strength of its weakest link, so the progress of transportation depends absolutely upon our ability to control the medium of interchange.

After a brief historical review of early forms of brakes, the paper discussed, in order, the steam brake of 1833, patented by Stephenson for use on his original steam locomotive, and the growth of the idea of continuous brakes which became prominent as more cars were drawn in trains. This led to the invention of the first form of air brake—the straight air brake—by Mr. George Westinghouse, in 1869. The early trials of this brake soon demonstrated the adaptability and efficiency of compressed air as a medium for transmitting and controlling the force to be used for retarding or stopping the motion of railroad vehicles through the medium of blocks or shoes rubbing on the periphery of the wheels.

The necessity for greater protective features as well as for meeting more severe traffic demands, led to the substitution of the plain automatic brake for the straight air brake, and with the introduction of the automatic feature the brake equipment may be said to have entered upon the course which it has followed consistently up to the present.

With the advent of longer trains, especially in freight service, and as a result of the important and well-known tests made by the Master Car Builders' Association on the Chicago, Burlington & Quincy R. R. in 1886 and 1887, the quick-action feature was added to the plain automatic brake for the purpose of hastening the application of the brakes throughout the train in case of an emergency application being made. The introduction of this quick-action feature solved for the time being the problem of obtaining a practicable and effective pneumatic brake by means of which trains of maximum length (fifty cars in those days) could be handled without damage to equipment or lading. This achievement was noteworthy from the fact that the official report of the Master Car Builders' committee in charge of the brake tests referred to, expressed serious doubt as to the possibility of accomplishing the desired and necessary results without the aid of electrically controlled pneumatic brakes.

The necessity for maintaining safe and efficient operation of passenger trains of rapidly increasing weights and at high speeds, led to the addition of the high-speed reducing valve and the increase from 70 pounds per square inch to 110 pounds per square inch in the brake pipe pressure, which changed the quick-action brake into what was known as the high-speed brake equipment. This, for many years, remained standard in passenger service.

With the high-speed brake the practical limit of improvement along the lines previously laid down was believed to have been reached, but now conditions requiring greater safety and protective features began to develop about 1903 and 1904 with a rapidity which made it evident that a turning point had been reached. A review of the conditions then existing and to be anticipated in the near future, together with numerous experiments under the most severe service conditions led to the addition of new features to the existing brake equipment, some of which would have been inherently impossible if the design were carried on along the lines previously followed.

In the case of the passenger brake, the improvements and novel features were in the direction of obtaining:

1. Maximum stopping power.
2. Uniformity of braking power on all vehicles.
3. Maintenance of brake cylinder pressure, notwithstanding leakage.
4. Insurance of proper margin between the power of service and emergency applications.
5. Promptness and certainty of brake application for service stops.
6. Protection against depletion due to careless or prolonged manipulation of the brakes.
7. Graduated release feature to provide for smooth and accurate stops being made.
8. Automatic emergency application on depletion of brake pipe pressure.
9. Maximum emergency braking power available at any time.

A graphic comparison of the effectiveness of the high-speed brake and the improved passenger equipment is afforded by a comparison of the emergency stops possible with the two equipments. From 60 miles per hour a modern 590-ton train can be stopped in 1100 feet with the improved equipment, or 575 feet less than the same train will run if the high speed brake is used. Moreover, the train, if equipped with the high-speed brake, will reach the 1100-foot stake 6 seconds sooner than the train having the improved brake and will pass this stake at a speed of 38 miles per hour, having then the equivalent of 40 per cent of its original kinetic energy at 60 miles per hour. At the time when the train with the improved equipment stopped at the 1100-foot stake, the train with the high-speed brake equipment was 275 feet further on and still running at a speed of 28 miles per hour which corresponds to a kinetic energy 22 per cent of the original amount when the train was running at 60 miles per hour.

The improvements incorporated in the freight brake equipment have been in the direction of insuring greater certainty and safety in the handling of long trains and heavy loads. This has been accomplished by providing for:

1. Ability to apply and release the brakes without fear of shocks on the longest trains.
2. Effective and uniform braking power obtained for comparatively light reductions.
3. Uniform release of the brakes on the train as a whole, thus avoiding shocks due to the brakes on the forward end of the train releasing while those at the rear still remain applied.
4. Uniform recharge feature largely increasing the factors of safety and effectiveness.
5. Economy in air consumption resulting from effective and uniform braking effort being obtained on each vehicle in the train for a comparatively light reduction.
6. Improved type of freight triple valve designed to work in harmony with the older valves, insuring a largely increased efficiency of the brake with new and old style valves, mixed in the same train.
7. One form of equipment is especially designed to give an increased braking power in proportion to the load carried and proportionate increase in the ability to handle trains of loaded cars, especially in freight service.

The improved features of the locomotive brake are not only complementary to those already mentioned in the case of the passenger and freight car equipments, but include certain operative features, long recognized as desirable but remaining impracticable until the establishment of a new basis of design permitted the including of all that previous experience had shown to be desirable in a compact and mechanically satisfactory combination of parts. These features include:

1. Either entirely independent or simultaneous operation of the train and locomotive brakes as may be desired, adding greatly to the convenience and flexibility of handling long trains, especially on grades, in switching, etc.
2. Predetermined and maintained brake cylinder pressure irrespective of leakage, number of brake cylinders, or variations in brake-piston travel.
3. Predetermined and desired increase in emergency-brake cylinder pressure over the maximum obtainable in service.
4. Automatic protective feature insuring against the loss of the brake through careless manipulation.

The result of this has been that during the last five or six years, complete and distinct types of brake apparatus have been evolved especially adapted for most efficiently meeting the peculiar conditions presented by modern locomotive passenger and freight service, respectively. With the incorporation of these new features, it may be fairly said that the air brake has entered upon a new era of its history as distinct from that which preceded, covering the progress of the art from the development of the plain automatic brake to the high-speed brake, as that era was distinct from those of the straight air brake and of the hand brake which marked the early history of the art.

* * *

LIGHT ALLOYS FOR AIRSHIP CONSTRUCTION

The advent of the airship as a practical means of locomotion has led to considerable competition among the manufacturers of light metals suitable for use in airship construction. At one time, the best metal in Germany was that known as "chromium," manufactured by the firm of Berg; but this material is being superseded by newer metals. Last year several new light metal alloys were judged for adaptability to airship construction at the aeronautic exhibition, Frankfort, Germany, the metal that received third prize, appearing lately to be the favorite. The first-prize metal was that called "electron," which contains upward of 90 per cent magnesium; but from its inability to stand sea water, and its dubious atmospheric resistivity, it has made but little progress on the market, although it has an ultimate strength of 50,000 pounds per square inch, and a specific gravity of 1.8. The second-prize metal, likewise a magnesium product, has dropped from the field. The before-mentioned third-prize metal, called "duralumin," shows every indication of becoming the favorite material of construction for airships, and has received favor from Count Zeppelin, and the British admiralty, both of whom have placed orders for the material. It has also been adopted by Messrs. Vickers' Sons and Maxim, in England, who have the British rights to its manufacture. The ultimate strength is 85,000, with a specific gravity of 2.8; this is much less than the specific gravity of brass, which it is rapidly superseding for such other purposes as cartridge cases, etc. It is sufficiently immune to the corrosive action of sea water to make its use at sea practicable, as experiments have shown.

WHAT IS A MACHINE TOOL?

By T. S. BENTLEY*

The question as to what is and what is not a "machine tool" has been exciting no little discussion of late, and the controversy has shown how widely opinions differ as to what machines may be properly so described and what should be put in some other category. The matter is of more than merely academic interest, as the term is of such importance and so constantly employed that a clear and well-recognized definition is certainly desirable. Accordingly many suggested definitions have been put forward and many diverse views expressed with regard to the question at issue.

Mere opinions on such a subject, if given without intelligible reasons to support them, are usually of little real interest or value. They are likely to be the unconsidered expression of casual preference, resulting rather from association or prejudice than from reasoned thought; while the process by which the significance of a word is fixed is not accidental nor haphazard as are the circumstances which control hastily formed conclusions.

Change there must be in any but a dead language, and nouns are especially subject to it. Verbs are perhaps least affected; the older ones refer to concepts that do not change, and for activities that are new fresh verbs are usually coined. Various writers—notably Herbert Spencer—have pointed out that there is a constant and inevitable evolution which tends first to generalize the meaning of a word, and later to restrict it within closer and more definite limits. Nouns, being symbols for ideas or objects, must of necessity be preceded by the things which they represent. As fresh varieties appear they have to be referred to by means of the nearest names which are current at the time; and the connotation of these words is thereby expanded. In this way the names soon lose their clear-cut significance and assume a general sense more or less vague, indeterminate and tending to ambiguity. This condition, being unsatisfactory, occasions a natural effort to remedy the defect by the use of qualifying phrases and the coining of new words. These actions are at first spontaneous and instinctive on the part of individuals; but after a time the more discriminating among those chiefly concerned commence by conscious and systematic selection to specialize the various terms and restrict each to a more or less definite sphere. The discussion concerning the most fit use of the term "machine tool" is an instance of this particular stage of the process.

Through the action described above, it comes about that words have commonly a general and also a special signification—of which the latter tends ultimately to predominate. This natural sequence explains much that is puzzling in the use and changing meanings of words. It also provides a logical basis for the attitude which we all as individuals are bound to assume in relation to this mental currency.

"Usage" is the final court of appeal in matters of speech, and to its formation all of us contribute in some slight measure. Authorities cannot coerce it; all they can do is to suggest, endorse and finally record the decision unconsciously expressed in the every-day talk of those who speak the language.

One or two examples will render my meaning clear and serve to illustrate the connection between the general rule and the particular instance which we specially set out to consider. Take the word "engine"; this originally signified *any* machine, practically without exception. Our modern phrase "engines of destruction" as applied to artillery suggests its association with the *ballista* and *catapulta* which among the Romans were what cannon are with us. The same broad sense is also preserved in the terms "dividing engine," "rose engine," "engine-turning," etc. The word engine is now practically restricted to certain classes of prime movers which are further differentiated by characteristic prefixes such as "steam," "gas," "oil," "internal-combustion," etc. It is also noteworthy that later forms of prime movers have been designated by other and more distinctive names such as "motor" and "turbine." In the same way the allied word "engineer" soon became so indefinite that some qualifying term is now coupled to it almost as a matter of course. The natural tendency towards ultimate specialization is exemplified, however, in the characteristic use of this word in American railway practice as the equivalent of the English word "driver" —the man in charge of a locomotive.

The word "engine" in its broad sense has been almost entirely superseded by "machine," which is now employed in such a multitude of connections that it must perforce be qualified by some descriptive word—often a participial adjective. Thus it comes about that in common speech we are likely to regard the primary word as redundant, and to shorten the combination by coining a new noun from the descriptive prefix. Hence we speak of planers, shapers, locomotives, etc.

The word "machine" itself has become so far specialized that, in place of meaning *any* mechanical aid, it now conveys the idea of a more or less complex piece of mechanism designed to transmit, transform or apply power in order to achieve some desired result. In like manner the word "tool" has run through a whole scale of meanings and, in a broad sense, is still applied alike to the simplest hand instrument and to some of the most complex machines which equip the modern engineering work-shop.

In general, however, the word "tool" signifies a small appliance for the performance of almost any simple operation. A large number of tools are intended for cutting, but this is not necessarily the case. A hammer is a tool for striking; a file for smoothing; a bookbinder's "tool" serves to impress patterns on leather, while a painter's "sash-tool" is a special brush for painting window frames; but though tools, or mechanical aids, are employed by everyone more or less they are not always known by that name, and it is interesting to note how they have become grouped by common usage under distinctive titles. Thus in the work-shop they are *tools*, in surgery and drafting-room, *instruments*; in the gymnasium, *apparatus;* in the kitchen, *utensils;* and on the farm, *implements;*—yet the word "tool" in its broad sense, covers them all. A similar process of differentiation is now taking place in connection with appliances of a more complex nature.

There have been many definitions suggested with a view to restricting the applicability of the term "machine tool," and on comparing them we discover that they not only differ in phrase but differ still more in the ideas which underlie them. In fact there is no unanimity as to the fundamental conditions which justify the use of the name. Some lay stress on certain characteristics of the machine itself, others on the kind of work which *can be done* on it; but most base their classification on the kind of work the machine *does actually perform* (as distinct from its potential capabilities), and many make the classification dependent on the purpose for which the work is produced. Who could expect agreement from ideas so radically conflicting!

Then again, we must not forget that there are circumstances in connection with the term "machine tool" which tend to render its definition peculiarly difficult by importing into the matter certain considerations other than that of mere philological fitness.

1. There is a vague feeling in many quarters that the name "machine tool" implies a status appreciably superior to that of the class dubbed "machinery." This idea is doubtless a relic of the time when machines were built singly, and those intended for the use of the builder or some other skilled mechanic were naturally more carefully made than such as were destined for those who were less critical or whose requirements were less exacting. Under present conditions of manufacture and use there is no longer the pronounced distinction.

2. The machine tool builders' associations are further embarrassed by the fact that their adoption of a restricted definition might, by implication, challenge the technical eligibility of some of their old and valued members for membership of their body. It is as though the modern definition of what constitutes a surgeon had been suggested for official adoption by the old guild of "barber-chirurgeons" in the days when the barber's pole still had a sanguinary significance and before the "tonsorial artists" had started societies of their own. The latter would naturally and inevitably have opposed any such strict definition because it would make them appear out of

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place where they had long been comfortably settled and desired to remain. Such a distinction between those who plied the scissors and those who wielded the lancet would not only have seemed invidious in what had hitherto been the common name of both, but would also have been difficult of application as many of the members practised both professions and were equally adept at both.

Now for months past thought has been given by many to this question of a suitable definition for "machine tools," yet no satisfactory conclusion has been reached because each suggested formula, when carefully analysed, has proved hopelessly defective. Let us consider some typical examples and try to discover wherein they fail.

A. "*A machine tool is a machine used in the building of other machines.*" This has the merit of brevity, but is at once too wide and too narrow. It would let in the crane or lifting jack while shutting out half the equipment of the toolroom!

B. "*A machine tool is any hand- or power-driven mechanism consisting of several parts, some of which move to perform any process or operation in making tools, machines, structures and the parts thereof, from metal and other alloys and which is not used in nor based upon other mechanisms to make it operative.*" While this is studiedly comprehensive it is too long for popular adoption and does not appear to do what is intended after all. The steam or self-contained pneumatic power-hammer would certainly come within its scope, but most of the portable machine tools which form so useful a feature in many modern shops would seem to be ruled out.

C. "*A machine tool is any hand- or power-driven unitary mechanism actuating cutters, tools, dies or other forming or shop implements, to perform any process or operation in making tools, machines, structures or any part thereof from metal, in distinction from one for producing a special or specific article.*" This is still too long for convenient use even if it adequately met every other requirement. It is not free from ambiguity, and might to taken to shut out the automatic screw machine though probably not so intended. It will be noted that this last definition lays stress on a characteristic which neither of the others referred to; and therein, to my mind, its principal value lies.

It is generally recognized that no satisfactory definition can be based on features of design or construction because the immense variety of machines to be covered makes any such attempt either hopelessly inadequate or too unwieldy for use. Besides, as new developments are constantly taking place, any such definition would speedily become obsolete. For this reason also, any attempt to solve the question by compiling lists of what should or should not be styled "machine tools" is foredoomed to failure.

Definitions making the particular work on which the machine is engaged the deciding factor will not stand analysis; neither will those which regard the ultimate use to which such product is to be put as the crucial point. These schemes involve such anomalies as that two similar machines working side by side might have to be classified differently, and if for any reason the distribution of work should chance to be reversed, then the classification would need to eb altered! Any such plan is manifestly absurd; a definition must be based on something less accidental and liable to change. It must rest not on a detail but on a principle.

Another idea seems more hopeful, and I will illustrate it by analogy. Suppose three men, A B and C are employed in the same shop. It may happen that we find A and B doing precisely similar work but that B stands higher than A on the pay-roll. B is more highly valued because he can do other work also—he is a "good all-round man"—while A is at a loss except on his usual job. But C may be rated equal with B although he does not profess to be an all-round man, and in fact always keeps on one class of work. He is valued as a *specialist* in his line. This seems to me a fair illustration of the principle on which our classification must be based. A may stand for the ordinary machine of no particular class; B for the "machine tool"; and C for the special machine, the two latter being equally valued for opposite reasons, as representing range of capacity on the one hand and concentration on the other. Thus the single-purpose machine is not necessarily inferior to one of greater adaptability—each must be judged on its merits.

One of the few points on which all suggested definitions appear to agree is that wood-working machines should be barred out. This seems to be either expressed or implied in every formula. Why are they excluded? A carpenter's mortise chisel, for example, is undoubtedly a tool. A mortising machine employs a similar tool or performs the same kind of work. Why then may it not be styled a "machine tool"? This distinction is a matter of some interest. Is it also a matter of principle—of widespread prejudice—or is it merely a coincidence?

Personally I believe it is neither, but that it is due primarily to convenience. Wood-working machines are so specialized that each is most conveniently referred to by its own particular name; so this is done naturally and as a matter of course. The general term is dropped not so much "on principle" as because it serves no useful purpose. It is just the same with the men in the shop. Suppose I needed more help in the press tool department I should not advertise for "a man," although I should expect to get one; nor for a "mechanic," as that may mean almost anything; even the word "toolmaker" would be too vague. The description "press-tool-maker" gives all necessary information at once and *does not deny, but includes* all the other terms. Therefore, they would not need to be employed in this connection.

This brings me to my final point, *viz.:* that the disagreement as to a definition is really inherent in the way the question is put. I would restate it as follows: "*Which machines should be called 'machine tools,' and which should be more definitely named?*" In this way the problem is changed from the negative to the positive; and, put into quite a different perspective. This method avoids all cause of embarrassment or offence, harmonizes with the natural process of evolution, and thus has every chance of resulting in an amicable and permanent agreement.

If space would permit, it would be extremely interesting to trace this same natural process in the evolution of all our standard machine tools. Although now so dissimilar in character and function, they are in fact all sprung from that machine tool *par excellence* the lathe, each function of which has been separately developed and specialized until in some cases all apparent relationship has been lost. The names have kept pace with the development and many of those indicating the descent, being no longer necessary, have dropped quietly out of use in favor of more special terms. But even a special title may become a misnomer—as in the case of the automatic screw machine—and call for revision. The machine referred to was designed for a specific purpose and designated accordingly, but its capabilities have been so greatly extended that it has really reverted to the class of general machine tools though still retaining its special name.

That these principles are of general application may be illustrated from quite another field. Any army officer is commonly referred to by his distinctive rank. This does not in any sense deny that he is a soldier—quite the opposite—but the usual practice is so well understood that the more indefinite term (except when used in an obviously general sense) is left almost entirely to the "rank and file." The army also furnishes examples of special terms which have now become general or at least divorced from their original and literal significance; for instances take fusileer, grenadier, etc.

These considerations force me to the conclusions:

a. *That wherever a machine is so modified as to be restricted to one kind of work, it should be described by a name which makes this clear, in preference to an indefinite one.*

b. *That machine tool builders should agree together as to the general adoption of such special names and their employment in all printed matter, advertisements, etc.*

c. *That this course would aid the natural solution of the problem by setting up an influential usage which would stand every chance of being generally followed.*

Similar concerted action might with advantage be taken to establish a well-defined use of certain important words at present very loosely employed—as for instance, "automatic," "universal," etc., which are at present decidedly ambiguous.

If the machine tool builders' associations would take this matter up in earnest, they would be doing signal service for the benefit of all English-speaking peoples: for the highest stages of any nation's progress depend on and are limited by the scope and clearness of the language spoken. Those, therefore, who count their mother tongue a priceless heritage, and strive to guard it as a sacred trust, not only serve *their* generation well, but win the thanks of others yet to come.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS*—6

THE AMERICAN TOOL WORKS CO.

By ETHAN VIALL†

The American Tool Works Co., of Cincinnati, manufactures a greater variety of machine tools than any other firm in that city, its line comprising lathes, planers, shapers and radial drills; in addition, it manufactures all the countershafts used in connection with its output. The shop practice of the different departments devoted to the various lines is equal in every respect to that of the single-specialty shops. All shafts or other cylindrical parts requiring smoothness and accuracy are ground and, if necessary, lapped. High-speed pulleys and flywheels for motor-driven planers or other purposes are given a standing balance and then a running balance on a Defiance balancing machine, which is one of the few balancing machines of this type the writer has seen outside of automobile factories. The heating and power boilers are fired with natural gas which is cleaner, cheaper and causes

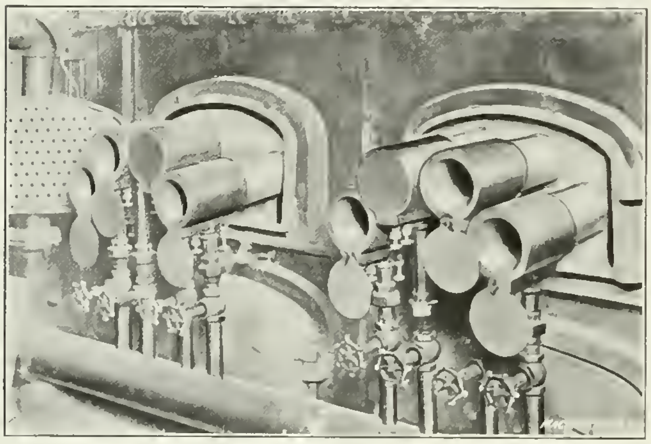


Fig. 1. Natural Gas Burners Fitted to Coal-burning Furnaces

less trouble than coal, besides doing away with the smoke nuisance that is such a factor in some cases. A view of one corner of the boiler room, showing the method of applying gas burners to boilers that were originally coal-fired, may be seen in Fig. 1.

Hobbing Teeth in Radial Arms

Probably as interesting to a mechanic as anything in the shop, is the way the worm-gear teeth are hobbed out on the universal arms of large radial drills. The large end of the radial arm is first turned to the right diameter, the end finished and the center hole bored, after which it is bolted down and the worm-gear teeth hobbed as shown in Fig. 2. In Fig.

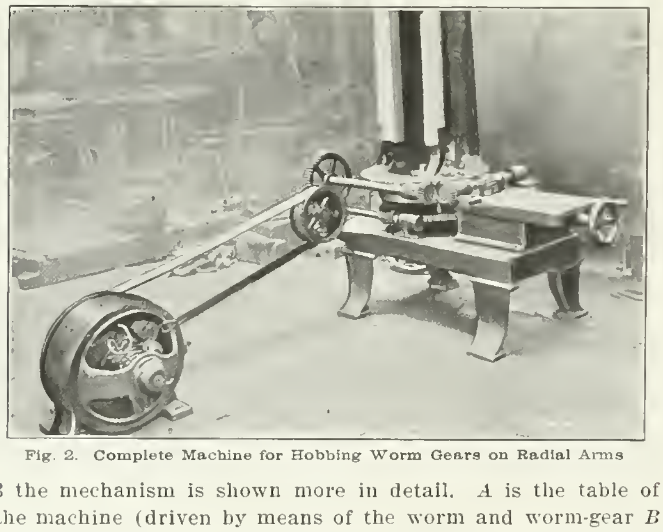


Fig. 2. Complete Machine for Hobbing Worm Gears on Radial Arms

3 the mechanism is shown more in detail. *A* is the table of the machine (driven by means of the worm and worm-gear *B* and *C*) to which the arm is clamped by the bolt *D* which runs through the center and is held by a nut underneath. The hob *E* and its arbor run in boxes on the carriage *F*, which is fed in or out by a handwheel, the shaft *G* being splined and keyed to the gear *H*, so as to allow the shaft to slide in or out as the carriage is moved. Power is supplied by a 2-horse-

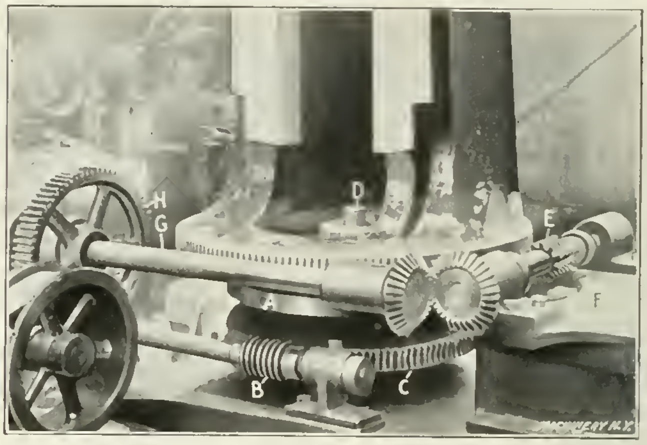


Fig. 3. View of Working Parts of Worm-gear Hobbing Machine

power Westinghouse motor through a belt and gearing as shown in Fig. 2.

Planing the Saddle Slides

The saddle slides for the universal head are finished after the arm and girdle have been fitted together, as shown in Fig. 4, by inserting a mandrel *A*, into the girdle *B*, and then mounting it on two V-topped angle-plates like *C*. The arm is then leveled and lined up from the bored hole in the center, and clamped securely. It is then ready for planing.

Machining Cone Pulleys

Cone pulleys of several sizes and types are first caught by the large end in a three-jaw chuck and the small end is bored

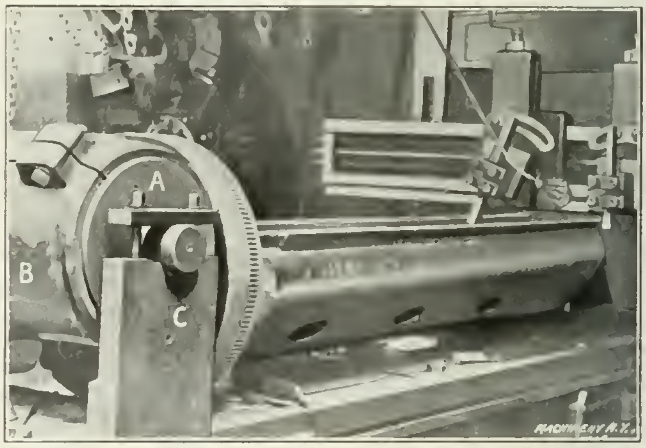


Fig. 4. Method of Mounting Radial Arms on Planer to plane Saddle Slides

and faced. After this operation they are put on a mandrel, with a nut on the outer end which clamps the pulley like a bolt, and all the steps are roughed off at once, including the faces, with a gang of tools, as shown at *A*, *B*, *C*, and *D*, Fig. 5. Tool *E* in the full-swing rest, is used to face the large end. The crowning is a separate operation and is done by using a former made of a flat piece of steel of the required width, the cutting edge of which is slightly concave; this forms each step separately, the tool being held in a special tool-block on the cross-slide. In order to make them balance properly and run smoothly, lathe cones and others without internal spider bracing or webs, are bored out inside on a big turret lathe, the tools for which are shown in Fig. 6. *A* is the chuck which is fastened to the lathe faceplate and into which the cone pulley is placed, large end out, and clamped by the two screws *B*, one on each side of the chuck. *D* is the boring tool used; this is held in the turret, and is steadied while cutting not only by the opposing blades but also by the pilot *E*, which fits a guide bushing in the lathe spindle. While different cone pulleys are shown in Figs. 5 and 6, the method of machining is essentially the same for both types.

* For previous installments of the series on Cincinnati shops, see Bradford Machine Tool Co., November, 1910, engineering edition, Cincinnati Shaper Co., July 1910, G. A. Gray Co., February, 1910, engineering edition, Lodge & Shipley Machine Tool Co., December, 1909, and R. K. LeBlond Machine Tool Co., November, 1909.

† Associate Editor of MACHINERY.

Cutting Internal Gear Teeth in Lathe Faceplates

An "American" planer has been fitted up to cut internal gear teeth in the simplest and most ingenious way imaginable as shown in Figs. 7 and 8, and the particular job for which it is intended is to cut the internal teeth on large lathe faceplates. The two sizes of faceplates that are machined with the device shown in the engraving are 30 and 36 inches in diameter, 86 and 102 teeth, though other sizes may be cut by substituting different index plates. Fig. 7 shows a faceplate

Fig. 5. Mandrel and Tools used in Rough-turning Cone Pulleys

in the cutting position, and it will be observed that except when being indexed the gear does not move, the necessary feeding being done from the tool carriage *A*, mounted on the platen of the planer, the cutting tool *B*, being held in a clapper-box *C* which is fed down by turning the ball-crank *D* by hand. The proper depth to feed the cutting tool is gaged by the templet *E*, which is set into the slot in the bed directly under the tool, but no other stop than the regular reversing mechanism of the planer is needed to gage the tool travel.

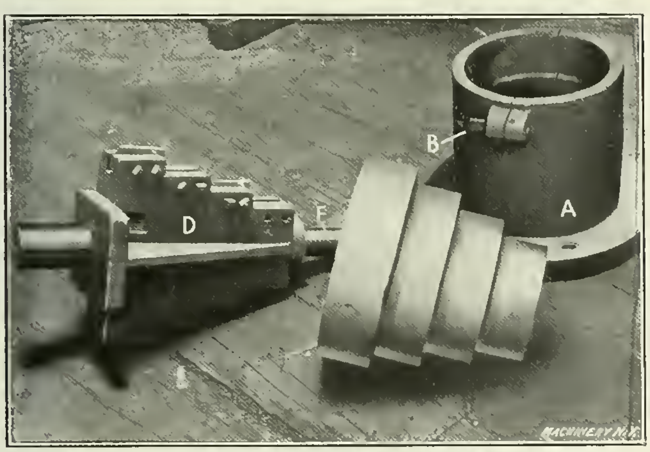


Fig. 6. Chuck and Boring-tool used for Machining the Inside of Cone Pulleys

Fig. 8 is merely a rear view showing the position of the indexing dial, but Fig. 9 shows the fixture removed from the planer housings and gives a good idea of its construction. From the foregoing engravings it will be seen that in order to apply this device, the regular cross-rail must be removed from the planer and these fixtures clamped to the housings in place of it. In the following description of the parts shown in Fig. 9 the letters indicate the same parts as in Fig. 7. *F* and *G* are latch-pin levers for operating the pins that engage the holes in the index plate *H*, the lever not in use being blocked up to prevent the wrong row of holes being used; *I* is a shaft on which is mounted a worm meshing into the worm-gear on the shaft carrying the index plate and internal gear to be cut, so that when the latch pin is out of the hole in the index plate, the parts may be rotated enough to bring the next index hole in line with the pin by turning the hand crank on the end of the shaft carrying the worm. *J* is a special cross-brace used to steady the gear while under a cut, a capstan screw *K* supporting a point on the faceplate directly back of the nose of the cutting tool.

Scraping and Fitting Stands

Two very simple and convenient scraping and fitting stands used in the lathe carriage section are shown in Fig. 10. The lever-wrench used to operate the lock-nut on the tilting-axis clamp may be removed for convenience when working, but it cannot be carried away and lost, as it is fastened to the stand by a small chain, which is an idea that might be followed with profit for many purposes by shops in general. Another style of stand, or rather table, is shown in Fig. 11, which is not only convenient for fitting work of various kinds but is also very handy for various special small machine jobs or repair work which can best be done by using angle-plates and air or electric drills, and a table of this kind should be of considerable value to a jobbing shop.

Graduating Drill Spindle Sleeves

Sleeves for drill spindles are graduated between the centers of a special machine shown in Fig. 12. In this engraving *A* is the sleeve, which has been slipped over a mandrel; *B* is the graduating tool and holder; *C* is the handwheel on the end of the cross-slide screw of the carriage, and *D* is the lever which operates the entire mechanism. Suppose, for instance,

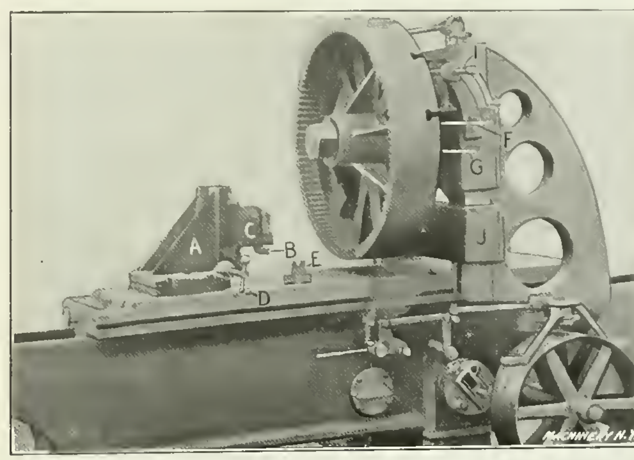


Fig. 7. Planer Fitted for Planing out Internal Gears

that a sleeve is being graduated: The tool carriage is set at the right end of the sleeve and feeds to the left, and by pushing down on lever *D* the connecting-rod *E* is pulled up, making the lead-screw that actuates the tool carriage rotate to the left, causing the carriage to move to the left an amount equal to the distance between the graduations for which the machine is set, the screw being right-hand as usual. As lever *D* is raised, the part *F* comes in contact with pin *G* which causes *H* to rise and rotate the spindle and sleeve sufficiently

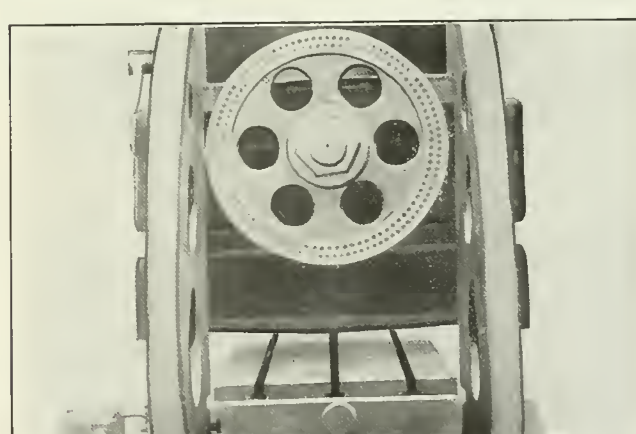


Fig. 8. Rear View of Gear Planer showing Index Dial

to give the required length of graduation; this length is determined by the depth of the slots in the cam-wheel *I* which is rotated on the downward stroke by the dog *J*. The lever *K* is used merely to assist in the working of the spindle and sleeve and is manipulated by the left hand while the right operates the other lever.

Fig. 13 shows a gear testing machine, which, in a general way, is of the usual design but which was made in the shop.

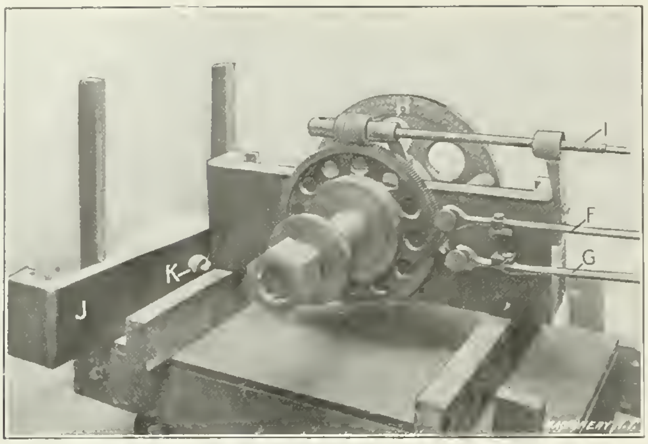


Fig. 9. Gear Indexing Mechanism Removed from Planer to show Details

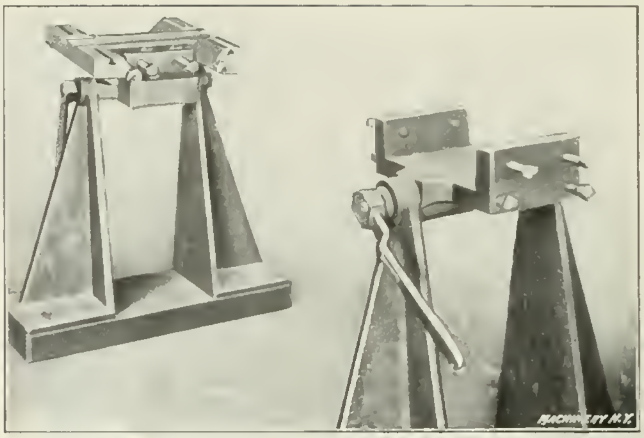


Fig. 10. Scraping and Fitting Stands used to hold Work in Erecting Department

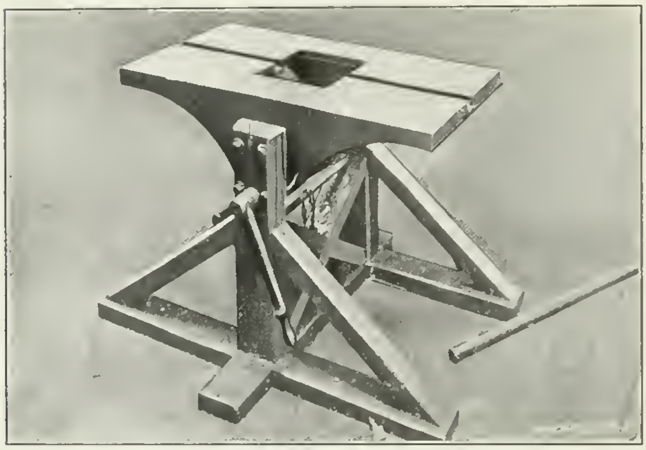


Fig. 11 Adjustable Fitting and Work-table for All-around Use

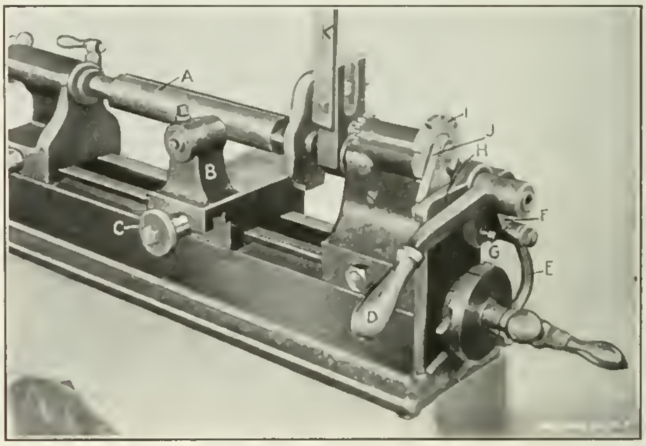


Fig 12. Special Machine used for Graduating Drill Spindle Sleeves

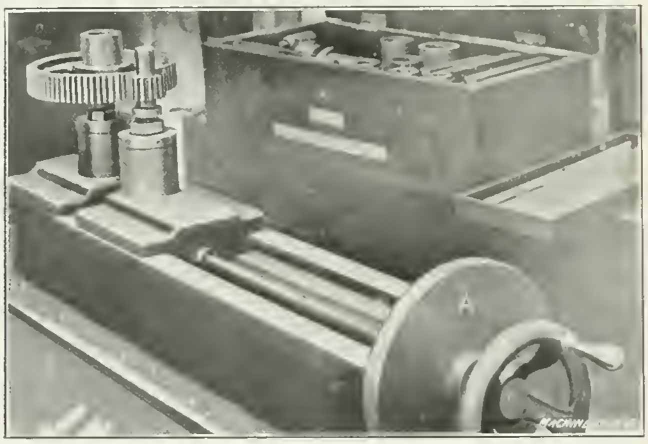


Fig. 13. Gear-testing Machine with Extra Large Graduated Dial

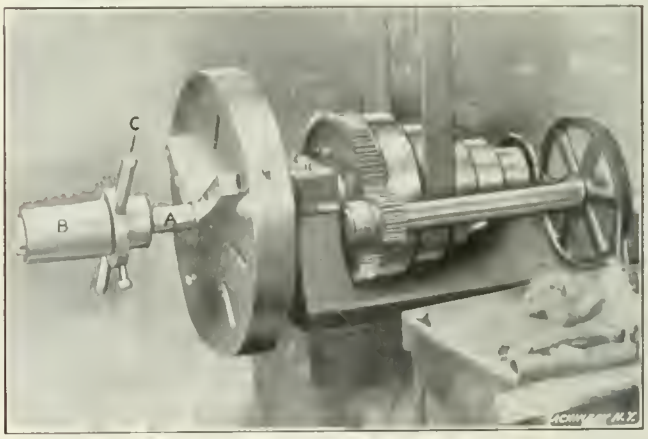


Fig. 14. Cone Pulley Lathe Head and Chuck used for Reaming

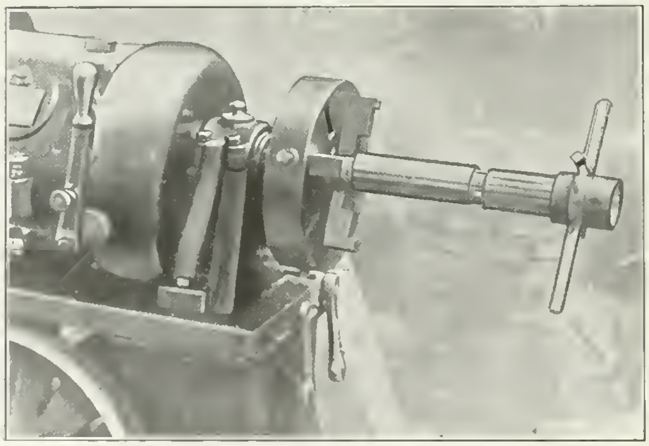


Fig. 15. Geared Lathe Head used in Same Way as in Fig. 14

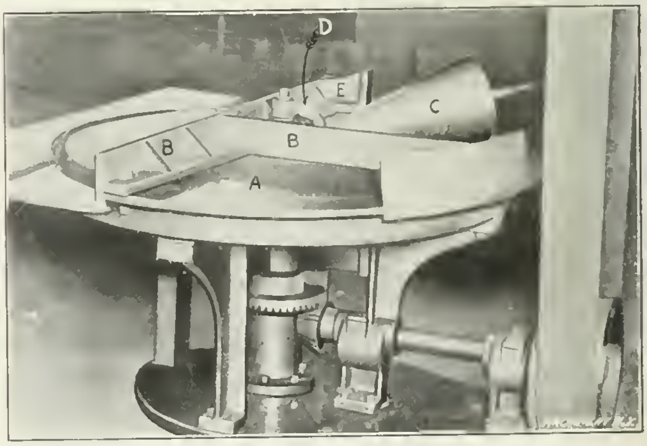


Fig. 16. Special Polishing Machine and Charging Roll for Polishing Flat Work

A feature of the machine is the large graduated dial *A* on the adjusting screw, which was cut from a precision master screw.

Reaming Heads

A rather novel use is made in this shop of lathe heads as reaming machines for reaming out bushings and other small

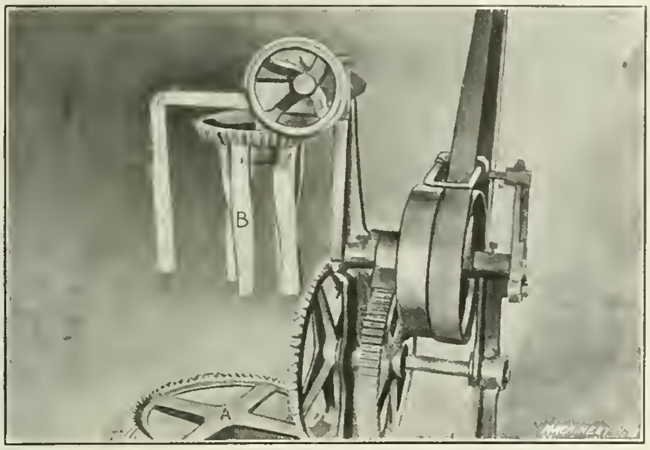


Fig 17. Machine used to thoroughly mix the Filler made in the Shop

parts. Fig. 14 shows a cone head with a three-jaw universal chuck, mounted on a stand. A reamer *A* is secured in the chuck and a bushing *B* held by a hand wrench *C*, is shown on the end of the reamer. Fig. 15 shows a geared head used for similar work.

A Machine for Polishing Flat Work

Flat work of various kinds is polished on the machine shown in Fig. 16. The polishing disk *A*, of a special composi-

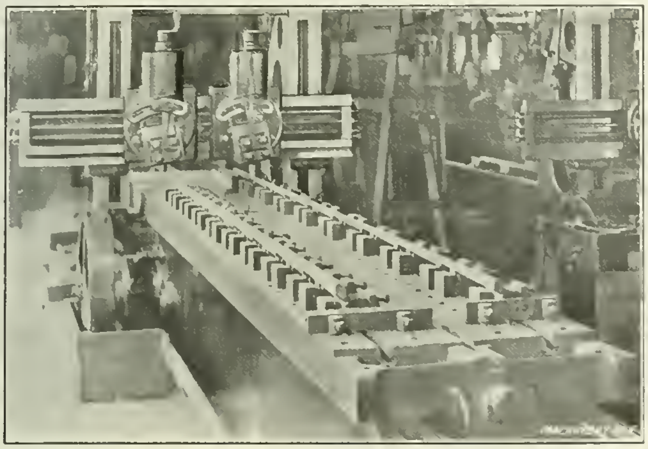


Fig. 19. Geng of Jigs used to hold Taper Gibs while Planing

tion charged with emery, is four feet in diameter, and the cross pieces *B* are intended to steady the work being polished. The charging roll *C* held by the swinging hinge *D*, is "hooked

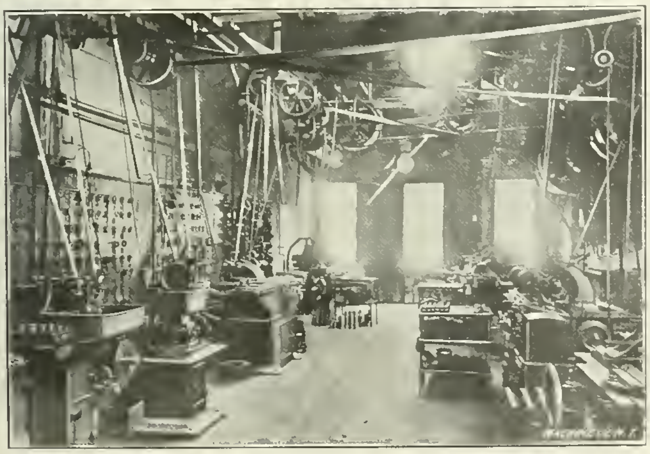


Fig. 21. Partial View of Grinding Room showing Different Types of Grinders in Use

up" onto the bracket *E* when not in actual use. For all-around use this machine is one of the best that the writer has seen.

Making Filler

So much trouble was experienced by this company in obtaining a filler that would not check or flake off that they have made their own for some time, from a special formula. The mixer used for stirring the ingredients thoroughly is shown in Fig. 17. In this engraving the can containing the filler mix-

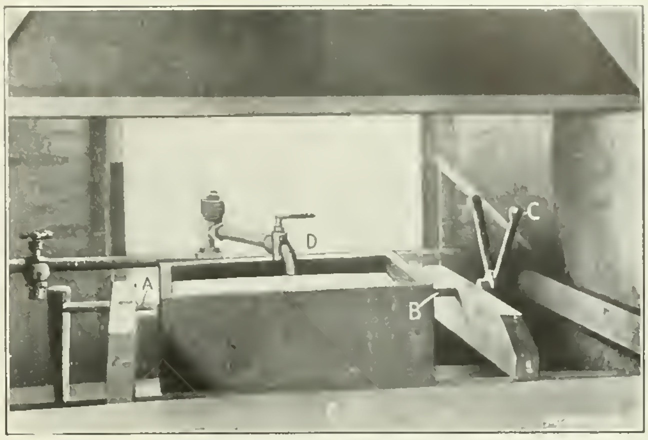


Fig. 18. Rocking Tank used to hold Acid for Recutting Files

ture is set on the gear *A* and rotated while the mixing paddles *B* rotate in the opposite direction.

Recutting Files with Acid

Fig. 18 shows a wooden tank used to hold an acid mixture for recutting old files. This tank is suspended on the shafts *A* and *B* and is rocked back and forth by means of the capstan *C*. The water faucet *D* may be swung out of the way when rocking or emptying the tank. A large tank *E* retains all

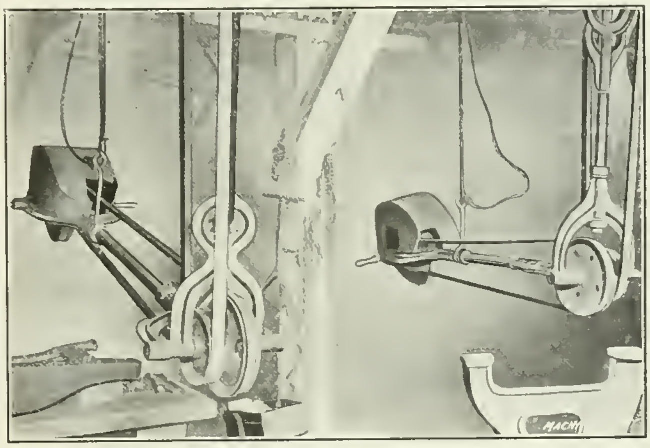


Fig. 20. Swinging Emery Wheels used for Dressing Rough Castings

acid slopping over or being emptied from the smaller one.

Taper gibs are placed in special jigs and planed in gangs as shown in Fig. 19. Fig. 20 shows two swinging grinders

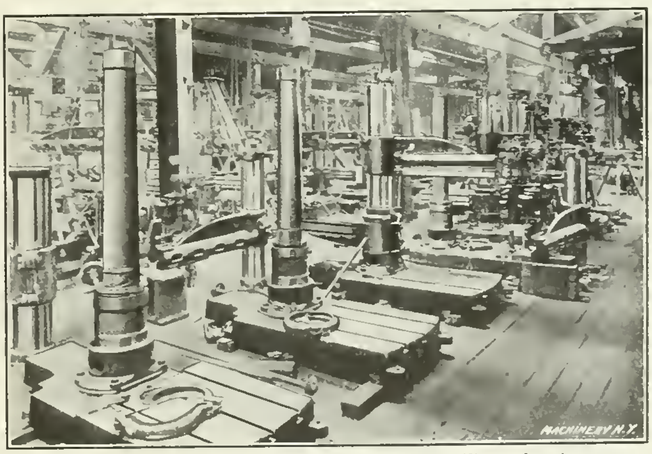


Fig. 22. One Corner of Radial Drill Erecting Floor showing Partially Assembled Machines

used for smoothing up rough castings.

As intimated at the beginning of this article, grinding plays a very important part in the manufacturing processes, and

the grinding room is one of the most complete in the West. A partial view of this room is shown in Fig. 21 and Fig. 22 shows one corner of the radial-drill erecting floor. More comprehensive views of these rooms could not be shown because the large amount of work on the floor interfered with the placing of the camera.

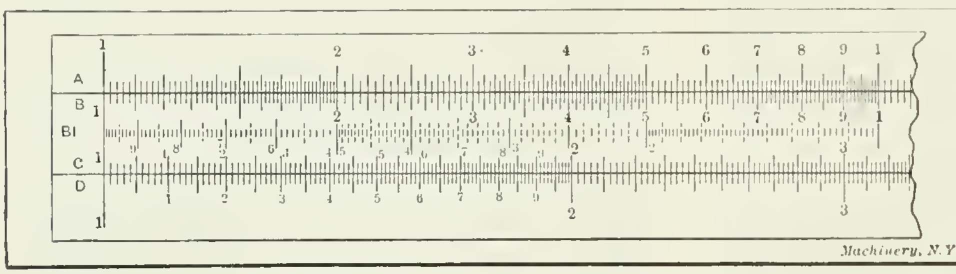
* * *

AN IMPROVEMENT ON THE MANNHEIM SLIDE RULE

By DESIGNER

Herewith is an addition made by the writer to a Mannheim slide rule, which greatly extends its field of usefulness. Anyone taking the trouble to make this addition to his slide rule, provided it is of this type, will be well repaid, and will find it to be a valuable asset.

The improvement consists of a reversed scale placed on the slide beneath what is usually designated as the B scale and divided exactly as the A and B scale; but, instead of commencing at the left and increasing numerically to the right, it commences at the center index and increases numerically to the left, making a scale reciprocal with B. This graduation may be accurately performed in the following manner: Invert the slide in the rule so that scale C is in contact with scale A and, having the index lines in perfect alignment, mark on the slide between scales B and C, using the divisions on scale A as a guide.



Additional Graduations on Mannheim Slide Rule

For a marking instrument use either a very sharply pointed needle or a knife, making use of a small toolmaker's try square placed along the upper edge of the rule to accurately position the lines on the new scale, which may be designated B_1.

The best method of making divisions, owing to the space being limited, is to make short straight lines for the main divisions and three, two and one prick marks for the subdivisions. After the markings have been made, take red ink and fill in each line and sub-division.

When the ink is dry use a damp, cleaning eraser to remove the surplus ink. The lines and points scratched in the celluloid facing will then stand out very clearly. If this method of division is used, the new scale may be marked as accurately as the original graduations.

After completing the marking, restore the slide to its normal position, and the rule is then ready for use. Besides having all the advantages of the duplex and the multiplex rules it has several exclusive ones; some of these are given herewith:

Multiplication of three numbers at one setting thus: Set the first number on B_1 to the second number on A; above the third number on B, read the product on A.

Multiplication of five numbers at two settings thus: Set first number on B_1 to second number on A; above third number on B set glass runner; set fourth number on B to glass runner; and above fifth number on B, read the product on A.

Division of one number by two numbers at one setting: Set one divisor on B to dividend on A; above the other divisor on B_1, read quotient on scale A.

Reciprocals are read directly; the reciprocal of a number on B will be found directly below on B_1, and *vice versa*.

In addition to these, there are many other settings that reduce the number of operations necessary on the ordinary Mannheim rule. These can be developed by the operator as necessity demands, as the range of this new scale is quite extensive.

LIMITATIONS IN DESIGN OF THE WÜST HERRINGBONE GEAR

By PERCY C. DAY*

The article on the limitations in design of the Wüst herringbone gear by "Charles Augustus," published in the December issue of MACHINERY is rather misleading. In the first place, the Wüst gears have not been brought out very recently, but have been extensively used in Europe, particularly in Great Britain, for the past six years.

It is true that these gears may be cut just as accurately on an ordinary hobbing machine as on the special double hobbing machine developed by Mr. Wüst, "if the proper form of cutter is provided and the proper indexing mechanism used." Those who are familiar with the production of these gears will appreciate the significance of the reservation. That Wüst gears can be just as accurately cut on an ordinary milling machine or spiral gear-cutter is incorrect. Helical gears cut by such methods, which necessitates the use of formed cutters, cannot be compared with Wüst gears generated by hobs.

The spiral angle of Wüst gears is not necessarily 23 degrees, although this has been adopted as a standard, as it makes a very satisfactory compromise between ideal running and the best manufacturing conditions. As a matter of fact, gears have been cut with a spiral angle of 30 degrees which cleared satisfactorily at the center.

In figuring out clearances, "Charles Augustus" seems to have omitted to allow for the fact that Wüst gears are usually cut with short addendum. There are many disadvantages in the adoption of a large spiral angle. It is perfectly true that the wear on the teeth for a given load is considerably greater with a spiral angle of 45 degrees than with 23 degrees. It is also true that the normal component of tooth pressure is greater and the normal tooth section is less with the higher angle. It is obvious that some fixed standard of spiral angle must be adopted by those who manufacture this type of gear, and the angle of 23 degrees is that which gives the best average results for the varied uses to which the gears are put. Wüst gears are used for the heaviest pumping, rolling and hoisting work as well as for high-power steam turbines where the pitch line velocity often reaches from 5000 to 7000 feet per minute. In nearly all cases where the gears are applied, it is possible to adapt the face width to suit the running conditions. Even in those cases where the available face width is narrow and the gears are required to run at high speeds, it is usually found to be a better solution to decrease the pitch than to increase the spiral angle. For gears of fixed diameter, load, speed and face width, a decrease of pitch, by distributing the load over more teeth at one time, will generally secure quiet operation with less wear and tear than if an attempt is made to meet the conditions by increasing the spiral angle. Not, by any means, the least advantage of the 23-degree angle lies in the fact that it admits the use of hobs which do not require to be set round but are made of the same angle as the teeth. This method allows the hob axis to be set perpendicular to the gear axis, so that the teeth are generated from the true rack section of the hob.

While there is no particular advantage in the staggered form of tooth where the number of teeth in gear and pinion lies within the ordinary limits, it must be borne in mind that Wüst gears are used for exceptionally high ratios and it often happens that a pinion of seven or eight teeth is used. In such cases the staggered form of tooth has a great advantage in securing the desired continuity of engagement without excessive face width. It is, of course, quite feasible to cut out the non-bearing portion in the center, but this only adds to the expense and it does not avoid the necessity of staggering the teeth to enable the cutters to clear.

* * *

Gravitation never kept a man from rising in the world.

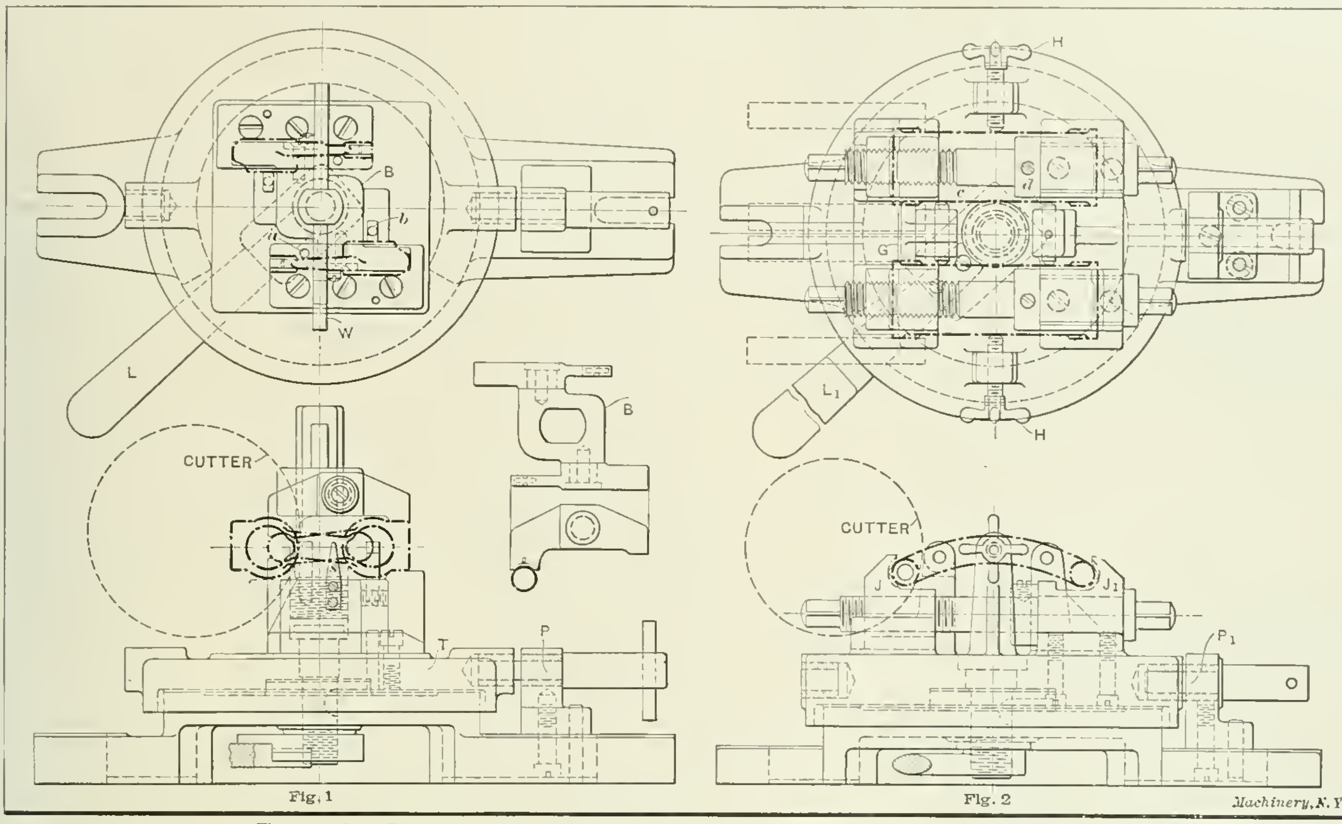
* Address: The Falk Co., Milwaukee, Wis.

SOME JIG AND FIXTURE DESIGNS*

EXAMPLES FROM TOOL DESIGNING DEPARTMENT OF TAFT-PEIRCE MFG. CO.

By FRANKLIN D. JONES†

The ingenuity displayed in the designs of many of the jigs and fixtures which may be seen in almost any up-to-date shop, compares favorably with the skill required in other work



Figs. 1 and 2. Fixtures of the Indexing Type for Milling Small Levers and Control Lever Sectors

which would appear, at first thought, to be of a much higher order. The factors which must be considered in the design of an efficient jig or fixture, such as the facilities for inserting, clamping, and removing the work, accuracy, strength, lack of

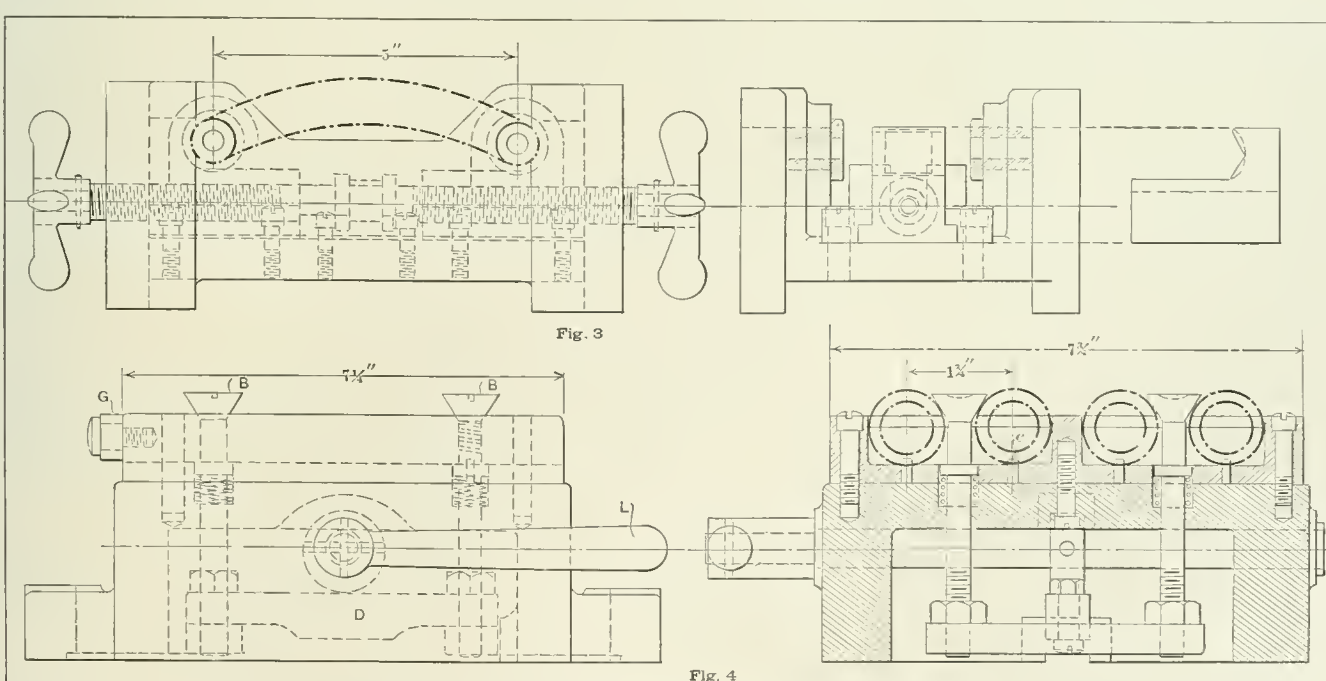


Fig. 3. Drill Jig for Control Lever Sectors. Fig. 4. Gang Milling Fixture

complication, cost, etc., require not only good judgment, but also an intimate knowledge of shop methods. As the various elements which should be considered in connection with this work have been discussed at length in previous contributions that have appeared in these columns, this article is intended to supplement those which have preceded, by the detailed description of a number of jig and fixture designs that have proved satisfactory in service and doubtless contain features that may be applied in a variety of ways by designers engaged on this class of work. The various designs illustrated are used on automobile work and all are the product of the tool-designing department of the Taft-Peirce Manufacturing Co., Woonsocket, R. I.

Fig. 1 shows a fixture that is used for gang milling small side-control levers. The work, in this illustration, is indicated by heavy dot-and-dash lines, the engraving being similar in this respect to the others accompanying this article. This fixture is of the indexing type, the work being clamped to a circular table T which may be rotated. The table is loosened or held firmly to the base by operating the hand-lever L, and

* For additional information on this subject, see the following articles previously published in MACHINERY: Pertinent Points on Jig and Fixture Design, August, 1910; Proper Designing of Milling and Drilling Fixtures and Jigs, May, 1909; and the series of articles on Jigs and Fixtures beginning April, 1908, and ending April, 1909.

† Associate Editor of MACHINERY.

it is accurately located in two positions, 180 degrees apart, by the indexing pin P which engages either of the two holes in the table, as shown. The work is clamped by driving a wedge W which forces down a central block B on each side of which clamps, free to swivel, are mounted. By having these clamps free to rotate, the pressure on the ends of the work is equalized. The form of these clamps and the way they are attached to the central block, is more clearly shown in the detailed view to the right. The work is located in this fixture laterally by the pins a, b, and longitudinally by the V's formed in the clamps and supporting blocks. Before

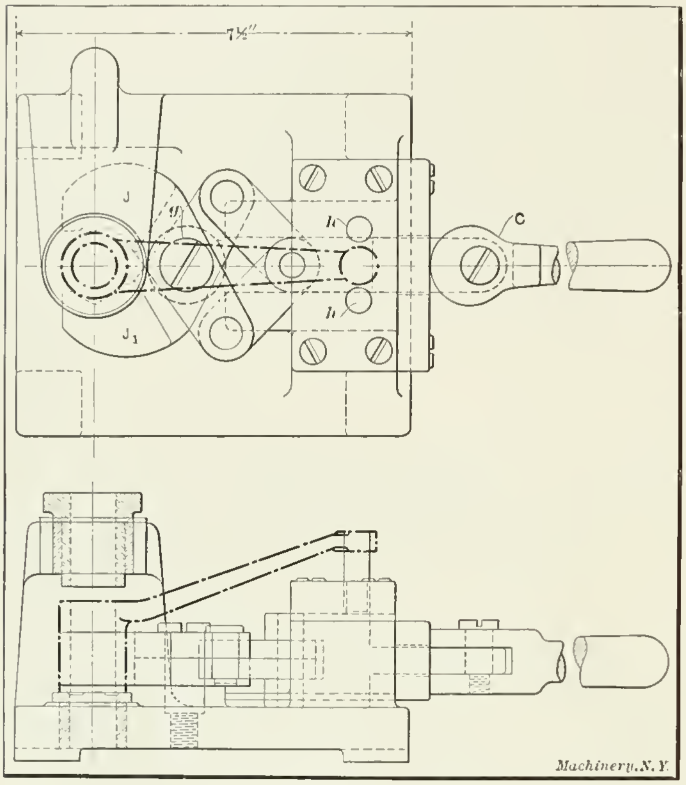


Fig. 5. Drilling and Reaming Fixture with Toggle Clamping and Locating Jaws

the clamps are tightened, the two levers to be milled are held against the pins a and b by springs s. The locating V's in both the clamps and base-blocks are milled out in the center (see detailed view of clamp) to obtain a firm grip. By referring to the plan view it will be noted that the ends of the work vary considerably in width and also that one wide and one narrow end are machined at a time. The advantage of arranging the work in this way is, of course, that the opposite ends will be in the proper relation to the cutters after indexing. It should be noted that the bearing between the table and base is protected from chips and dirt by a guard or flange which projects ½ inch below the bearing.

Another fixture of the indexing type that is similar to the one referred to in the preceding paragraphs, is illustrated in Fig. 2. This fixture, which is intended for straddle milling the hubs of control lever sectors, also has a swiveling table that is located in two positions, 180 degrees apart, by an indexing pin P_1, and it is clamped by the operation of hand lever L_1. The work is accurately located by the pins c and d, and the V-jaws J and J_1, one of which is movable for clamping. Hand-screws H bring the work up against the locating pins before the jaws are tightened. This fixture has a unique feature in the form of gage G which is used for setting the gang cutters in the correct relation with the fixture when the latter is first set up on the machine. The length of this gage is equal to the width between the finished inner faces of the work, and it is centrally located. When the fixture is set laterally so that the gage is in alignment with the two interlocking cutters in the center, the bosses on both sides of the work will be finished to the same height on the first piece milled. By this method the number of improperly finished parts is reduced to a minimum, and the time consumed in setting the fixture by the cut-and-try method is eliminated.

Fig. 3 illustrates a jig for drilling the bosses of the sector shown in the fixture, Fig. 2. It will be noted that V-jaws are also employed in this jig for clamping; in this case, however, both jaws are moved in unison by a right- and left-hand screw, held stationary—as far as longitudinal movement is concerned—by two thrust collars in the center, and operated by handwheels at the ends. The object in having both jaws movable is to locate the casting in a central position regardless of its length, with the advantage that the holes at the ends will be as nearly central with the bosses as possible. If one jaw were stationary, obviously a long or short casting would have the error all on one side, the hole being central with the boss at one end and out at the other. The work is located laterally by the finished bosses which fit between the flanges of the drill bushings.

A milling fixture of the gang type is illustrated in Fig. 4. This fixture is for holding four reverse tubes, while oil grooves are being milled. As these tubes have previously been splined, small pins e are used for locating, as shown in the end view, so that the oil grooves will be in the same relative positions in each case. The four tubes are clamped by a similar number of conical-headed bolts B which are tightened by a cam (operated by lever L) bearing against a bar D, the bar being mounted centrally on two connecting links at the ends. This central bar is of cast steel and spring tempered to give a certain amount of resiliency, this having been found desirable. When the work is released by operating lever L, the four clamp-bolts are forced upward by the springs shown in the end view. The tubes are located longitudinally by gage G which is swung up out of the way when "loading" the fixture.

An odd type of drill jig which has proved efficient in service,

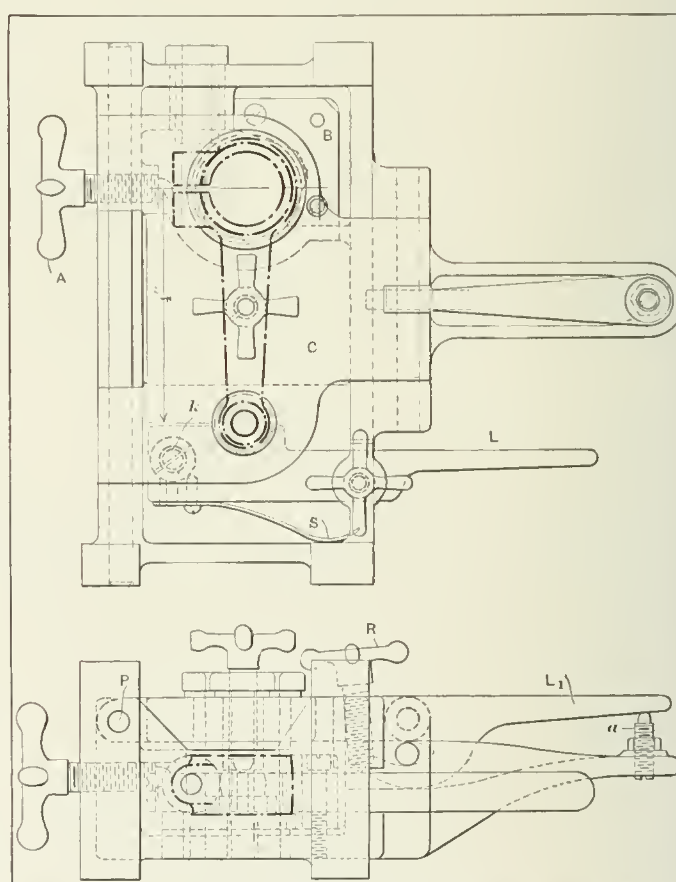


Fig. 6. Drill Jig for Small Lever

is shown in Fig. 5. The work is a clutch lever, the hub of which is drilled and reamed. This hub is located with reference to the guide bushing by two jaws J and J_1 which also act as clamps. These jaws, which are pivoted on stud g, are moved in unison by the double cam lever C which actuates a sliding block, connected to the jaws by the links shown, thus forming a toggle which gives considerable clamping power. The small end of the work is steadied by two pins h, as shown in the plan view.

The box type of jig illustrated in Fig. 6 is for drilling the two end holes and the clamp-bolt hole in a small reverse lever. The lower view shows the jig in a position for drilling the clamp-bolt hole, while the upper view indicates its position when drilling the large and small holes in the ends.

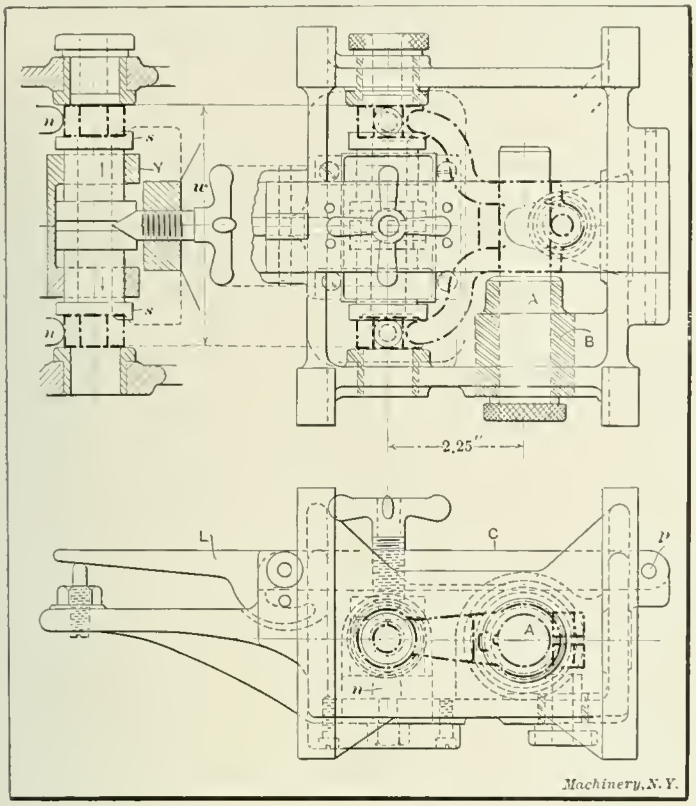


Fig. 7. Drill Jig for Clutch-shifting Yoke

The work is positioned by a stationary V-block B, at one end, and a V-lever L at the other. This lever is pivoted at k and has a flat spring S at the back which bears against the side of the jig. After the leaf or cover C—which swivels on pin P—is thrown back and the work is inserted, it is instantly located by the spring-actuated lever L. The top leaf is clamped by the eccentric- or cam-lever L_1 which rests, when in the closed position, on the adjustable stop-screw a. To insure a good bearing against the stationary V-block, there is a handscrew A that is placed slightly above the center line as shown, so that the pressure of its spherical end against the round clamping-bolt boss will tend to force the work downward. All play between the lever L and the stud k on which it swivels, is eliminated by tightening the hand screw R, this screw being set at an angle of 5 degrees which tends to draw the lever against the stud, thus holding it rigid.

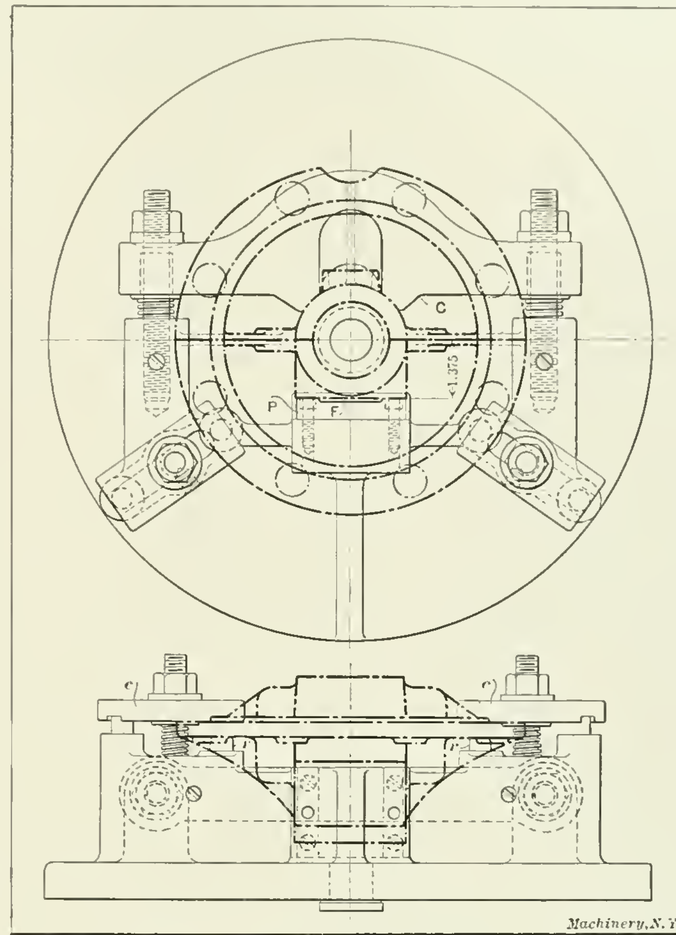


Fig. 8. Fixture for Chucking and Reaming 2-inch Hole in Bearing

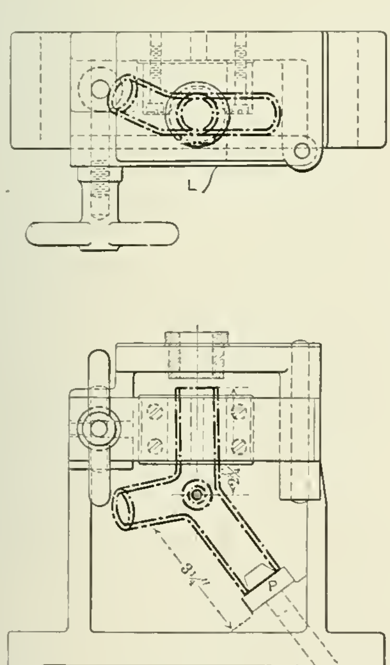


Fig. 9

Fig. 9. Jig for Reaming Water Inlet Y

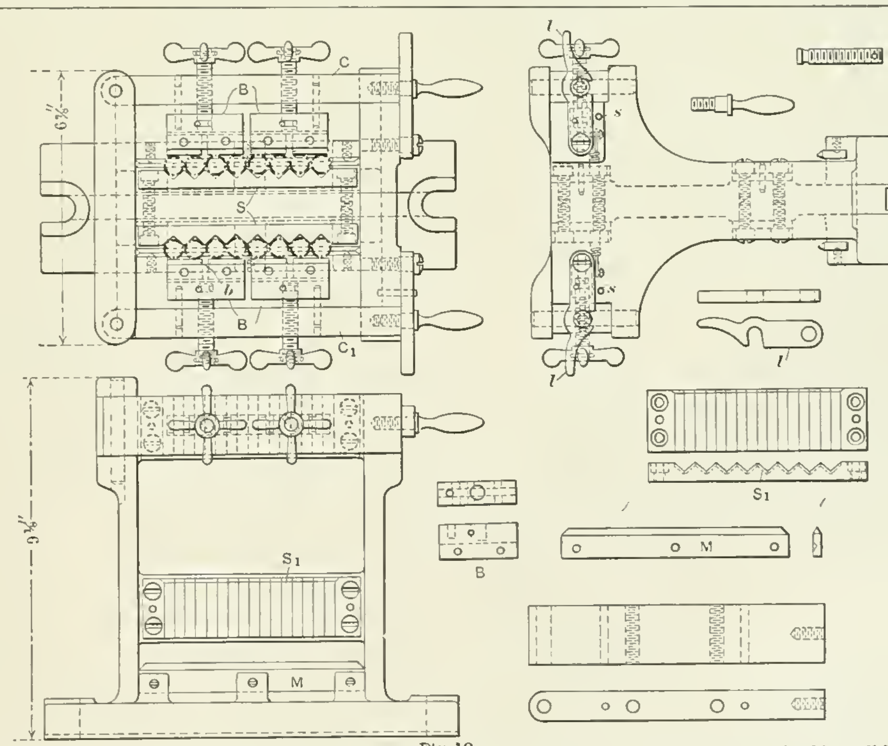


Fig. 10

Fig. 10. Fixture for Milling Slots in Sixteen Sliding-gear Yoke-shafts

An interesting type of drill jig for a clutch-shifting yoke, is shown in Fig. 7. This jig is also of the box type, and it has a cover C that swivels on a pin p and is locked in the closed position by a cam-lever L. The work, shown in both

plan and elevation by the dot-and-dash lines, is located by a plug or arbor *A* (which passes through a previously finished hole in the hub) and also by the spherical pins *n*, which support the arms on each side. As the width *w* over the outside of the small bosses, had to be accurate, the clamping mechanism was designed not only to hold the work, but to prevent distortion from the strain of drilling. The construction of this part of the jig is clearly shown in the plan view, in conjunction with the detail section at the left. The finished bosses of the yoke are a close fit between the accurately-finished inner faces of the drill bushings, and they are held rigidly against these bushings by the sleeves *s* which are forced outward by the conical-pointed screw shown, bearing against beveled surfaces on the inner flanges of the sleeves. These clamping sleeves are guided by the yokes *Y* through which they pass. The outer ends of the sleeves which bear against the work, have flanges with conical extensions on the upper side that force the work downward against the pins *n*. The locating arbor *A* is hardened and ground and it has a good bearing in a large bushing *B* which is also hardened and ground.

The fixture shown in Fig. 8 is for chucking and reaming a 2-inch hole in a bearing, the shape of which is indicated in the two views. In this case it is necessary to have the hole 1.375 inch from the finished face *F*, so that the work is located by clamping it against a hardened pad or plate *P*. The large V-clamp *C* also gives an accurate setting laterally, while the vertical position is determined by the pins *r*. One of the noteworthy features of this fixture is the arrangement of the small clamps *c*; these are supported at the back by pins which engage slots milled in the clamps on the under side so that the latter will not swivel out of place while being shifted back and forth. These small clamps as well as the large ones are equipped with springs which hold them against the binding nuts. This fixture is located centrally by a projecting boss in the base, as shown.

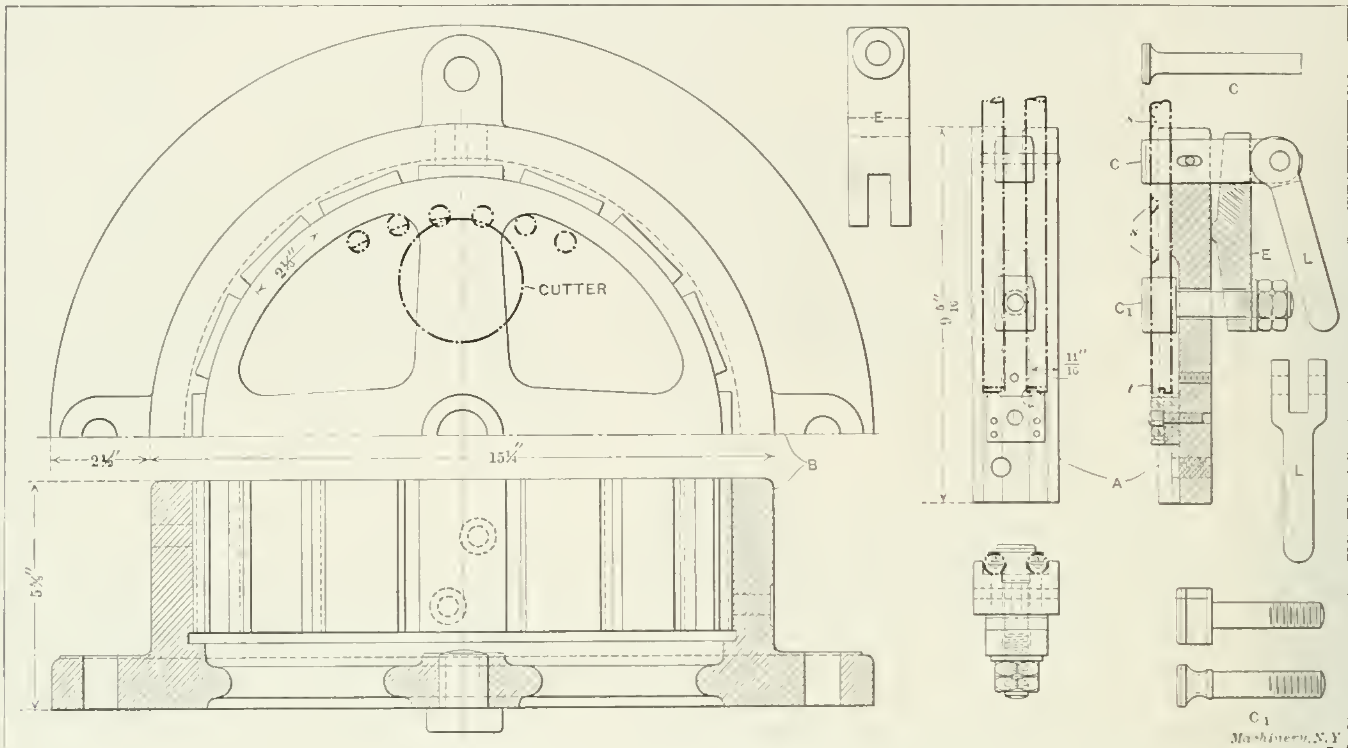


Fig. 11. Fixture for Continuous Rotary Milling Operation

A jig for reaming an end of a water inlet Y is illustrated in Fig. 9. This inlet is located by a V-block at the top, and a conical boss *P* at the lower end. The clamping is effected by the leaf *L* which is tightened by the hand-nut shown. The design is simple and the work is easily inserted or removed. If the jig which the average draftsman would design for this part could also be shown, the reason for the illustration, Fig. 9, would doubtless be more apparent.

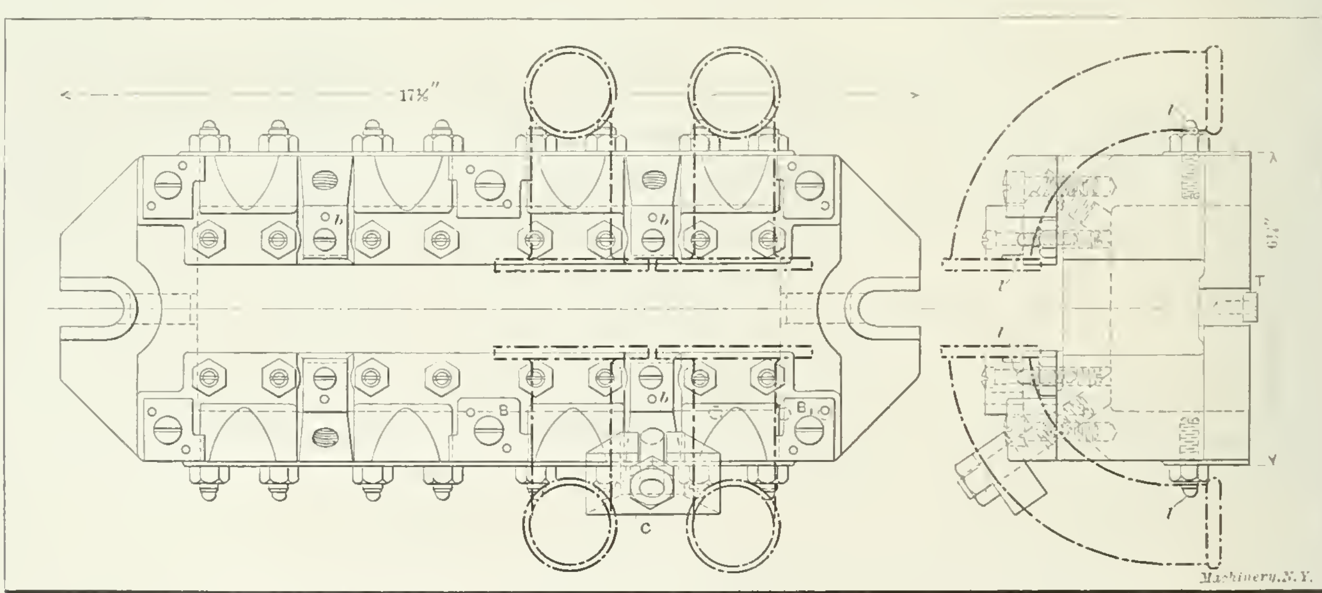


Fig. 12. Fixture for Surfacing Flanges of Eight Exhaust Fittings simultaneously

In Fig. 10 a fixture is shown which holds sixteen sliding-gear yoke-shafts while the ends are being slotted. As shown

by the plan and front elevation, these shafts are located by strips S and S_1, having V's as shown, and they are clamped by the four blocks B which are operated by hand-screws. Each of these blocks contains two pieces b which are mounted on pins inserted in the main block and are free to swivel. This construction insures a firm bearing on each of the sixteen shafts, even though some of them vary slightly in diameter. The fixture is loaded by inserting the shafts end-wise at the top. To prevent the ends of the shafts from catching on the tops of the lower strips S_1, the edges of the V's are beveled as shown. After the two rows of shafts have been slotted by a slitting saw operating on each side, they are quickly removed by swinging open the clamping bars C and C_1 which allows them to drop out of the fixture. As shown in the end elevation to the right, these bars are retained in the closed position by the thumb-latches l, which are held down, normally, by small spiral springs; small stop-pins s prevent the latches from swinging below the horizontal position.

After the shafts have been slotted as described in the preceding paragraph, they are placed in the fixture shown in Fig. 11, which is for milling the angular slots s shown in detail to the right. The main base B of this fixture has sixteen vertical slots as shown in the plan view, and each of these slots contains one of the clamping attachments A, which, in turn, holds two shafts as indicated by the dot-and-dash lines. The fixture rotates continually on a vertical machine, and the work is inserted and removed at the front, thus making the milling operation continuous. The relation of the work and cutter is indicated in the plan view. The interesting feature of this fixture is the clamping device with which each holder or attachment is equipped. This consists of two clamp-bolts C and C_1, which are operated by a cam-lever L that bears against an equalizing lever E engaging the lower clamping bolt, thus giving a uniform pressure at two points. With this arrangement, the two shafts in each holder are released or tightened by the operation of a single lever. The shafts are further prevented from turning by the slots, previously milled in their ends, which engage tongue-pieces t. The entire fixture is located centrally by a plug in the bottom of the base.

A fixture for holding eight exhaust fittings while the flange faces are being finished, is illustrated in Fig. 12. Each fitting is located by four spherical screws l and also by the oblong flanges which rest against the blocks b at the top. The clamping is effected by four slotted clamps C having beveled sides which force the fittings against the serrated faces of the blocks B and B_1. The fixture is aligned by the tongue-pieces T at each end. The spherical-headed screws l are slotted on the inside so that they can easily be adjusted when being set in the proper position, as determined by the casting itself. This fixture is a good example of the type which is efficient and at the same time inexpensive.

* * *

SOLVING A PRACTICAL PROBLEM BY SIMULTANEOUS EQUATIONS

By HOWARD TERHUNE

The following problem came up in our drafting-room a short time ago, and as it was rather difficult to solve, the writer presents the solution herewith hoping that it may be of interest to others.

This problem was worked out in connection with a hydraulic brake of the geared type, as indicated in Fig. 1, the original form of which was as shown by the dotted lines. After testing, it was found that this type was not elastic enough, so it was necessary to add two small reservoirs, which were filled up after the valve was closed. The writer does not know the exact reason for the reservoirs being made as they were, or the location of them, but it is a good problem, however, and may be of interest to some one.

The problem was as follows: Given the diameter of the cylinders C and D, Fig. 1, as 7 inches, and their center distances equal to 7⅞ inches, equidistant from the center line of the large circle A, and the distance from the center line of the circles C and D to the top of the circle A as 6¼ inches; find the radius of the large circle.

As shown in Fig. 2, a line from the center F of the large circle A through the centers of either of the smaller circles will pass through the point of tangency of the two circles. Then we have two values for the radius of the large circle, R, as follows:

$$R = x + 6\tfrac{1}{4} \text{ inches} \qquad (1)$$

$$R = y + 3\tfrac{1}{2} \text{ inches} \qquad (2)$$

But in the triangle B, $x^2 = y^2 - \left(3\frac{15}{16}\right)^2$

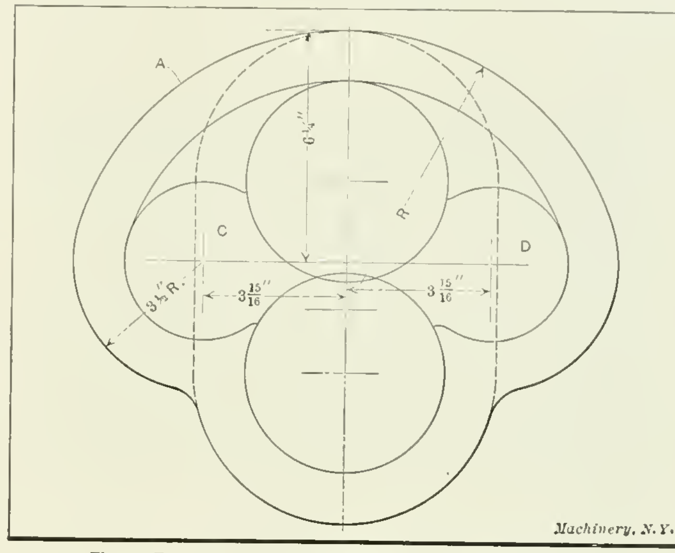


Fig. 1 End View of the Hydraulic Brake showing Location of the Cylinders

Substituting this in (1) we have:

$$R = \sqrt{y^2 - \left(3\frac{15}{16}\right)^2} + 6\tfrac{1}{4} \qquad (3)$$

Subtracting (2) from (3) we have:

$$0 = \sqrt{y^2 - \left(3\frac{15}{16}\right)^2} - y + 2\tfrac{3}{4} \qquad (4)$$

Then transposing and squaring we have:

$$y^2 - \left(3\frac{15}{16}\right)^2 = y^2 - 5\tfrac{1}{2}\,y + (2\tfrac{3}{4})^2 \qquad (5)$$

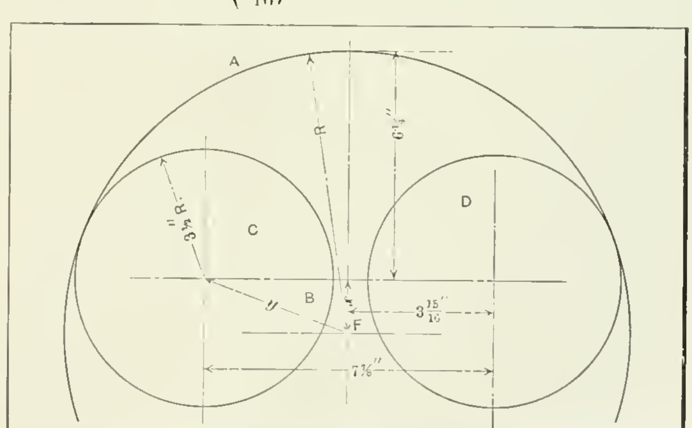


Fig. 2. Illustration showing the Location of the Cylinders C and D in Relation to the Large Circle

Collecting terms we get:

$$5\tfrac{1}{2}\,y = \left(3\frac{15}{16}\right)^2 + (2\tfrac{3}{4})^2 \qquad (6)$$

in which $y = 4.194$. Then $R = 4.194 + 3.5 = 7.694$ inches.

* * *

Of the machinery imported into Brazil, the United States in 1909 supplied 27 per cent, while Great Britain supplied nearly 39 per cent and Germany nearly 18 per cent. The total value of the machinery imports from the United States were approximately $4,730,000.

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THE SYSTEMATIC SCRAP BOOK

By R. E. ASHLEY*

Since the appearance of the aritcle "A Systematic Scrap Book" in the November issue, the writer has received many inquiries from different parts of the country, regarding various details of the system used, and as lack of time forbade answering those inquiries as fully as the writer would wish to do, or at the length necessary to make a full and complete explanation, this second article is presented, in which these questions will be answered, and different phases of the system taken up in anticipation of the troublesome points which engineers may encounter in commencing a similar system.

In beginning a scrap book, perhaps the first perplexing question is that of dimensions—what size will be most convenient and best accommodate the scraps. This is a question that is rather difficult to answer in a general way, as each engineer must decide upon the size that will best care for the information which he gathers on his own particular line of work. The writer, however, finds a sheet 13 inches wide by 16 inches long a very convenient size for a scrap book such as is shown in Fig. 1 of the former article, and believes this size would answer the requirements of the majority of engineers. If a sheet much larger than this is used the book will be cumbersome, and inconvenient to use for reference purposes at the desk or drafting board, and will, in all probability, be too large to keep in a book-case or drawer. On the other hand if the sheet is too small the book will build up rapidly and become too bulky for convenience, and besides trouble will be experienced in keeping the book open, especially when the pages being referred to are near either cover.

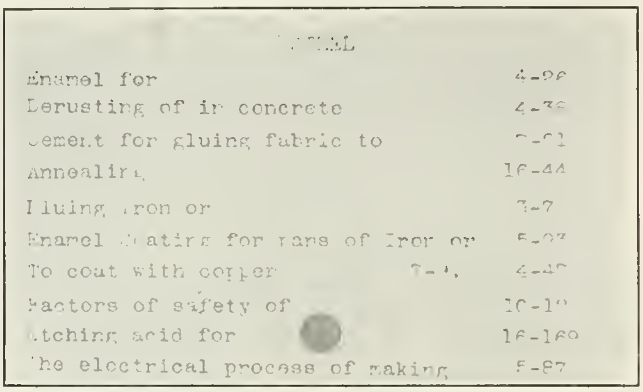

Fig. 1. File Card showing Convenient Method of Indexing

As to the kind of binder to use, there are a great many styles on the market, but, in the writer's opinion, the best and cheapest one for general purposes, is the sectional post binder, with 3/8-inch posts, in sections one inch long with the bottom section riveted to the base. In this connection the writer recommends the top section threaded, and the use of countersunk thumb-nuts, for the thickness of the book can always be regulated to the length of the thread, and by screwing down the nuts a positive grip is obtained on the cover. With a key locking device, unless a very expensive style is used, trouble arises by the covers working loose and refusing to hold when the book has grown to a thickness of two or three inches. With regard to the style of cover, one can get stock covers in standard sizes from loose-leaf outfitters, but these are usually heavy and stiff. The writer had special covers made of black leather, which are flexible and much more convenient.

In place of the binders shown in Fig. 3 in the former article, one could use a "price book cover" which can be obtained at nearly any stationer's or dealer in office supplies. These come in different sizes, and an index and plain or cross-section paper can be secured for each size at any place where the covers are carried. There are several styles of these covers, the least expensive perhaps being the ring style which would probably answer in most cases.

The writer has been asked whether he would recommend the keeping of the "hand-book" in writing or by lettering. This is a point that depends upon the amount of time one could devote to it, though undoubtedly a typewriter would be quicker and more satisfactory where there are many notes to copy and but few sketches, drawings or diagrams. A note illustrated by sketches or drawings would have to be entered by hand, and in this case lettering would be preferable. So if one has the time and ability, the writer would say to put the work in by lettering, as this adds to the interest and individuality of the work, and tends to fix the matter in one's mind, making it easier and more valuable for reference.

The making of the index requires considerable thought, and it should be laid out to some extent on pieces of paper to determine the main and sub-headings necessary to best fulfill the requirements of one's particular business. The main headings should be general subjects, each of which is distinct from the other: and then, as stated in the former article, the number of sub-headings would depend upon the importance of the subject and the extent to which one would wish to facilitate the finding of any topic. Of course the greater the number of sub-headings, the smaller the number of cards one would have to look through in locating any subject, and hence time is saved. With any engineer there are a great many articles and references which would be seldom required, while other articles, touching more directly upon the work engaged in, would be referred to perhaps several times in a day, and the finding of such references would be facilitated by closer subdivisions of the subjects.

The size of the card for the index would depend to a great extent upon the completeness with which one wished to enter and describe the articles. The writer uses a standard 3 by 5 card and finds this size very satisfactory. In indexing it is well to enter the points touched upon in the article rather more fully than may at the time seem necessary when the whole text is fresh in the mind, for one is likely to abbreviate so much that, when looking up the matter later, he will find that doubt exists as to whether that particular article contains the information wanted, making it necessary to look up several articles before the one desired is found.

Fig. 1 shows a card and method of indexing. This particular card is for "steel" and is found under the sub-heading "Steel" of the subject "Materials." The color and its title show its position in the index, so that it can always be returned to its proper place. The figures at the right-hand side of the card give the book and page number. Because of the similarity of two or more articles it is often necessary to enter more of a description on the card than the illustration shows. As it is impossible to so subdivide every subject that each article could be entered under a proper sub-heading each subject has its alphabetical index for miscellaneous articles.

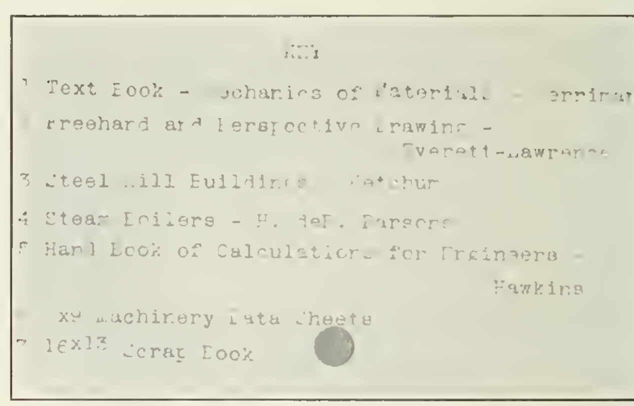

Fig. 2. File Card giving Key to the Assigned Numbers of the Article to be referred to

In the former article, reference was made to the number assigned to each book, volume of magazines or catalogue in which information that was indexed was to be found. The numbers begin with 1 and are consecutive. The key to the assigned numbers is given on several cards at the front of the index, one of which is shown in Fig. 2. The description consists of the book number, title and author, and the volume number if the book is one of a set.

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MACHINE SHOP PRACTICE*

A VERTICAL BORING-MILL OPERATION

The turning of a flywheel, which is an operation described in the current Supplement, is a good example of the kind of work to which the vertical boring mill is adapted. The horizontal work-table makes it comparatively easy to adjust and clamp the casting, and this type of machine is also designed to take the heavy cuts required on work of this class.

A flywheel should preferably be machined on a double-headed mill so that one side and the periphery can be turned at the same time. A common method of holding a casting of this kind is indicated in Fig. 1. The rim is gripped by the chuck jaws *C* which, if practicable, should be placed on the inside, as shown, so as not to interfere with the movement of

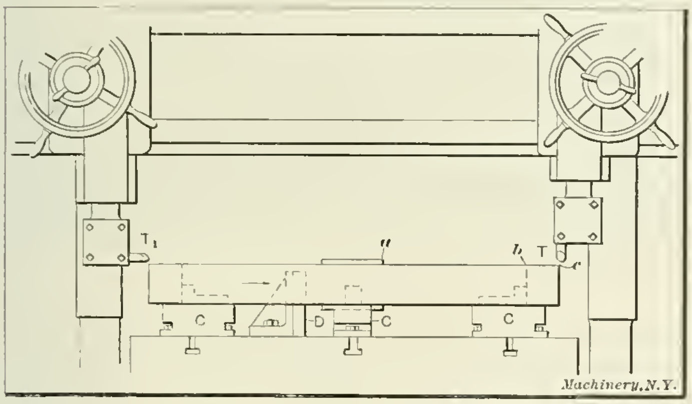


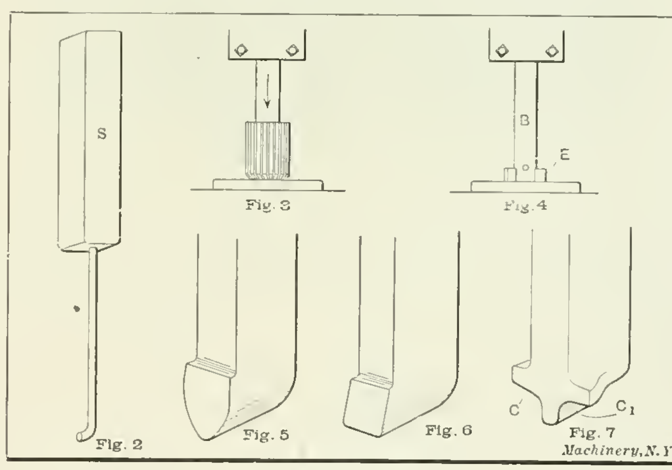
Fig. 1. Double-headed Boring Mill arranged for Turning a Flywheel

tool *T*. If the inside of the rim is so shaped that the jaws cannot get a good grip, it will, of course, be necessary to place them on the outside, which surface will then be machined after the casting is turned over; it is advisable, however, to finish the outside or periphery when the hole is bored, so that the hole and rim will be perfectly concentric. In addition to the chuck jaws, there should be a clamp placed across the spokes on each side of the wheel, and the casting should be further prevented from slipping in the chuck jaws by the use of two drivers *D* which, in this case, are stiff angle-irons, set against the spokes on opposite sides of the wheel. When a heavy cut is being taken, with the work revolving in the direction indicated by the arrow, the casting, owing to the circumferential pressure of the cut, will tend to shift around in the opposite direction; by means of the drivers *D*, however, such movement is resisted.

After the casting is clamped lightly, it should be set to run true. As the inside of the rim is usually left rough, the work should be set by this surface rather than by the outside, so that the rim, when finished, will be uniform in thickness. The tool or gage, illustrated in Fig. 2, will be found a great aid when truing up cylindrical work in the boring mill. It consists of a hard-wood shank *S* into which is inserted a piece of brass or copper wire (about No. 8 size) having the outer end bent as shown. When this gage is clamped in the toolpost, the wire, owing to its flexibility, is excellent for testing, as moving it too close to a surface which is not true, simply causes it to be bent backward. If the under side of the rim, because of unevenness, does not bear on all the jaws, packing should be inserted so that it rests solidly. It is well to test the rim with a surface gage to see that the sides are practically parallel with the table.

When taking the first or roughing cut, a tool similar in shape to the one illustrated in Fig. 5, should be used. Ordinarily one roughing and one finishing cut is sufficient. If the rim needs to be a certain width, about the same amount of metal should be removed from each side, unless bad spots, such as blow-holes, etc., make it necessary to take more from one side than the other. By placing that side of the work up which was uppermost when the casting was made, blow-holes and porous, sandy spots which are often found at the top, can be discovered while truing the first side. After tool *T* is started across the side, tool T_1 should be set in far enough to true the rim and be fed downward across the periphery, both tools operating at the same time. The tool for turning the periphery must, of course, be clamped in the toolpost with the cutting edge toward the back of the mill. When tool *T* has finished its cut, it should be used for roughing the hub. After the roughing cuts are taken, the tools are replaced by broad-nose finishing tools, similar to the one shown in Fig. 6. The feed should be increased for finishing so that each tool will have a movement, of say, ¼ or ⅜ inch per revolution of the work, and the cut should be deep enough to remove the marks made by the roughing tools. The cutting edge of tool *T* should be parallel, and that of tool T_1 at right angles to the table so that the finished surface will be smooth. After finishing cuts over the rim and hub have been taken, the corners *a*, *b* and *c* are usually rounded to give the work a more finished appearance, by the use of a tool shaped as shown in Fig. 7; this tool has two rounded cutting edges *C* and C_1, one being for the inner and the other for the outer corners.

The hole through the hub is next finished to size. The method of performing this operation will depend somewhat on the tools available. Ordinarily where flywheels are being machined in quantity, all holes should be finished to the same size by the use of a standard reamer; this should be fed slowly down through the hole as indicated in Fig. 3, after the hole has been previously bored slightly less than the size. In some shops, double-ended flat cutters *E*, Fig. 4, are used. These cutters are in roughing and finishing sizes and are inserted in a bar *B* held at the upper end by the ram, and in some instances guided by passing through a close-fitting bushing in the table. Evidently this cutter must be set central, as otherwise it will cut larger than its length. The position of the cutter may be tested by raising it as soon as the hole is started and inserting pieces of thin paper on each side; if when the cutter is returned to the hole, the paper strips on both sides are held fast, the position of the cutter is practically central. On interchangeable work where all holes are required to be of the same size, the use of a reamer of the "floating" shell type is preferable for finishing.



Figs. 2 to 7. Tools used on Flywheel Work

When the hole is finished, the work is turned over so that the lower side of the rim and hub can be faced and the corners rounded. If much flywheel work is being done, it is well to have a plug that fits the central hole in the table and the bore of the wheel, for setting the partly finished casting central when it is turned over. The chuck jaws are removed, and the work, which is located by the plug, may be clamped against parallels resting on the table. Care should be taken when facing the hub, to have it central with the rim, or in whatever relation is indicated on the drawing.

* * *

About 4500 vessels (or an average of between 12 and 13 a day) pass yearly through the Suez Canal. The average tonnage of the vessels is about 3600 tons. The length of the canal is about 100 miles, and the average time of passage is 17 hours. The largest vessel which ever passed through the canal is the 18,000-ton Hamburg-American liner *Cleveland*.

* With Shop Operation Sheet Supplement.

MACHINE TOOL DESIGN A LA COBHOUSE

These illustrations of a universal grinding machine built in Germany were reproduced from a foreign contemporary several months ago with the idea in mind of calling attention to its exceptional (!) features. Perhaps it is not far from the truth to say that our original intention was to "roast" it, but the hot weather came on to roast us and we relented—for the time being. Summer quickly passed away as summers have a way of doing and still the job rested on our hands.

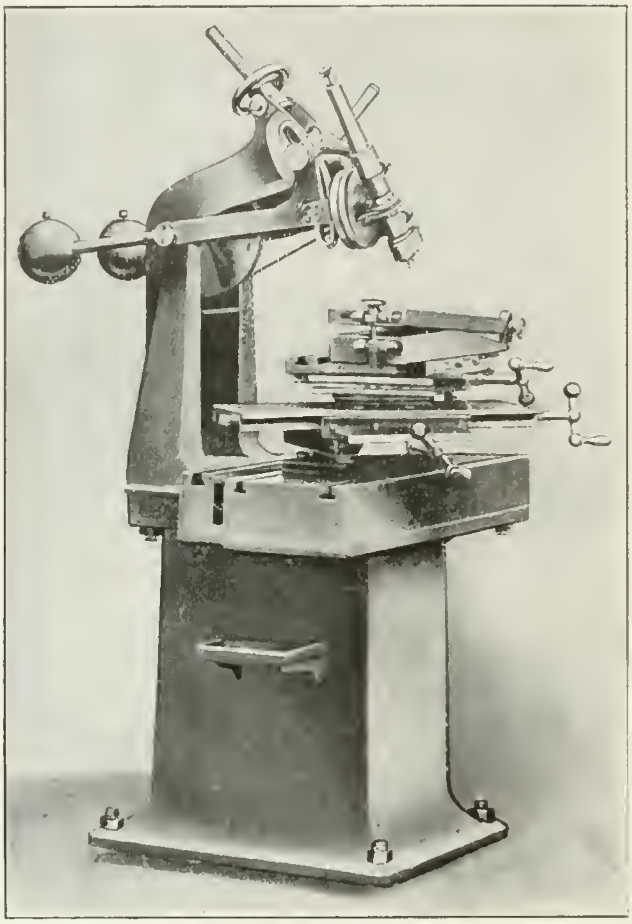


Fig. 1 German Universal Grinding Machine of Weird Design

What could we do? What could we say that would do justice to this cob-house aggregation of slides—slides at angles, slides superimposed, slides thrown in for good measure, slides for goodness knows what! Pelion on Ossa! We gave up. Not for the world would we now say anything derogatory of this striking and liberal application of Maudslay's great principle. We would not point to overhanging slides so slender that the inexperienced might fear they would break off sheerly by their own weight. Nor would we preach a sermon on the folly of constructing precision machines with a multiplicity of joints and frail working parts between the cutter and the frame. People don't like to be criticised or told of the faults of their work; it tends to make them stubborn and set in evil ways. They don't like to be told that rigidity is the prime essential in successful machine tool design—everyone knows that, so what's the use? The rub is to get them to apply what they know.

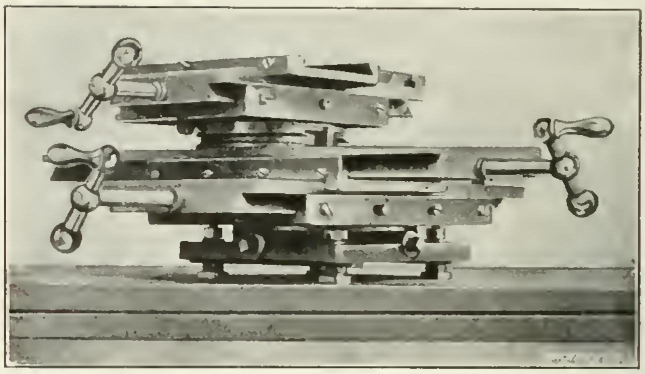


Fig. 3. Five Slides and Two Joints—Count 'em!

Perhaps there are a few machine tool makers on this side of the salt pond who could spare a slide or two. Who knows?

* * *

An interurban railway in Pennsylvania has painted a narrow horizontal stripe extending along the sides and ends of the cars at a distance of 45 inches from the floor. The purpose of this line, according to the *Railway and Engineering Review*, is to afford a gage by which juvenile passengers may be measured. All who reach above the line will be expected to pay full fare; those who do not reach up to the line will be passed for half fare. The age limit as a means of determining whether a child will pay full or half fare has thus been abandoned for the height limit, which is really a more rational gage, as the cost of transportation depends upon the size and weight of the passenger. Besides, this method removes the temptation for breaking the ninth commandment.

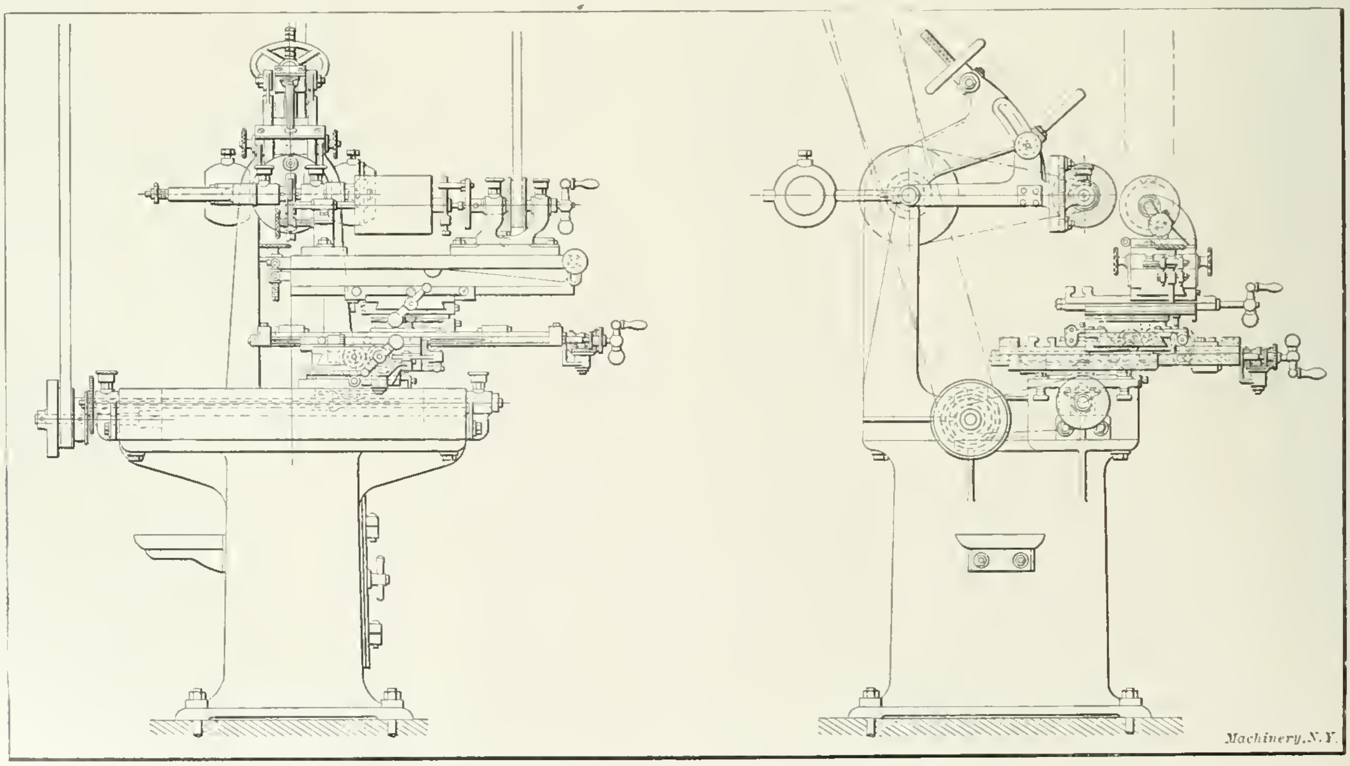


Fig. 2. Front and Side Elevations of German Universal Grinding Machine

TOOLMAKER'S FILES*

HISTORY OF THE DEVELOPMENT OF MANUFACTURE IN THE UNITED STATES

By E. P. REICHHELM†

The making of toolmaker's files, or "files of precision" as the Swiss call them, is practically an infant industry in the United States, whose effective competition with imported Swiss files did not begin until about six years ago, when a full line of this distinct class of files was first placed upon the market as a domestic product.

The development of this branch of the file industry was retarded by the difficulty of producing the great variety of shapes, cuts, and sizes to match the Swiss line consisting of about 2300 different files, the finer cuts, and accurate shapes of which required the modification of manufacturing methods in essential particulars, especially in the use of machinery.

About twenty-five years ago, the first attempt was made to produce "Swiss" files, in Paterson, N. J., a number of Swiss workmen having been brought over from Switzerland to teach us Swiss methods. These men, of course, received American wages which amounted to about as many dollars as they had received francs for the same work in Switzerland, and the tariff wall, high as it was, proved too low to cover the difference in labor cost, to say nothing of the higher cost of material.

Furthermore, it was discovered that these Swiss filemakers, transplanted to America, did not produce the standard quality of Swiss files; and not only were they disinclined to teach other men the tricks of the trade, but, removed from their accustomed environment, and the direction of their former employers, their skill deteriorated, while their demands for higher wages still further discouraged the enterprise.

Several subsequent attempts to make "files of precision" resulted in producing only a limited assortment of inferior files, so that toolmakers, gunsmiths, makers of fine instruments, jewelers, silversmiths, die sinkers, and other mechanics using fine files in shaping and finishing, naturally came to believe that none but the genuine imported Swiss files would do.

But that Swiss files *could* be made in America, seemed a self-evident proposition to the writer. As a builder of gas furnaces, he had occasion to visit file factories with a view to equipping them with gas furnaces, and from observation of their practice, he was convinced that, with proper modifications in methods and machinery, the imported files could be duplicated, and even improved upon, especially in temper.

Practical mechanics will agree that a mere imitation of other people's methods of work will never produce first-class results; and that to improve the means of production in any line, it is not only necessary to be posted with regard to the best practice in that particular line, but to find out how analagous work is done in other lines, for only in this way can settled prejudice be overcome, and the daily practice lifted out of old ruts. The writer therefore looked at the file industry as carried on under his observation, with different eyes than those of the filemakers themselves; and, convinced that Swiss files could be made in America, at a profit, was induced to try it.

The enterprise was started in January, 1900, in a small but well-equipped factory, at Elizabethport, N. J. At first, the Swiss files made there cost twice as much as they could be sold for, and it took five years to improve manufacturing methods sufficiently to make many shapes and sizes at a low enough cost to leave a small profit.

In 1906, however, the factory yielded a fair return on the capital invested, and plans for its enlargement were made, resulting in the present factory, covering an area of about thirteen city lots. The equipment of the enlarged factory resulted from the experience in the small one, and not from the imitation of either foreign or domestic file-making practice.

The output of this larger factory, completed in May, 1907, is now somewhat restricted by the difficulty of training a sufficient force, the men with experience in other file shops having to be taught to do their work in a different manner than that to which they have been accustomed, while the training of apprentices, new to the trade, is hindered by the absence of an equitable law governing apprenticeship. It is easy enough to hire hands if the wages offered are high, but to get a boy to learn the trade from the bottom up, and be satisfied with small wages until he has mastered the trade, is a different matter; so the working force can be increased only gradually and at considerable loss, represented in spoiled work.

Toolmaker's files are in a class by themselves, differing as much from the common American files as do silk from woolen fabrics; and considering the accuracy of the workmanship, and the high-grade steel out of which they are made, the selling price must be considered very moderate indeed. Owing to their keen cut, correct shape, and the superior steel used in making them, they are frequently preferred to cheaper files, even for uses for which they are not intended, their greater durability compensating for the difference in cost. The marked differences between the common American files, and the toolmaker's files, are the following:

1. *With regard to Cut:* The ordinary American files are made in five cuts, namely, rough, bastard, 2nd-cut, smooth, and super-smooth, while toolmaker's files are made in twelve cuts, numbered respectively from 000 to 8, the cut No. 3 in this line being as fine as the super-smooth cut of the common file.

2. *In Shape:* The toolmaker's file is distinguished by its sharp outline, teeth covering extremes of points and edges.

3. *In Size:* The toolmaker's files never exceed 12 inches length in any shape, and in width or thickness are more slender than the common files, and somewhat lighter.

One of the reasons for the present superiority of the American over the imported Swiss "files of precision," is the heat treatment of the American toolmaker's files, which, in the processes of forging, annealing, and tempering, is automatically regulated. This is done by means of a heat controller, invented by Mr. George Machlet, Jr., of Elizabeth, N. J., which keeps the temperature of annealing and hardening furnaces constantly within 10 degrees of a standard heat to which the heat controller is set, thus producing a uniformity of temper never before obtained in manufacturing a similar product.

* For articles on the manufacture of "files of precision" see "Making Swiss Files in America", September and October, 1907.

† President American Swiss File & Tool Co., 24 John St., New York.

* * *

NEW BUILDINGS FOR THE UNIVERSITY OF CINCINNATI

One of the finest mechanical and engineering buildings in the West is being erected for the University of Cincinnati, at Cincinnati. The building itself is of concrete, 135 by 260 feet, three stores high over the entire area and four stories high at the middle section. It will accommodate 500 students at one time, which means 1000 cooperative students working on the plan carried out at the school, and is to cost $250,000. An additional $50,000 is also to be spent for equipment. The main walls and part of the floors are already in place, and it is expected that it will be ready for occupancy in time for the fall term of 1911.

An important feature of the building is the mechanical laboratory, 40 by 220 feet, which will contain machinery and instruments for all sorts of mechanical engineering tests and practice. There are six well-lighted rooms for students of drawing, capable of holding 40 each or 240 in all. Numerous points of unusual interest have been incorporated in the design and equipment of the building which will be gone over more thoroughly when the building is nearer completion. One point, however, that will be mentioned, is the fact that the class lecture rooms are so arranged that if a professor is instructing his class in machine design or work, a small shaper, lathe, drill-press or whatever it may happen to be, can be taken directly off the shop floor and set in the lecture room close to his desk, where it may be shown dismantled or used in any way he sees fit. This one feature alone is of unusual importance and the method by which it is actually done will be fully illustrated later.

Besides the building just described, a $150,000 power house and $100,000 gymnasium are in course of construction and will be finished about the same time.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

PUNCH AND DIE FOR BLANKING HEXAGON NUTS

The accompanying illustrations show a very interesting punch and die for blanking out seven hexagon nuts at one stroke of the press which makes practically no scrap. All the scrap that is made is half a nut on the first row on the starting of each sheet, and also a narrow strip and small V-portion removed from the sides. This punch and die with proper care will cut out an average of 250,000 nuts in a day. This the writer considers a very good production.

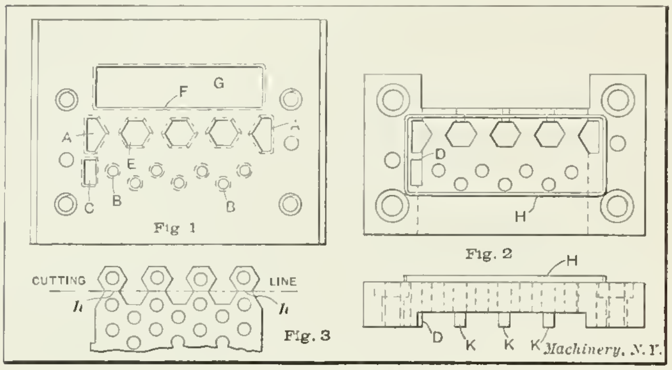


Fig. 1. Plan View of Die-block showing how Punches are laid out to save Stock. Fig. 2. Plan and Elevation of Stripper-plate showing Stops for Gaging the Stock to Length. Fig. 3. Condition of the Sheet after the Third Stroke of the Press

A plan of the die-block is shown in Fig. 1, where it can be seen how the holes are laid out so as to waste practically no stock. The two end holes *A* are made so that they cut V-notches in each side of the strip which produces one side of two nuts on each side of the strip as shown in Fig. 3. The seven holes *B* in the die are used for blanking the holes in the nuts. A punch working in the hole *C* in the die cuts a narrow strip from the sheet, thus forming a ledge on it, which is used for a guide in allowing the stock to be fed in the required amount for each blanking. A corresponding ledge *D* is formed on the stripper-plate shown in Fig. 2, which acts as the stop in starting the sheet. After the first row of three holes has been blanked, the projections *K* on the stripper-plate act as stops. By having the stock located in this manner it is not necessary to have pilots in the punches.

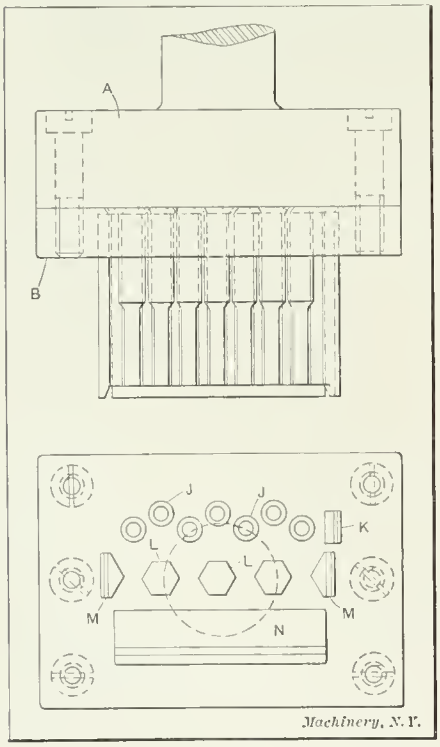


Fig. 4. Plan and Elevation of Punch-holder and Punches

The three hexagon holes *E* in the die are used for cutting out three nuts. The fourth row of nuts is cut off at the edge *F* of the hole *G* in the die, it only being necessary for the small webs *h* to be severed in this operation (see Fig. 3). As the punches are made a good fit in the stripper-plate, it is necessary to have them well lubricated, so a narrow strip of sheet steel *H* is bent to the shape shown, and soldered onto the top of the stripper-plate, thus preventing the oil from spreading, and confining it to the punches.

A plan and elevation of the punches and punch-holder are shown in Fig. 4. Here *J* are the piercing punches for the holes in the nuts, *K* is the punch which is used for shaving a narrow strip from the blank, forming a ledge on it, which is used in stopping the stock to the desired length. The three hexagon punches *L* are used for blanking out three nuts, and the punches *M* are used for forming one side of the fourth row of nuts, while *N* is the punch which is used for shearing the four nuts from the sheet. The punches are driven into the punch-plate *B*, as shown, and are riveted over to prevent them from pulling out. The punch-holder *A* is made of cast iron and the punch-plate is held to it by six fillister-head screws. As the punches are well supported in the stripper-plate this method of holding them in the punch-plate is effective enough for this class of work.

CHARLES PABESHUTZ

Milwaukee, Wis.

TURNING RUBBER WASHERS

Recently the writer had occasion to turn down the outside diameter of some rubber packing washers, such as are used for garden hose, hydrants and also sometimes around the engine-room. Some difficulty was first encountered in turning these washers as, being decidedly soft, they would not stand up to the tool, especially when a heavy cut was taken. After having used a number of methods the following was adopted and proved satisfactory.

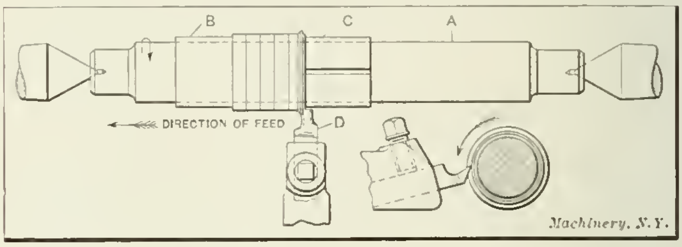


Fig. 1. Method used in Turning Rubber Washers

An ordinary arbor *A*, which was a good fit for the inside diameter of the washers, was used, and a sleeve *B* pressed onto it. The washers were placed on this arbor five at a time, and a piece of sheet copper 1/16 inch thick was bent around to the shape of the arbor, leaving an open space of about 1/16 inch. This sleeve *C* was then removed and squeezed in, so that it was made a tight fit for the arbor, and was then placed tight up against the washers as shown in Fig. 1. It might be well to mention that the pressure of the sleeve should not be too great, as it will tend to bulge out the washers. After

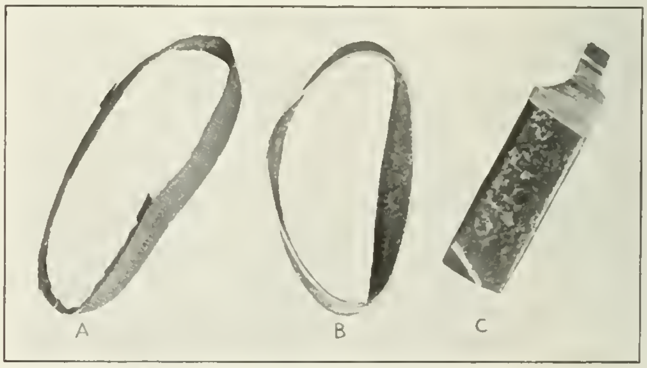


Fig. 2. Turning Tool and Rings removed by it

the washers were put on the arbor and held with the sleeve *C*, the arbor was put on the centers of the lathe as shown, and a tool *D* made from high-speed steel, ground to the shape shown, was made. This tool was ground with considerable top rake, and also set at an angle with the horizontal center line. The action of this turning tool is clearly shown in the illustration, and the results of the turning are shown in Fig. 2. Here it can clearly be seen that it is not a chip that is

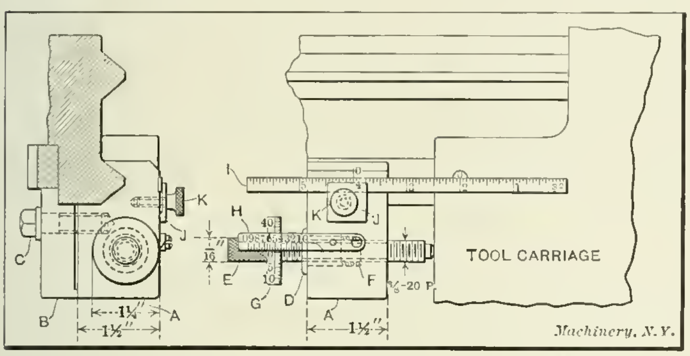
taken off, but a ring. The first ring removed is shown at *A*, and the second one is shown at *B*. A clearer view of the turning tool is shown at *C*.

The speed used in turning was from 125 to 130 surface feet per minute, and the feed was not greater than from 0.010 to 0.015 inch per revolution. If a greater feed than this were used, the tool would not cut nearly so well, and would make a more ragged job. It was also found that five washers were the most that could be turned at one time, and give entire satisfaction. If more washers than this were put on the arbor they would crowd up on each other and would make an uneven job. Forty-eight washers were turned without regriuding the tool. FRANK LANG

Covington, Ky.

A MICROMETER STOP FOR THE LATHE CARRIAGE

The accompanying illustration shows a stop which the writer believes will be of interest to readers of MACHINERY. It consists of a frame *A*, which is held by a block *B* and a capscrew *C* to the ways of the lathe. This frame can be conveniently made from 1½- by 2- by 1½-inch machine steel, and is counterbored to receive the tension bushing *D*. The micrometer screw *E* is tapped into the rear portion of the block *A*, and backlash is prevented in the screw by means of the bushing *D*, which is also tapped to fit the screw, and held out from the frame *A* by means of a tension spring *F*. The



A Convenient Micrometer Stop for the Lathe Carriage

threaded portion of the micrometer screw *E* is made ⅜ inch in diameter with a 20-pitch thread, so that for every revolution of the screw it will advance 0.050 inch. The graduated portion *G* of this screw has, therefore, fifty divisions, each division being equal to 0.001 inch. On the top of the bracket is fastened a scale *H*, which is graduated for one inch, this space being divided into hundredths of an inch. It, therefore, can be seen that readings to 0.001 inch can easily be obtained.

An additional scale *I* is fastened to the frame *A* by the clamp *J* and thumb screw *K*. This scale can be used when distances varying more than 1 inch in length are required. This scale is a 6-inch narrow scale and can be set separate or in conjunction with the micrometer screw. Two zero marks are provided, one on the frame *A* and one on the carriage of the lathe, either one of which can be used as desired.

The writer has found this attachment very useful for facing work and also for boring holes, as the depth of the hole can be readily measured or bored by means of it. The attachment could also be made without the tension bushing *D*, if desired, but as the screw wears, of course there would be a considerable amount of backlash, and it is therefore desirable to have this tension bushing to prevent it. The scale *H* should be made very carefully and can be held by a screw and dowel pin, as shown. A. J. PETERSEN

Greenfield, Mass.

A SYSTEMATIC SCRAP-BOOK

In the November number of MACHINERY R. E. Ashley gives a description of an excellent plan for filing and preserving in a systematic manner articles of value which must be referred to frequently. In the article mentioned the writer lays stress on the fact that the most important and difficult feature of such a plan is the compiling of a thorough index system. For some time past the writer has been saving issues of MACHINERY containing articles on subjects not generally treated in other publications or text-books, and which are of great value to him in his everyday work. As the majority of readers know, it is a laborious task to keep up a card index, as each article has to be recorded and the card put in its proper place.

Most of the subjects which are of special value to the writer are jigs, fixtures, screw machine tools, etc. To keep the articles dealing with the above subjects in a systematic manner, a loose leaf binder was devised. This binder holds the various articles in such a manner that they can be conveniently located on short notice without the use of a card index system.

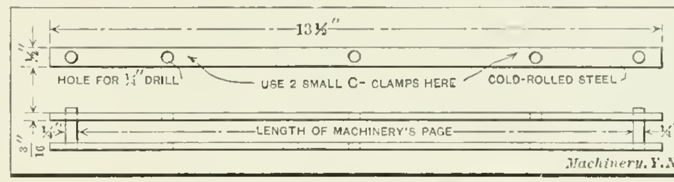


Fig. 1. Jig used for Drilling Binding Holes

After reading each issue of MACHINERY, the contents are filed in a loose leaf post binder, which is the size of a page. This is done by drilling holes to fit the three posts of the binder by means of the jig shown in Fig. 1. By drilling the holes in the magazine before the binding staples are removed, a much better and neater job is accomplished than when a quantity of loose sheets are drilled.

After drilling the holes, the advertising pages are removed, and the reading matter carefully separated. The latter is then collected and put in a binder with the different subjects separated by guide sheets such as shown in Fig. 2. These are made of stiff manilla paper and are prepared with projecting tabs on which are printed the general title of the articles filed under them. The articles are classified, such as drill jigs, gages, milling fixtures, planer tools, screw machine tools,

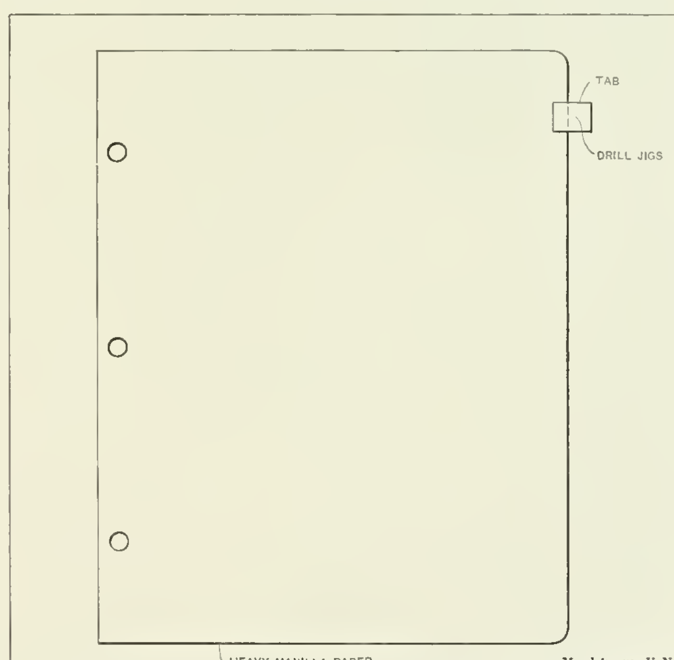


Fig. 2. Guide Sheet for Separating the Various Subjects

blanking dies, bending dies, etc. About fifty of these guide sheets are employed, and the pages containing articles on the various subjects are placed under their respective guides. In case there is a page containing articles on two or more subjects, the page is cut up and each piece is put in its proper place by being pasted to a blank page under the correct heading.

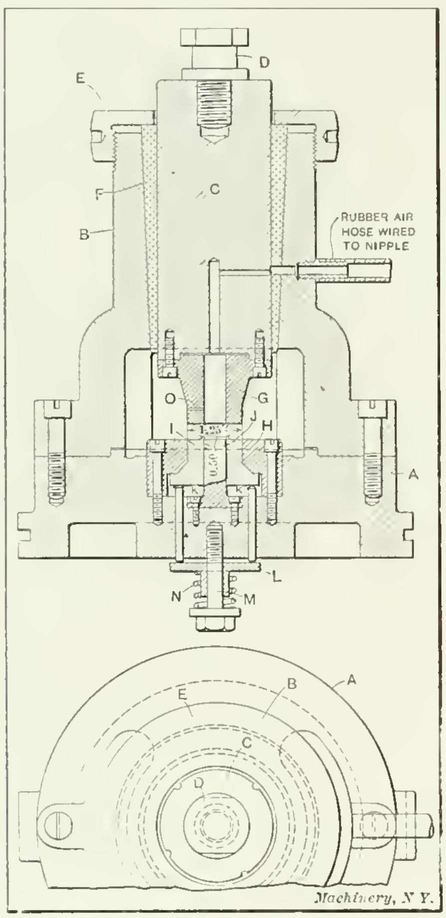
The above plan possesses several advantages, one of which is that it eliminates all elaborate and laborious index systems, for after the guide sheets are put in place it is an easy matter to insert any additional pages under the correct guide, and no further trouble is necessary. Another advantage is that

the binder can be taken away from the office and any particular reference looked up without either carrying a tray of index cards along or returning to the office to look through them.

It would appear to some that this system would require a longer time to find what you are looking for than it would by the card index system, but this is not the case, as it is only necessary to look at the tabs to find the heading under which the subject is located. If a sufficient number of these guide sheets are used and the space sub-divided as much as possible, there will not be a very large number of sheets under one guide. DESIGNER

SUB-PRESS DIE FOR BLANKING THIN WASHERS

The accompanying illustration shows an interesting sub-press die, which embodies some new features in its construction. This die was designed to blank out thin copper washers 1¼-inch outside diameter, 1/2-inch hole, and 0.025-inch thick. It consists of the base *A*, and the sub-press *B*, these being of the usual construction, as are also the plunger *C*, button *D*, cap *E*, and the babbitting *F*. The piston *C* carries the upper die *G*, which is screwed and doweled to it. The base *A* accommodates the lower die *H*, stripper *I*, and punch *J*, for the hole. The punch *J* is held to the base *A* by screws as shown, and is also doweled. The push-pins *K* extend through base *A*, their ends resting upon the plate *L*, which has a hole drilled in it to receive the stud *M*. This stud is threaded at one end and has an integral nut-and-washer shaped head at the other. It is screwed tightly into the base *A*, supporting the plate *L* and compression spring *N*. This arrangement has been found to give a more uniform thrust on the push-pins than was obtainable when each pin was operated by an individual spring.



A Sub-press Die from which the Scrap is ejected by Compressed Air

In place of a shedder in the upper die, it was decided to use compressed air in the design for this particular case. Several other dies were in operation on practically the same class of work, and in these the complicated shedder was not altogether satisfactory, owing to breakage of push-pins, springs, etc. The piston *C* has a 1/4-inch hole drilled in its lower end, and a 1/8-inch hole drilled in from the side of the piston, which meets the central hole. This 1/8-inch hole registers with another 1/4-inch hole in the babbitting and sub-press casting, when the piston is at the top of its stroke. The hole in the casting is threaded, a brass nipple is screwed into it, and a rubber air hose is wired fast to the nipple at one end, and to a convenient air main at the other. It will, therefore, be seen that when the piston is at the bottom of its stroke, the air is cut off, and as it rises to the upper end, the air rushes in as the holes come into register, the air pressure forcing the scrap out of the hole in the die *G*.

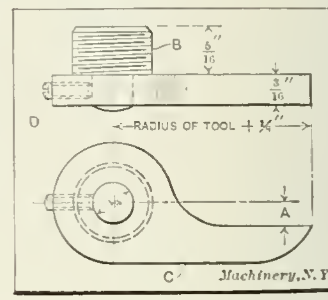
In order to relieve the air which is compressed in the hole in the die *G* during the blanking operation, a small hole *O* is drilled in *G* before it is hardened. This allows free working of the dies and at the same time does not interfere with the removal of the scrap. The sub-press complete is used in any power-press in the ordinary manner, except that the table of the press must have a hole in it large enough to clear the push-pin mechanism. F. B.

TEMPLET USED IN GRINDING CIRCULAR FORMING TOOLS FOR SCREW MACHINES

The articles published in MACHINERY from time to time on automatic screw machine practice have been of particular interest to me, as I am engaged in making tools for automatic screw machines.

Having difficulty in grinding tools of varying diameters so that their diameters would be correctly transferred to the piece when cut below the center, I devised the gage shown in the accompanying illustration. This gage was made in three different sizes to fit the circular tools for the Nos. 00, 0 and 2 Brown & Sharpe automatic screw machines, respectively. The dimension *A* on the templet is made to suit the various tools, as is also plug *B*. This plug rotates freely in the gage *C*, but can be held in any desired position when necessary with the small headless screw *D*. By using this templet, it is obvious that all the tools are ground the same amount below the center, and will consequently reproduce the correct diameters on the work. F. W. RANDALL

New Haven, Conn.



Templet used in Grinding Circular Tools the Correct Distance below the Center

I-BEAM TROLLEY DESIGNS

There is a strong and unmerited prejudice in the minds of many practical men against the form of trolley which is designed to run on the lower flanges of an I-beam, the reason given being that it "runs hard." An examination of some of the designs used reveals abundant reason why they should "run hard." Fig. 1 shows a design which, apart from its somewhat flimsy construction and consequent tendency to spring, has two marked defects which mar its efficiency. The first and most conspicuous defect is that of having cone-wheels running in a straight line, whereas the natural tendency of a cone is to roll in a circular path. In other words, a point on the larger diameter of the wheel moves say 24 inches per revolution, whereas a point on the smaller end of the wheel would only traverse say 22 inches per revolution, thus leaving a discrepancy of two inches, to be made up by sliding or scraping at every turn of the wheel. This discrepancy, of course, varies as the difference between the smaller and the larger circumference *A* and *B* of the wheel.

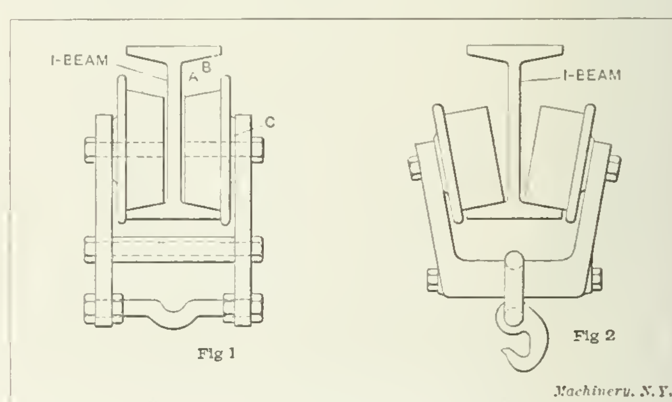


Fig. 1. Objectionable Design for I-Beam Trolleys

Fig. 2. Commendable Design for I-Beam Trolleys

The second objection to this design of I-beam trolley is

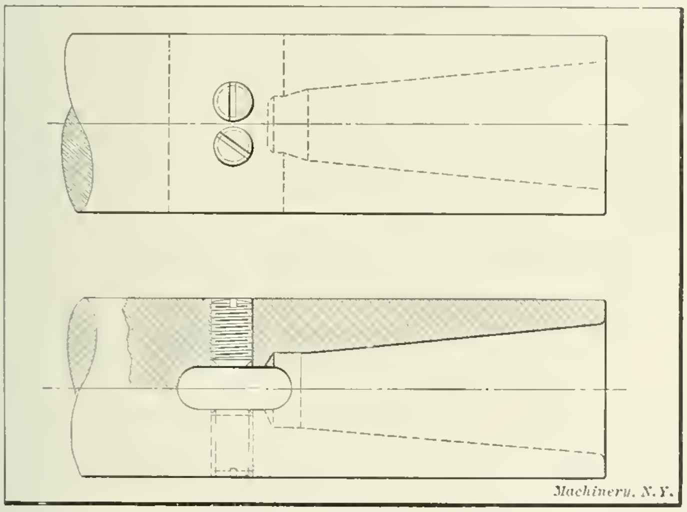
that the axes of the rollers are at an angle with the roller path, and hence considerable setting up or wedging action is the result which tends to push both wheels apart, thus causing unnecessary friction and a consequent wear between the hub *C* of the wheel and the frame. Both of these defects may be obviated, and a smooth-running trolley obtained by using wheels with a straight face and tilting their axes to the same angle as the face of the I-beam flange on which they run. A trolley of this description is shown in Fig. 2. Here, as can be seen, the axes of the rollers are in a horizontal position with the flange on the I-beam, thus allowing them to rotate freely without undue friction or wear. The wheels for this design of trolley should be as large in diameter as conditions will permit. S. M. RANSOME

Cleveland, Ohio.

[The design of I-beam trolley shown in Fig. 2 of course is not new, nor is it patented. The superiority of the design as compared with that of Fig. 1 is so obvious that it is a matter of surprise to find the latter in use but it is—to the discredit of the designer. It was described by Henry R. Towne in his "Treatise on Cranes," published in 1883. The flanges as shown on the pulleys are unnecessary.—EDITOR.]

METHOD OF REPAIRING A DRILL SOCKET

The mechanical journals are full of advertisements of cures for twisted drill tangs; but they do not say what you could do when the trouble is not with the tang, but with the spindle or drill socket itself, as is sometimes the case owing to careless handling. It frequently happens that the flats in a drill socket are often bruised or worn away by imperfect drill tangs, which causes considerable trouble. The accompanying illustration shows a very simple method of overcoming this difficulty, and



A Simple Method of Repairing a Worn Drill Socket

is as follows: The drill socket is tapped out for four tool-steel headless screws which are located as close together as possible. These screws are hardened aud will last a considerable time. When broken or worn they can easily be removed and replaced with new ones. JOHN E. COOK

Birmingham, Ala.

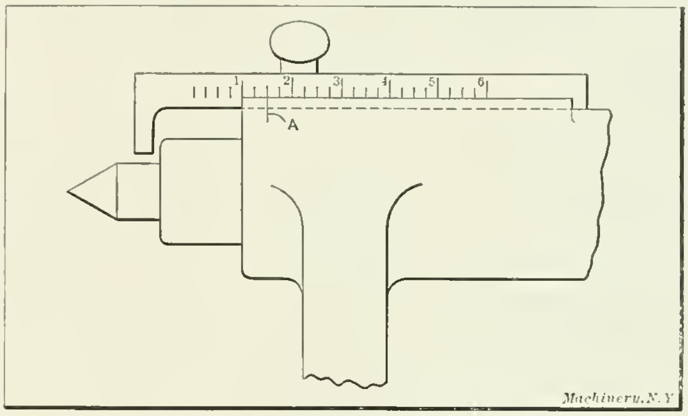
DEPTH GAGE FOR TAILSTOCK DRILLING

In the July number of MACHINERY Fred Horner suggests the use of a rubber band on the tailstock spindle for gaging the depth of holes when drilling in the lathe. This is a good device and is certainly easily accomplished and inexpensive, but it necessitates frequent measuring between the band and the tailstock to ascertain the depth. However, it is better than disfiguring the spindle with a confusion of scriber marks, which usually lead to errors.

A piece of chalk (preferably colored) having a sharp edge, obviates the difficulty which results from the too frequent use of the scriber, but the line made is not distinct. A string coated or saturated with red lead, and wrapped around the spindle close to the end of the tailstock makes a very good mark.

If much drilling is to be done and the tailstock spindle has no provision for gaging the depth, it is a very simple matter for a machinist to graduate the spindle. In the absence of a milling machine, the spacing may be accomplished to a certain degree of accuracy by placing the spindle on the centers of a lathe, and making the graduations with a suitable marking tool held in the toolpost. To do this, the carriage is moved by turning a gear keyed to the end of the lead-screw. For example, if the lead-screw is 1/4-inch lead, 1/16 of a revolution of the gear will move the carriage 1/64 inch; one-eighth of a revolution will give divisions 1/32 inch apart, etc. The gear can have sixteen teeth or any multiple of this number, such as 32, 48, 64, etc.

It would require but little time and ingenuity to make a simple locking device so that the divisions of this gear could be easily obtained. This locking device should fit approximately in a tooth space, and should slide in some sort of planed guide clamped to the headstock or the bed of the lathe.



A Convenient Stop-gage for Tailstock Drilling

It will be understood, of course, that this locking pin or wedge is to hold the gear (which is, of course, disengaged from the other change gears) while the lathe carrying the tailstock spindle is being turned by hand a fraction of a revolution. For each line required, the carriage is moved the proper distance, the locking-pin forced into a tooth space in the gear, the marking tool pressed lightly against the spindle by means of the cross-feed screw, and the lathe moved by hand through a small arc, thus making the graduations on the spindle. The locking pin is then disconnected from the gear in order to move it another space.

If the locking device is considered too expensive, a fixed pointer or finger may be used which can be brought into position against the face of the tooth, and thus gage the distance that the gear is moved for each graduation made on the spindle. The lines on the spindle should be of different lengths, so as to clearly distinguish the fine from the coarse divisions, and one or more limiting lines should be made lengthwise on the spindle to indicate the finishing points of the division lines.

A method which is better than a graduated spindle is a small stop-gage adjustably secured to the tailstock, as shown in the accompanying illustration. This stop-gage when set for the required depth, will stop the feed of the drill without auy watching; therefore it is more convenient than the graduated spindle. If instead of a fixed zero line as shown at *A*, an adjustable finger were used, the device would be still more convenient. The writer has never known of a stop-gage being used on the tailstock of a lathe, but the idea occurred to him while reading Mr. Horner's article. W. S. LEONARD

Atlanta, Ga.

CUTTING THREADS HAVING FRACTIONAL PITCHES

It is not often that one is called upon to cut a thread having a fractional pitch, but we had to cut sixteen and one-third threads to the inch. This was accomplished in the following manner: A lathe was fitted up with a taper-turning attachment and the tailstock set over; then the taper attachment was set to correspond with it, so that the tool would cut evenly

all the way along the work. The thread was then cut as usual, the tool being set by the face of the tap. A thread cut in this manner would be slightly greater in pitch than the gears ordinarily would give if the tailstock had not been set over and a taper attachment used. It was necessary to take three or four trial cuts, but by setting the tailstock over nearly to the limit, it was accomplished successfully.

Seneca Falls, N. Y. WILLIAM FUESS

[A similar method, but illustrated, is given in MACHINERY'S reference series No. 32 for cutting taps long in lead. This was taken from the April, 1899, issue of MACHINERY.—EDITOR.]

A DANGEROUS DRIP-CUP

We hear so much talk about having to dodge airships these days that the writer thinks it would be appropriate to speak about dodging oil drip-cups, which the machinist sometimes has to do. Although there are a large number of first-class types of drip-cups on hangers, one objectionable type which is commonly used is shown in Fig. 1. This drip-cup has a

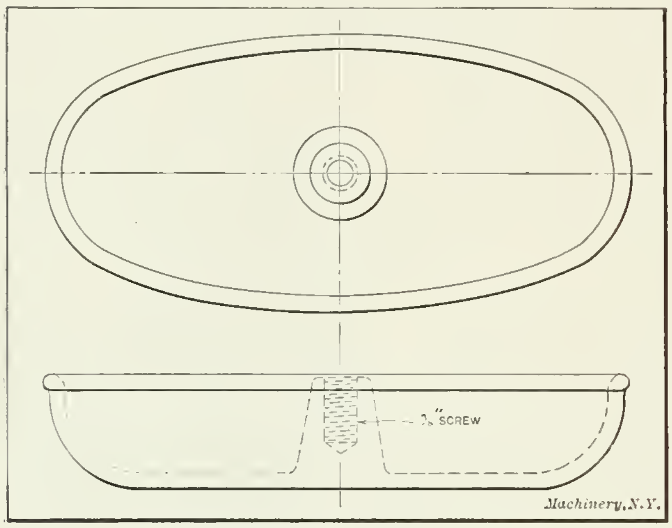


Fig. 1. A Common but Dangerous Type of Drip-cup

hub cast inside of it, which is tapped to fit a ⅜-inch bolt screwed into the hanger. After this type of cup has been removed from its bolt a few times, the tapped hole becomes considerably worn, owing to the fact that each time it is screwed on the workman endeavors to make it secure by putting it up, what he calls "good and tight."

There is always considerable vibration in a shop, so that it is not an uncommon occurrence to have a cup of this or a similar design work loose and drop from its bolt. When a man is hurt or is given a scare by one of these cups falling, he is not very anxious to have it put back in place, so that a

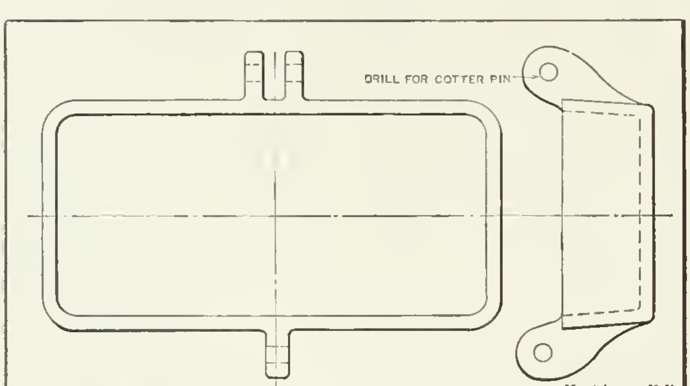


Fig. 2. An Improved Design of Drip-cup

large number of these drip-cups will be found lying in various places, or, in other words, not doing what they were designed for.

A more efficient type of drip-cup which can be used by designing the hanger with the necessary lugs to hold it in place is shown in Fig. 2. Holes can be drilled in both lugs of the hanger for cotter pins, and with very little extra expense you have a cup which is just as easy to put up—can be emptied by either taking it down or putting a pail under it, after withdrawing one pin—and has the advantage that both pins will not come out at the same time. If it so happened that one pin should come out, the workman would receive a shower bath, which after the first complimentary remarks are over, he forgets. FRANK H. MAYOH

Pawtucket, R. I.

A HANDY BORING-MILL CHUCK

The writer once had charge of a shop where nearly every week it was necessary to machine one or two castings of the

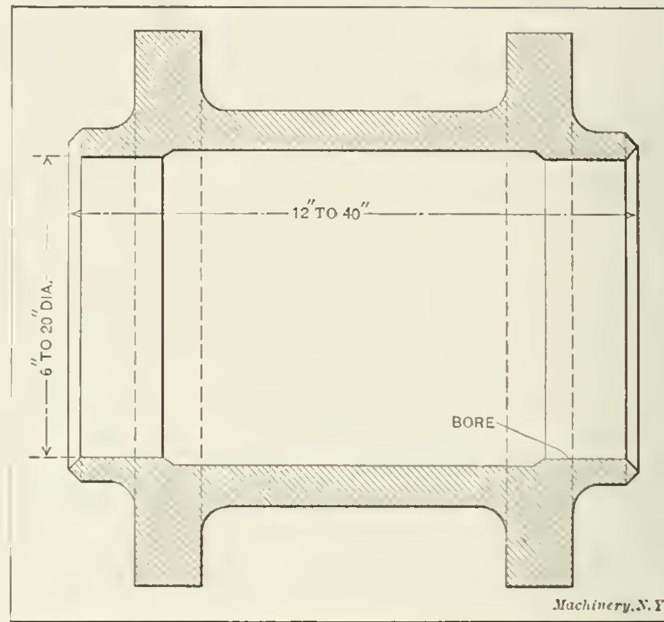


Fig. 1. Casting to be bored

form shown in Fig. 1. These castings had to be bored and the ends beveled as shown. We had to do them on a 52-inch

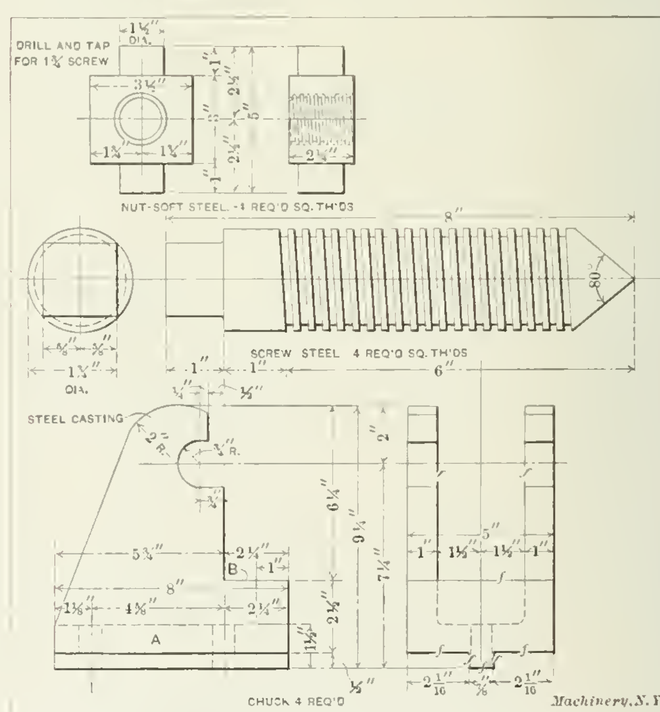


Fig. 2 Details of Chuck used on Boring-mill for Boring Casting shown in Fig. 1

vertical boring-mill, and it took considerable time to rig up and clamp them for boring and facing. The clamping method of holding them did not prove satisfactory, so the writer designed a chuck, the details of which are shown in Fig. 2. This chuck has been used for the past two years for holding the work shown and has given entire satisfaction.

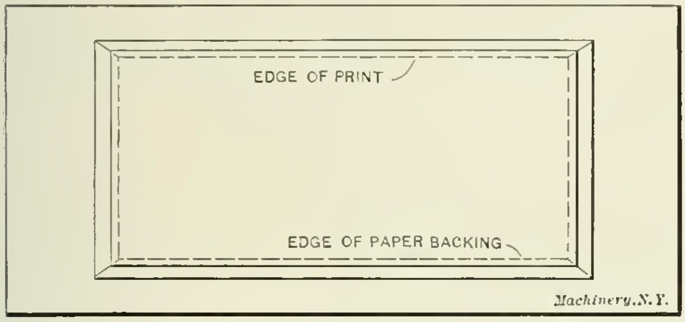
The body or part *A*, of which there are four, are provided with a tongue which fits the T-slots in the boring-mill table, and they are each fastened to the table by two bolts. There is not much strain on these bolts owing to the fact that the flange of the casting rests on the projecting part of chuck *B*, the pointed screws coming in contact with the casting at the junction of flange and body, at an angle of 45 degrees. The screws are in swing nuts to allow moving the casting laterally while chucking; when doing this the clamping screws should be loosened, otherwise they might be bent.

Bradford, Pa. JAMES CLARK

MOUNTING BLUEPRINTS

In the December number of MACHINERY J. B. & Co. ask for a method of mounting blueprints for shop use. The following method has been used by us and has proved satisfactory:

To mount the print cut a piece of No. 25 junkboard to a size that will allow about ¼ inch margin around the blueprint. The junkboard is then backed with a sheet of cheap white paper, the edges of which are folded over on the face of the board and extended about ½ inch in on all sides, as shown in the accompanying illustration. Now fasten the blueprint to the face of the board, and give it a good coating



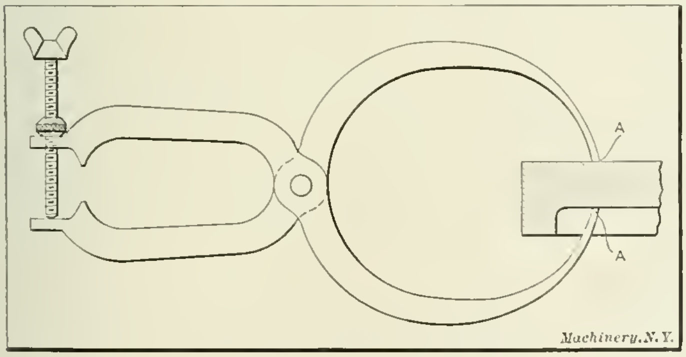
Method of Mounting Blueprints for Shop Use

of white shellac. The object of the paper backing is to keep the mount flat. We have hundreds of blueprints mounted in this manner which have been in constant use, and have given perfect satisfaction. By using white shellac instead of paste, a new print may be placed over an old one which will not crack or loosen, as is usually the case if paste is used.

Rochester, N. Y. H. D. AYLSWORTH

CALIPERS FOR MEASURING OVER A FLANGE

In the August number of MACHINERY several methods of measuring over a flange were shown, and while the methods are all right in their place, the writer would suggest what



Calipers for Measuring over a Flange

he considers a still better one. This is accomplished by making a pair of calipers, as shown in the accompanying illustration. The thumb-screw is screwed into the outer end of these caliper legs and a locking nut screwed onto it, which acts as a stop when measurements are to be taken.

To take a measurement proceed in the following manner: Set the calipers so that they bear lightly on the faces of the work, then screw down the thumb-screw until it touches the opposite leg and tighten the lock-nut. After screwing down the thumb-screw the calipers should again be moved around on the work to see that they are adjusted correctly. The calipers are then opened, after which they can be closed to the position at which they were previously set, by means of the thumb-screw and lock-nut. The measurements are taken between the points *A* of the calipers with an ordinary scale.

Philadelphia, Pa. CHARLES H. BETTLE

KEYSEATING LARGE SHAFTS

The article on keyseating large shafts in the August number of MACHINERY was interesting to the writer, as he has had considerable keyseating to do on some large shafts. A description, therefore, of how they were keyseated may be of interest to some readers of MACHINERY. The shafts were

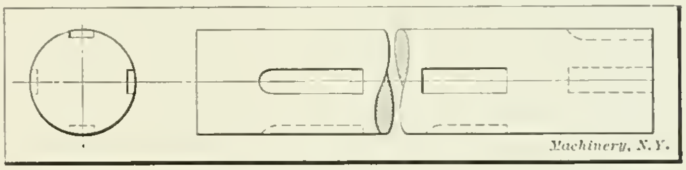


Fig. 1. Shaft to be keyseated

4½ inches in diameter by 52 inches long, and keyseats were to be cut arouud the periphery 90 degrees apart, as shown in Fig. 1.

The operation of keyseating these shafts was performed on a Burr keyseating miller, and as the shafts were nearly as long as the bed they did not leave room enough for the use of an indexing fixture; so to provide for this an ordinary flanged set-collar was taken and the flange shaped square, as is shown in Fig. 2. This collar was then fastened onto the shaft by a set-screw, and a connecting-rod key placed under it. The shaft was held on V-bolts clamped to the table, as is

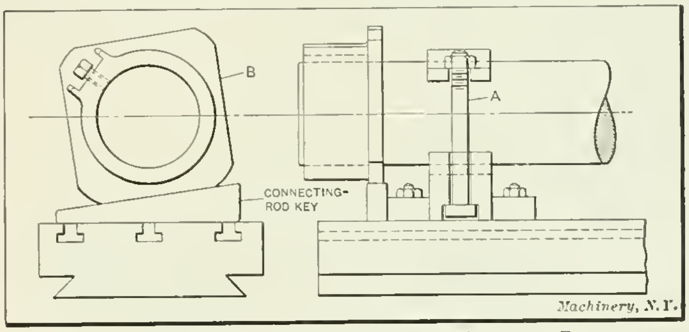


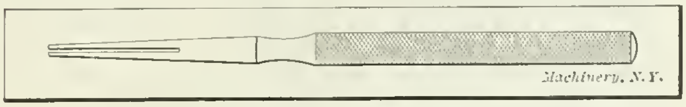
Fig. 2. Method used in Keyseating Large Shafts on a Burr Keyseating Miller

clearly shown in the illustration. After one keyseat had been completed the nuts on the clamping bolts *A* were released, the flanged-shaped piece *B* rotated 90 degrees, and the clamping nuts again tightened. By this method we obtained an accurately divided shaft at very little expense.

Oil City, Pa. JOHN REID

INSERTING SMALL SCREWS

In the July number of MACHINERY a method of inserting small screws was shown, and while it may be effective in some cases the writer thinks that the tool shown in the accompanying illustration would be better. As the illustration shows, this is made from a piece of steel which is slotted, and the slotted end is then spring tempered. To use this "screw-inserter," the screw is held in one hand, and the tool in the other; then by springing the slotted end into the slot in the screw, it holds it effectively, so that the small screw can be inserted easily. When the screw is once inserted, this tool can be removed, and the screw put in the remainder of the way with an ordinary screw-driver.



A Tool for Inserting Small Screws

FRED HENKE

Philadelphia, Pa.

PREVENTING A PENCIL POINT FROM BREAKING

In the December number of MACHINERY, W. Thompson suggests cutting one end of the pencil round, and forcing on a piece of steel tubing about ¾ inch long, thus making one end heavier than the other, so that when the pencil falls on the floor, the point will not be broken. This appears to me to be more bother than it is worth. In the time spent in rigging up this device the pencil could be resharpened two or three times, and anyway one frequently uses up a pencil completely without its ever having fallen on the floor during its use, so if the steel piece has been affixed, we have lost just so much time which could have been better spent.

If this addition to a pencil were worth all the attention which has been paid to it by contributors at different times, it seems strange that it should have escaped the attention of pencil manufacturers, and that they should not include such provision in their product.

The scheme of making the end opposite the point heavier, was taken up by one of the large pencil companies some time ago, but did not result very satisfactorily, for the reason that it was tiresome to hold the pencil, as it had to be gripped more firmly than usual on account of the added weight which had to be supported. It also had a tendency to make the pencil wobble around. Anyone, for instance a draftsman, who uses a pencil eight or nine hours a day, will soon be impressed with this point. He will find that his fingers become cramped after holding the heavy pencil for any length of time.

DESIGNER

MACHINE FOR GRINDING SQUARE HOLES

Referring to the November issue of MACHINERY, and the article regarding "Square *versus* Splined Change-gear Shafts", (for automobile transmissions) we notice that your contributor mentions the difficulty of truing up a square hole. It may, therefore, be of interest to your readers to know that some time ago we brought out a machine for grinding holes, by means of which the operation of truing up a square hole becomes a simple and easy matter, and although, as your correspondent suggests, the gears can be made large enough to compensate for any inequalities, yet by the use of the square-hole grinding machine, illustrated herewith, the limits can be made closer, and this machine will enable gears which have closed in a small amount during the hardening process to be finished to the proper size much more quickly than by any methods of lapping. The illustration Fig. 2 shows the arrangement of the essential parts of the machine; *A* is the pulley driving the grinding wheel *B*, *C* is a section of the bar carrying the wheel and pulley. This illustration shows a blank with a square hole in it, with the wheel at work on one side. The blank is indexed around for each side to be ground.

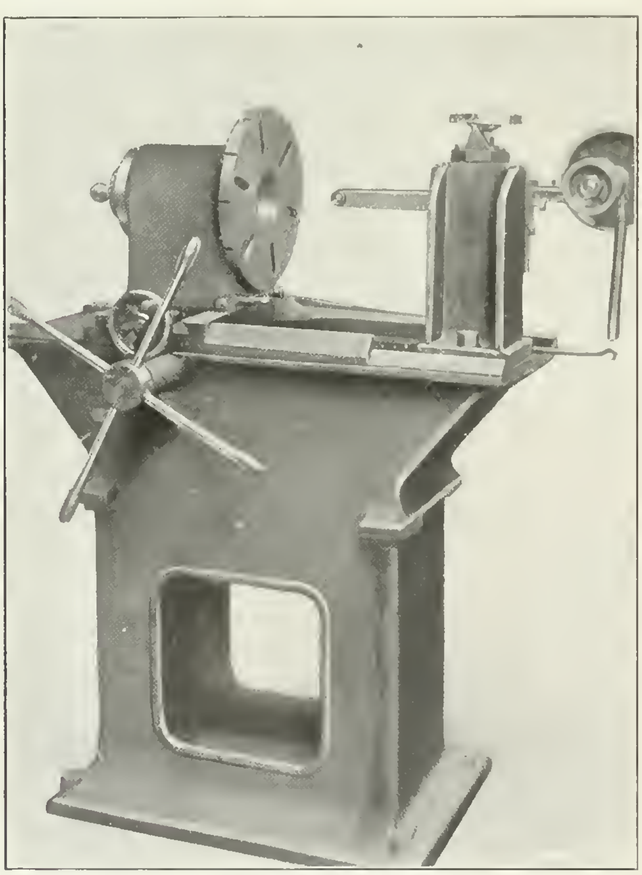


Fig. 1. Burton Griffiths & Co.'s Square-hole Grinding Machine

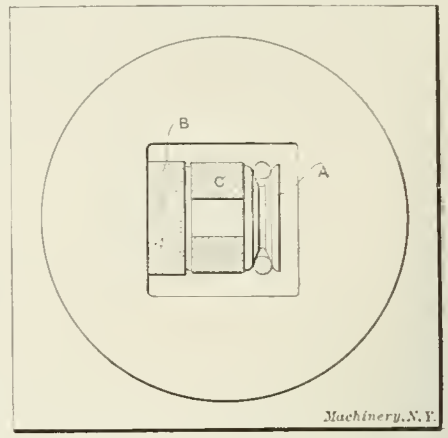


Fig. 2. Cross-section of Grinding Bar showing Wheel at Work

C. W. BURTON, GRIFFITHS & CO.
London, England.

[The square hole grinding machine referred to above was described in MACHINERY, February, 1907; this description may be referred to for further details regarding the construction.—EDITOR.]

REBORING LARGE WHEELS ON A SMALL LATHE

A man who has worked mostly in a manufacturing shop and then changes to a regular jobbing shop cannot help but admire the many ingenious ways the men in the latter have of doing things.

Some years ago I worked in a jobbing shop in the South, where I saw a large pulley, about six feet in diameter, brought in to be rebored. As the largest lathe they had only swung thirty-six inches, I thought they would have to rebore the wheel by hand, that is, clamp it on a rig and turn the crank, which is a mean job at the best. It was given to the man on the thirty-six inch lathe, who in about twenty minutes turned his headstock around end for end, with the chuck overhanging the end of the lathe, where he then chucked the pulley in a very short time. A bushing was put in the tapered hole of the spindle, made to fit a boring-bar, which was long enough to reach through the hub. The spindle was clamped in the toolpost of the carriage, and of course, the feed belt could not be used in the regular way, so a large wooden pulley was fastened to the rear end of the feed-rod, and an old belt run over the line shafting. In a little over two- and one-half hours the job was completed and the lathe back where it belonged.

This sort of job came in frequently and I always thought it a good "stunt." I also saw a large pulley chucked in this manner, and rebored and turned. The turning was done by bringing over another small lathe, where it was bolted down at right angles to the pulley, the back of the small lathe being next to the face of the pulley. A turning tool was then put in the toolpost, and the carriage fed along, thus turning the pulley. With the use of a helper this job was done in a remarkably short time.

To me a jobbing shop was always interesting, and it was very seldom that any job grew monotonous. I have often wished since that I could get some of the apprentices that were turned out of that shop.

B. J. F.

* * *

"DRAWING DEEP CYLINDRICAL SHELLS"—ERRATUM

In the article on "Drawing Deep Cylindrical Shells" in the December number the formula $D = \sqrt{d^2 + 4\,dh}$, was given as $D = \sqrt{\ } d^2 + 4\,dh$, which is erroneous. It was also stated that the drawing punch was fastened to the counter-shaft plunger; this should have been "crankshaft plunger."

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

PRATT & WHITNEY CYLINDRICAL GRINDER WITH AUTOMATIC SIZING ATTACHMENT

The latest development in the cylindrical grinding machinery manufactured by the Pratt & Whitney Company of Hartford, Conn., is shown in Figs. 1 and 2, which are front and rear views, respectively, of a 4- by 30-inch automatic sizing grinder. This machine, which is of the reciprocating table

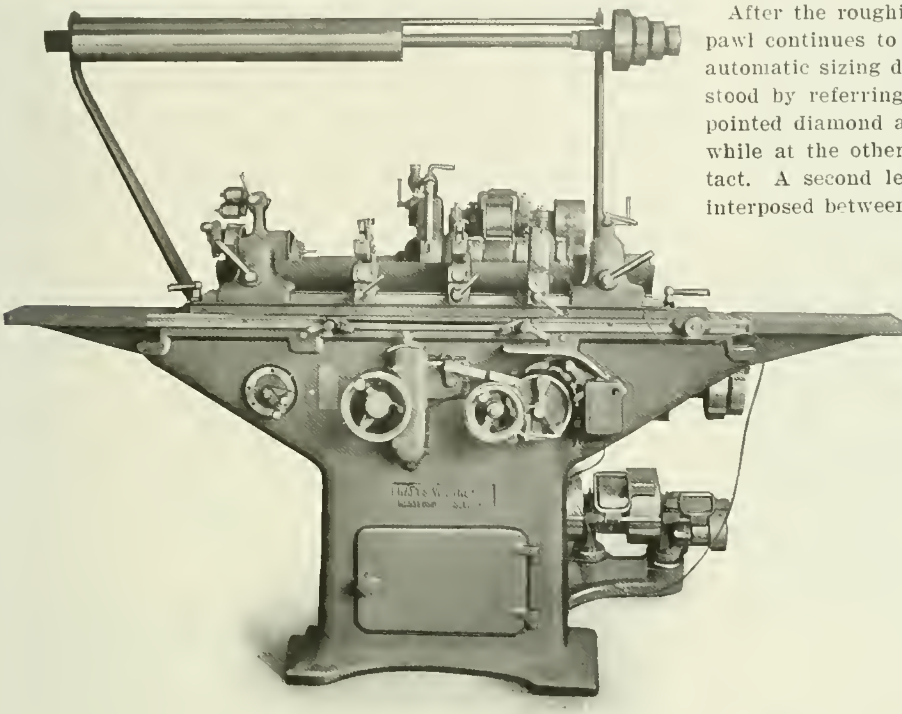


Fig. 1. Front View of the Pratt & Whitney Cylindrical Grinder with Automatic Sizing Attachment

type, contains several features of unusual interest, among which may be mentioned the sizing attachment for automatically grinding duplicate diameters regardless of the wheel wear, and the independent feed pawls which give both roughing and finishing feeds.

Wheel Feed and Automatic Sizing Device

The construction and operation of the automatic feeding and sizing mechanism will be understood by reference to Fig. 3 and the detailed view of the sizing device, Figs. 4 and 5. The wheel feed proper may be operated entirely independent of the automatic sizing device if desired. The transverse movement of the wheel slide is obtained through a large screw and nut, and it is accurately controlled by the feeding mechanism through encased spur gearing located on the back of the machine. Both roughing and finishing automatic feeds are obtained, as before stated, by means of separate feed pawls *A* and *B* (Fig. 3) which operate upon a ratchet as shown. These feed pawls, while independent of each other, derive their movement from the same connecting lever. Variations in the feeding movement ranging from one-half notch to twelve notches, can be obtained by means of conveniently located adjusting screws, thus giving diameter reductions on the work of from 0.000125 to 0.003 inch. By having two pawls, a feeding movement of ½ notch may be obtained, as stated, when required for finishing. The automatic feed may be instantly engaged or disengaged by a conveniently located knob, or by the automatic sizing device. When setting these two pawls, the roughing pawl *A* might be set, for example, to feed eight notches, while finishing pawl *B* would be set for one notch; the disengager *C* should then be located to disengage the roughing pawl within, say 0.001 inch of the finished size. In setting this disengager, it is important that the set screw *D* come against stop *E* on the disengager, as this has the effect of automatically maintaining the relation between the roughing and finishing pawls, so that the amount left for finishing always remains the same, regardless of the wheel wear.

After the roughing pawl has been disengaged, the finishing pawl continues to feed until it, in turn, is disengaged by the automatic sizing device, the operation of which will be understood by referring to Fig. 5. The lever *H* carries a smooth-pointed diamond at one end which bears against the work *M*, while at the other end there is a point *K* for electrical contact. A second lever *J* is also provided with contact points interposed between point *K* and point *L* in the frame connecting with a magnet at the front that disengages the feed pawl. As the diameter of the work is reduced, lever *H* drops until point *K* touches the contact point of *J*, which through an electrical connection changes the feed of the wheel and causes it to move against the work at a slower rate. When the work has been reduced to size, lever *H* drops still further, carrying with it lever *J* until an electrical connection is established between the contact points of *J* and *L*, when the fine-feed pawl is instantly disengaged by means of the magnet *F* (Fig. 3) which releases the disengaging trip *G*. This magnet is operated by a dry battery, and its sole function is to disengage the feed, when the work has been reduced to the required diameter.

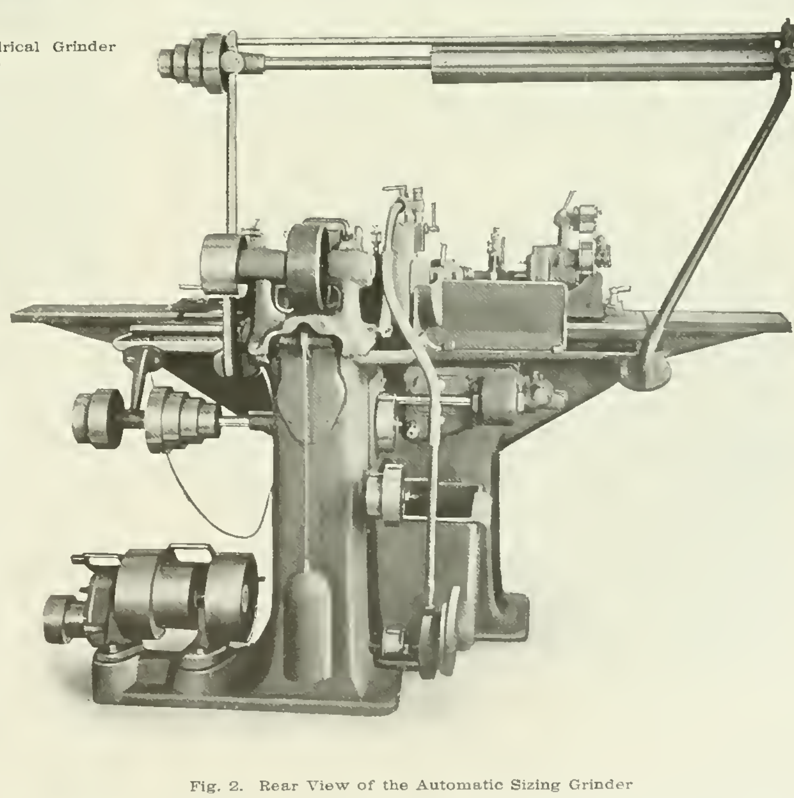


Fig. 2. Rear View of the Automatic Sizing Grinder

When new work is being placed in the machine, the sizing lever is returned to its upper position, both the upper aud lower positions of this lever being indicated in Fig. 5 by the dotted lines. In setting this device, a piece is ground to the required size, after which the proper adjustment of the sizing lever is determined by means of a micrometer screw and dial

which governs the transverse adjustment; an adjusting screw is also provided in the sizing lever for very delicate adjustments. This attachment is self-contained, simple in construction, and it may be located in any position on the bed. The connecting wires are encased or insulated to prevent short circuiting, and the voltage required is so low that the dry battery used will last a long time without being replaced.

The Bed and Work Table

The bed of this grinder is massive and well braced internally to insure rigidity and accuracy. It has wide bearing surfaces of the V and flat types. The work table is also well ribbed to prevent warping and to resist torsional strains.

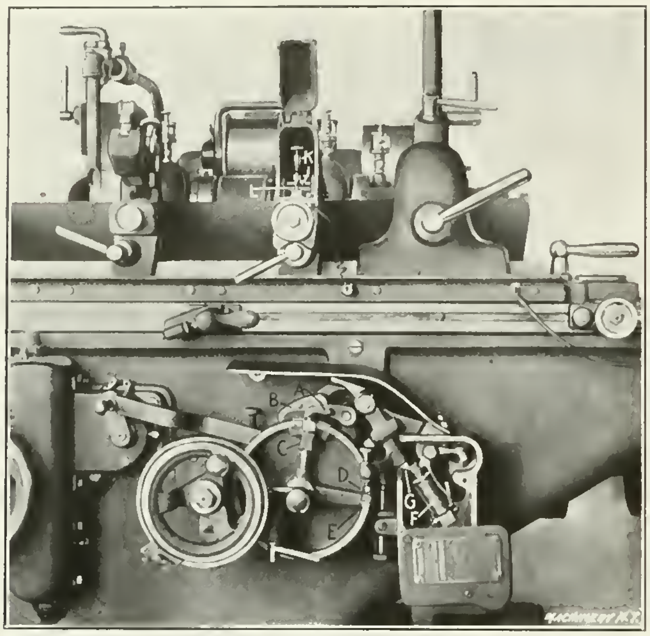


Fig. 3. Automatic Feeding Mechanism

Both the bed and table are made true by means of masters, and the table is made slightly longer than the bed so that the reciprocating movement will tend to keep both members true. The bearings are automatically lubricated by reservoirs and rolls located in the bed, and guards are provided which protect the bearing surfaces. The table may be swiveled for grinding taper work, and the swiveling movement may be accurately determined by means of a micrometer screw and dial. Six changes of table feed are instantly available by means of

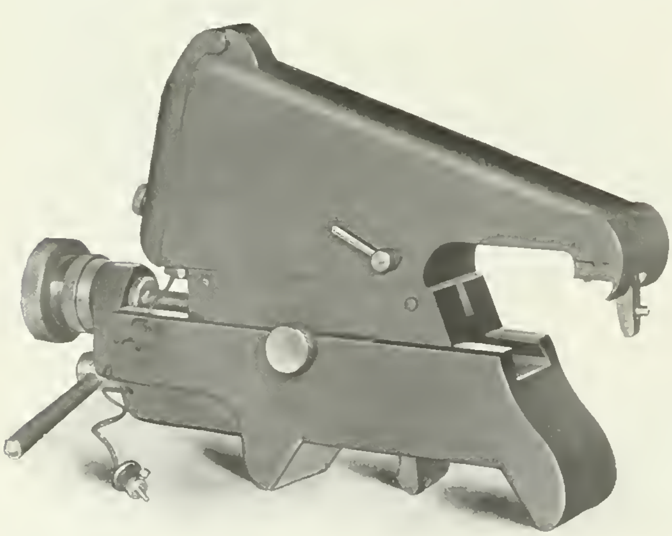


Fig. 4. Sizing Attachment

a change-gear mechanism located at the rear of the machine. These changes are effected by a sliding key that is operated by levers located at the front and within easy reach of the operator. The table feeds are entirely independent of either the wheel or work speeds. The reversing mechanism, which forms a part of this gear box, is of an efficient and substantial type. The point of reversal is determined by the location of dogs on the table that are provided with a sensitive adjustment.

Wheel-base, Wheel-spindle Construction, and Drive

The wheel-base is mounted upon the bed in dovetailed bearings that are provided with a taper gib to compensate for

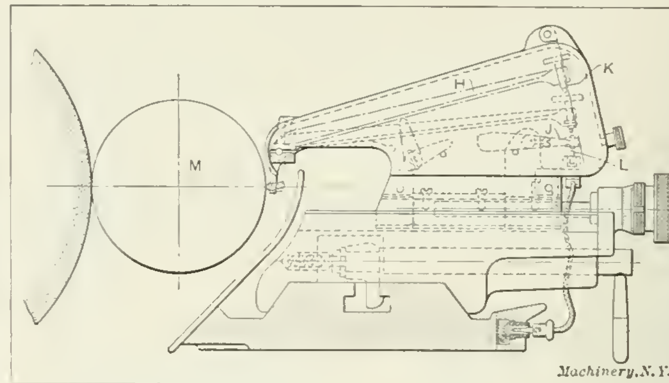


Fig 5. View showing Mechanism of Sizing Attachment

wear. This wheel-base is heavy but sensitive, backlash in the feed-screw being prevented by means of a weight which is mounted on a roller in such a manner as to obtain the desired result without affecting the sensitiveness of the slide. This weight is shown in the rear view, Fig. 2, which also shows how the slide is mounted directly upon the bed, there being but one working joint between the wheel and bed so that the latter forms a direct support.

The wheel spindle is of tool steel hardened, ground and lapped, and runs in adjustable bronze boxes that are substantially mounted in conical seats. Extra precaution has

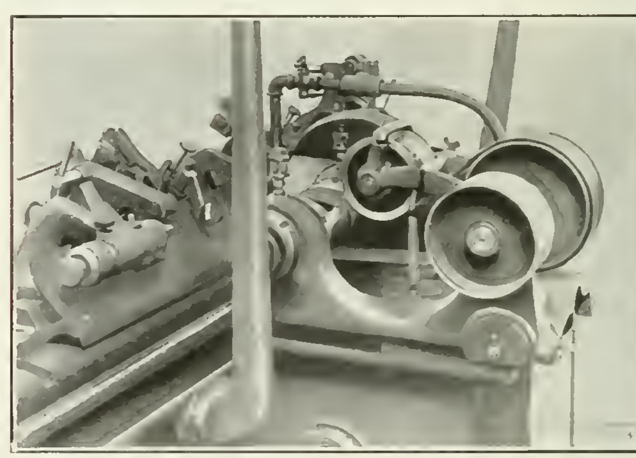


Fig 6. Side View showing Wheel-spindle Drive and Belt Tightener

been taken to insure proper lubrication, the boxes being provided with self-feeding oilers. The wheel mount is self contained and is so constructed as to hold the wheels firm and true. Provision is made for accommodating wheels 12 inches in diameter and with face widths of from ½ to 1¾ inch.

The drive to the wheel spindle is from a countershaft on the base at the rear, which drives an intermediate shaft on the wheel slide that, in turn, connects with the wheel spindle by an endless belt. With this form of drive, the backward pull of the endless belt keeps the spindle against the inner side of the boxes, thus preventing the wheel from digging into the work if, because of improper adjustment, too large a lubricating space is allowed in the box. As shown in the detailed view, Fig. 6, this endless belt has an automatic tightener which eliminates all upward pull. The downward pull of the belt which connects the intermediate shaft on the wheel slide with the countershaft at the rear, does not interfere with the free movement of the base, as the pressure is taken by a hardened and ground roll in the slide that travels on a hardened and ground parallel in the bed. The makers state that this drive has proved exceptionally efficient and gives ample power under the most severe tests.

Head- and Tail-stocks and Work Table

The head- and tail-stocks may be effectively clamped to the table by means of an eccentric binder, and the offset construction (clearly illustrated in Fig. 6) permits the introduction of efficient water guards. The work revolves on hardened and ground dead centers, and the work driver is gear-driven. The work may be instantly started or stopped independent of the belt drive, by means of a clutch in the head-stock. This gear drive gives ample power, and no trouble has been experienced from chattering or vibration. The tail-stock spindle, which is under spring tension, is quickly operated by means of a rack and pinion. The tension of the spring is varied for different classes of work, by a nut which serves to tighten or release it as desired. An efficient binder is also provided for securely clamping the spindle when necessary. As the engravings show, the work-driving drum is integral with the machine. Four work speeds are obtained through four-step cones, and these speeds are entirely independent of the table or wheel speeds. The cones and drum are accurately balanced which practically eliminates all vibration. A belt tightener for varying the tension on the drum belt, is provided on the head-stock.

Backrests

The backrests employed on this machine are of a new and original design and of such construction that the shoe automatically follows up and supports the work throughout the

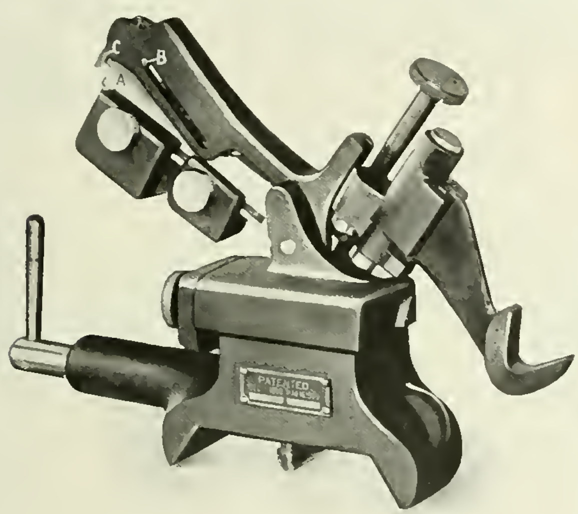


Fig. 7. Automatic Positive-feeding Backrest

grinding operation. The proper relation between the work and the supporting shoe is maintained by the downward movement of lever *A*, Fig. 7, which raises the shoe-holder and the shoe as the work is reduced. This downward movement of lever *A* causes roll *B* to advance along its path, which has sufficient inclination to permit the back pressure being taken by the roll without slipping. The pressure is governed by means of adjustable weights located on lever *A*, as shown. When the work has been reduced to the required diameter, the backrest shoe is withdrawn by returning roll *B* to its original position and raising lever *A* to its upper position, where it is held by latch *C*. Both radial and vertical adjustments are provided by means of adjusting screws. This backrest may be easily removed from the bed by a slight inward pressure on the eccentric binder which releases the binding clamp.

Center- and Wheel-truing Devices—Water Supply—Equipment

In order to insure accurate centers, each grinder is equipped with a center truing device, similar to the one illustrated to the left in Fig. 8. This attachment is driven by means of a round belt from the work-drum, and it may be easily located on the table without interfering with the other attachments. The wheel truing device, shown to the right in Fig. 8, is designed to hold a diamond tool, and the wheel may be trued without removing the work or disturbing any other attachments. A liberal water supply is available, there being an efficient type of pump at the rear of the machine and a large water tank, both of which may be seen in Fig. 2. The pipe through which the water is conveyed to the wheel, is so attached to the guard that it may be easily adjusted or instantly removed if desired. A pan of liberal dimensions surrounds the rear of the bed for collecting the water and receiving the chips.

This machine can be furnished with a motor base to accommodate any standard motor. This base is provided with an automatic belt tightener, and a five-horsepower constant speed motor, having a two-stepped driving pulley for varying the wheel speeds, is used. The regular equipment furnished with this grinder includes the automatic sizing device; one emery

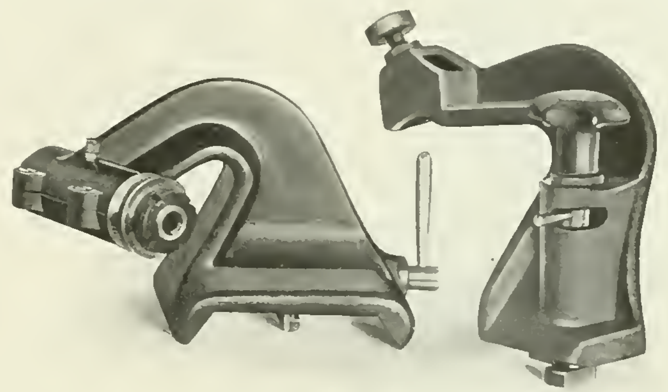
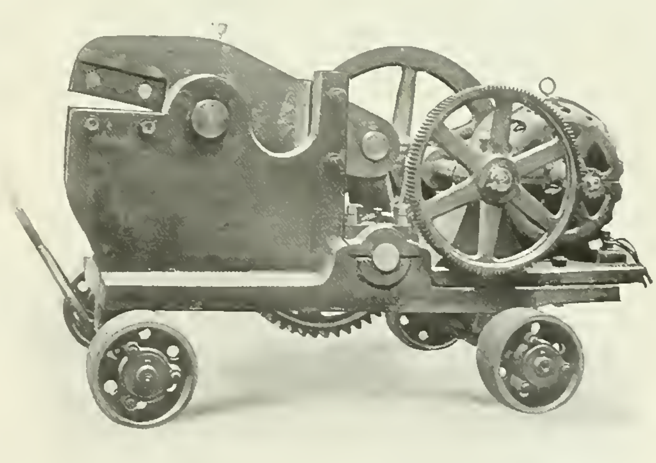


Fig. 8. Center- and Wheel-truing Attachments

wheel; wheel truing device, center grinding attachment; 2 universal backrests; 36 backrest shoes; 16 work dogs; a countershaft, and the necessary wrenches.

LITTLE GIANT PORTABLE SHEAR

A portable shear especially designed for cutting scrap material is now being built by the Danville Foundry & Machine Company, Danville, Pa. As the accompanying illustration shows, this shear is mounted on four wheels which are provided with anti-friction rollers so that the shear may be easily moved about. The drive is by a five-horsepower Westinghouse motor which forms an integral part of the equipment as shown. This motor drives an intermediate shaft which transmits power to a crankshaft connected by a pitman to the movable shear. The knives are 10 inches long and have four cutting edges so that one set of knives is in reality equivalent to four sets. The knives are made of a good grade of tool steel and are capable of long and continuous service. This shear has a capacity for round iron or soft steel up to 1½ inch in diameter, or for square material up to 1¼ inch. The maximum opening of the knives is 3½ inches at the heel. The height from the floor up to the knives is approximately 30 inches. All the gears used in this machine are cut, with the exception of the large one on the steel crankshaft. The crankshaft has a stroke of 6 inches, and it runs in journals having a diameter of 3 inches and a length of 6 inches.



Portable Shear built by the Danville Foundry and Machine Co.

NEW BRITAIN MOLDERS' RAMMING STAND

As there is always more or less work in a jobbing foundry that cannot be done in a molding machine and must, therefore, be hand molded, ramming stands can frequently be used to advantage for this class of work. The New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has placed on the market the design of ramming stand illustrated herewith. With this type, the struck sand falls to each side of the column where it can be easily shoveled up again. The base and top of this stand are machined, and the hollow supporting column, gives the required rigidity. Unlike the wooden devices which rapidly rot in the damp sand, this stand is both durable and fireproof. The top is arranged for holding mold boards with cleets having a center distance of about 10 inches. The height of the stand is 30 inches, and it measures 21 inches front to back. The weight in shipping order is 200 pounds.

New Britain Molders' Ramming Stand

GOULD & EBERHARDT AUTOMATIC GEAR CUTTING MACHINE

One of the latest gear cutting machines designed and manufactured by Gould & Eberhardt, Newark, N. J., is shown in Figs. 1 and 2. This machine is intended for cutting spur, bevel, and face gears, and it is particularly adapted for roughing out automobile bevel gears preparatory to finishing them on a bevel gear planer. It has a capacity for cutting spur gears up to 36 inches in diameter and with a 10-inch face width, and bevel gears up to 24 inches in diameter and 8 inches face width. Teeth up to 3 diametral pitch in cast-iron, and 4 diametral pitch in steel, can be cut in either spur or bevel gears. As the illustrations show, the cutter slide, instead of working horizontally, moves in a vertical plane, and the work is solidly supported on a table that is adjustable on the horizontal ways of the bed. The feeding arrangement for the cutter slide and cutter is on the draw principle, the feed-screw being under tension instead of compression, which eliminates vibration and insures a smooth cutting action. There is also a separate and direct drive to the feed-screw mechanism. This vertical cutting feature gives a rigid and strong construction and eliminates the disadvantage, when cutting bevel gears, of tilting the cutter slide with all its moving parts. The drive to the cutter is also more direct, and the work is rigidly supported, as the strains imparted by the cutter are transmitted to the main base of the machine.

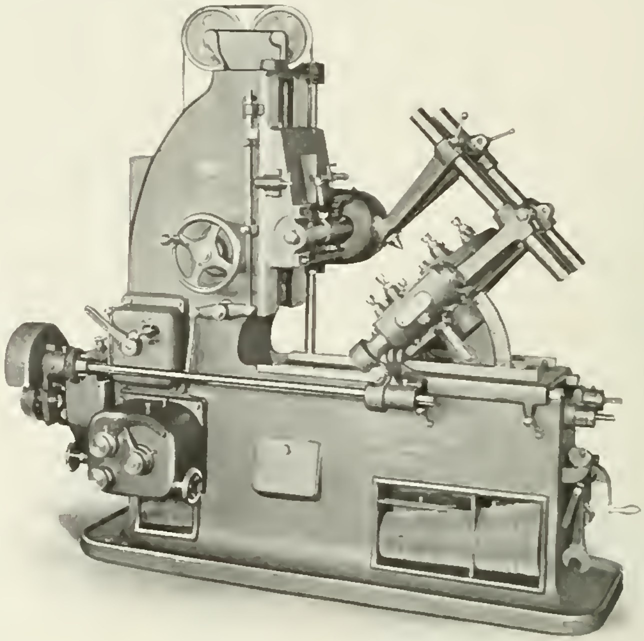


Fig 2. Gould & Eberhardt Machine set for Bevel Gear Work

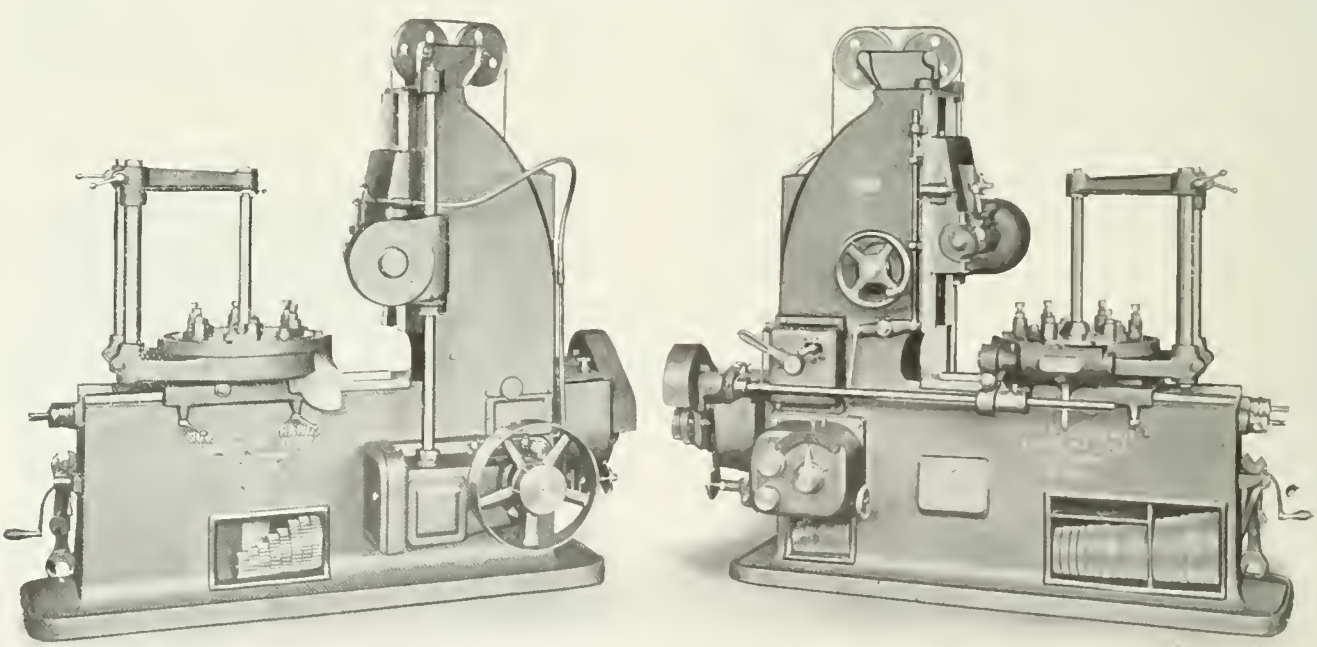


Fig. 1. Gould & Eberhardt "Vertical Cutting" Automatic Gear Cutting Machine

The work table is adjustable to any angle and when it is set in an angular position for cutting bevel gears, as shown in Fig. 2, it is supported by a segment arranged centrally and provided with a worm-wheel sector by means of which the table is adjusted. In addition to the locking feature of the worm and worm sector, there is a strap in the segment that enables the table to be rigidly locked when it is properly adjusted. A crank handle at the front end of the machine, enables the operator to adjust the work table by degrees and minutes. One turn of the crank handle indicates one degree, and a sector vernier, graduated in degrees, shows the exact angle to which the table is set. The indexing of the table is controlled by a novel and patented mechanism, which is posi-

tive, simple in construction, and practically the same as that employed on some of the latest designs of spur gear cutting machines. The last mover of the indexing train is a worm-wheel of large diameter that is rigidly secured close to the work table upon which the gear blank to be cut is fastened. Upon the table, a triangular work mandrel is mounted for supporting the gear blank at its outer end in any angular position. The feed to the cutter slide is controlled by a direct-reading gear-box which enables the different feed variations within its range to be quickly obtained. This gear box provides for 16 different feeds ranging in geometrical progression from 1 inch to 15½ inches per minute, and any of the various feeds may be obtained by the operation of two handwheels. The cutter slide is counterbalanced and it is provided with a rapid return. The feeding, indexing and return movements are interlocking so that the succeeding movement cannot take place until the preceding movement is entirely completed. The cutter driving mechanism is of the simple and direct form found in the spur gear cutting machines built by this company. The cutter is driven by a steel worm and bronze worm-wheel of special construction which insures smooth running and a powerful drive. The cutter arbor is made of chrome-nickel steel and it can accommodate different sized bushings to permit the use of cutters having holes of various diameters. The speed variations for the cutter spindle vary in geometrical progression from 23 to 145 revolutions per minute, the different changes being effected through change gears. The machine is driven by a single driving pulley, as shown to the left in Fig. 1, and all gears are entirely enclosed by guards. The machine weighs 3500 pounds, and, if desired, it may be equipped with an electric drive. It is especially adapted for roughing out nickel steel automobile driving gears and pinions, and the makers state that it has already been placed in many of the prominent automobile factories.

BROWN & SHARPE NO. 13 B PLAIN MILLING MACHINE

The Brown & Sharpe Manufacturing Company, Providence, R. I., has brought out a new design of milling machine of the manufacturing type, embodying in its construction a number of interesting and important features which adapt it to modern manufacturing methods and the production of duplicate parts. This machine, different views of which are shown in Figs. 1 to 3, is of the constant-speed drive type, and it is adapted for either belt or motor drive. As the engravings indicate, the construction is very rigid, the upright which supports the spindle head being of the box form, and the bed and saddle being so constructed as to give a maximum support to the table—an essential feature on a machine of this type, which is often required to take heavy cuts. In this connection it should also be noted that the saddle has large bearing surfaces on the bed. The location of the operating levers and handwheel, and the facilities for changing speeds and feeds are also noteworthy features. The spindle, which is made of crucible steel, is heavy and it has large bearings that are accurately ground and correctly proportioned to withstand hard service. There is a standard taper hole in the spindle, and the front end is threaded to receive a chuck or large cutter; there is also a slot across the end for driving an arbor or collet having a clutch collar. A draw-in bolt is also furnished for holding arbors, etc. The spindle boxes are made of phosphor-bronze and they are provided with means of compensating for wear.

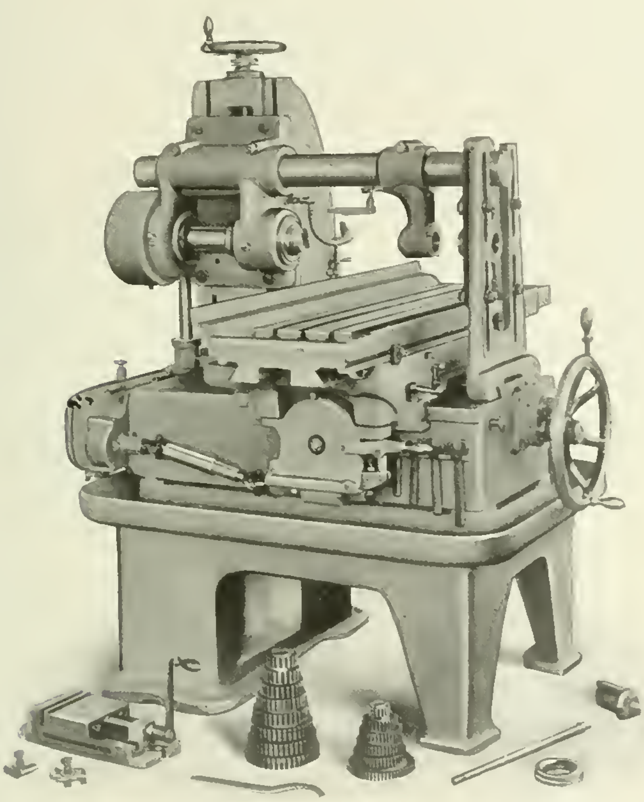


Fig. 1. Brown & Sharpe 34- by 6- by 12-inch Plain Milling Machine

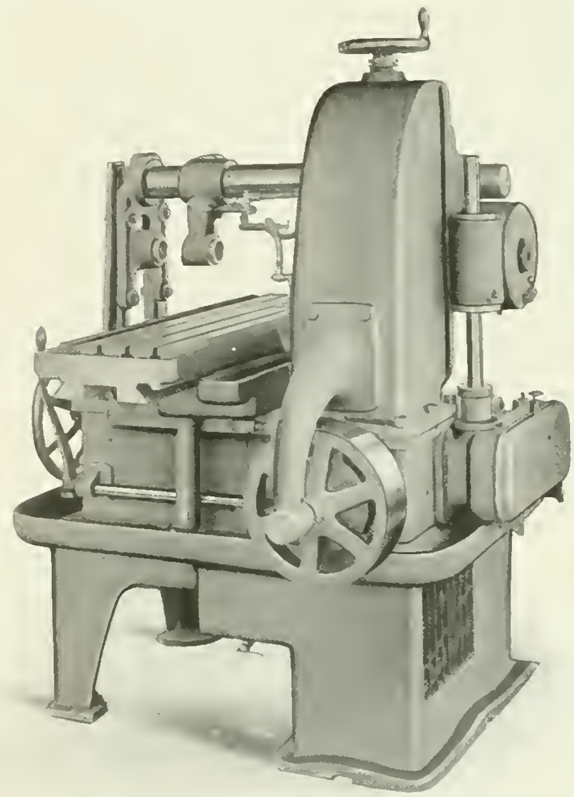


Fig. 2. Showing Constant-speed Driving Pulley and Clutch-controlling Lever

The Spindle Drive

As the machine is of the single-pulley type, the drive may be direct from the main line if so desired. The driving pulley is 14 inches in diameter, 4½ inches wide, and runs at a speed of 300 revolutions per minute, which gives a powerful and efficient drive. A friction clutch is located in the driving pulley and provides means for starting and stopping the machine. This clutch is operated by a vertical lever that is located to the right of the large handwheel. Figs. 4 and 5 illustrate how the drive is transmitted to the spindle. The main driving shaft *A* upon which the constant-speed pulley is mounted, is connected through bevel gearing with the shaft *B* which transmits the movement through the change-gears *C* and *D* to the shaft *G*. This latter shaft, in turn, is connected through bevel gearing with shaft *H* upon which is mounted a hardened steel worm that meshes with the large bronze worm-wheel *J* to which the spindle is keyed. The worm gearing runs in oil and furnishes a smooth and powerful drive. Provision for wear in the worm is made in the following ways: The adjustment of the worm for end thrust is obtained by loosening the screw *a* and tightening nut *b*;

this forces bushing c against the worm which has a ball thrust bearing at its opposite end, as shown. To compensate for backlash between the worm and wheel, the nut d is loosened, which releases the bushing K. As the shaft H is mounted eccentrically in its bearings, the screws e and f are then adjusted until the proper center distance is established between the worm and wheel and backlash is removed.

Table Feeding Mechanism

The method of transmitting the feeding movement to the table is indicated in Figs. 4 and 6, which show, respectively, a sectional view of the change-gear case, and a longitudinal section of the table. The power is transmitted from shaft B through the spur-gears E to the shaft F which is connected through change gears M and N to the shaft L which, in turn, is connected by sliding gear O and gear P (either directly or indirectly, depending upon the direction of the feed) with the universal joint shaft Q. Shaft Q, through the worm gearing shown in Fig. 6, drives the shaft R which transmits the movement to the table through bevel gears and a rack and pinion. A quick return for the table is obtained by means of the large handwheel seen at the front of the machine, after the driving worm W has first been disengaged from its wheel by operating the lever seen at the left of the bed in Fig. 1. By referring to Fig. 7, it will be seen that the large handwheel S controls both the longitudinal and transverse feeds. Normally this handwheel is used to operate the longitudinal feed, and when so used, it is in the position indicated in the illustration. When the operator desires to adjust the table transversely, the

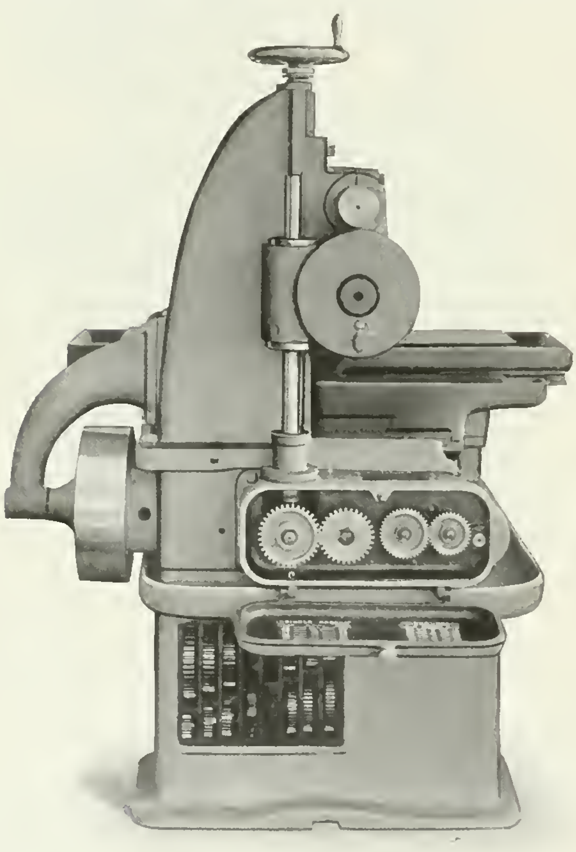


Fig. 3. Rear View showing Change-gear Case and Cabinet Base

handwheel is pushed in against the tension of spring h, thereby disengaging the clutch at T and engaging the spur-gear U with a corresponding gear located on the screw which controls the transverse adjustment. As most of the adjustments are in a longitudinal direction on a machine of this type, the spring h is employed to automatically engage the handwheel with the longitudinal feed as soon as the transverse adjustment has been made. With this construction, an independent handwheel for the transverse feed is avoided, though one wheel has, as the result, a double function; this, however, should not be confusing to the operator, inasmuch as the cross movement is only required occasionally, and the wheel is normally held in the position where it is most used. The longitudinal feed of the table is positive and automatic in either direction, and it can be automatically released at any point.

The mechanism for reversing the table movement is illustrated in Figs. 4 and 8. The gear O, which is the driving member, is free to slide on the shaft L and its position is controlled by the rod V which extends to the front of the machine. To reverse the feed, gear O is moved along by the knob on rod V (which may be seen to the left of the hand-

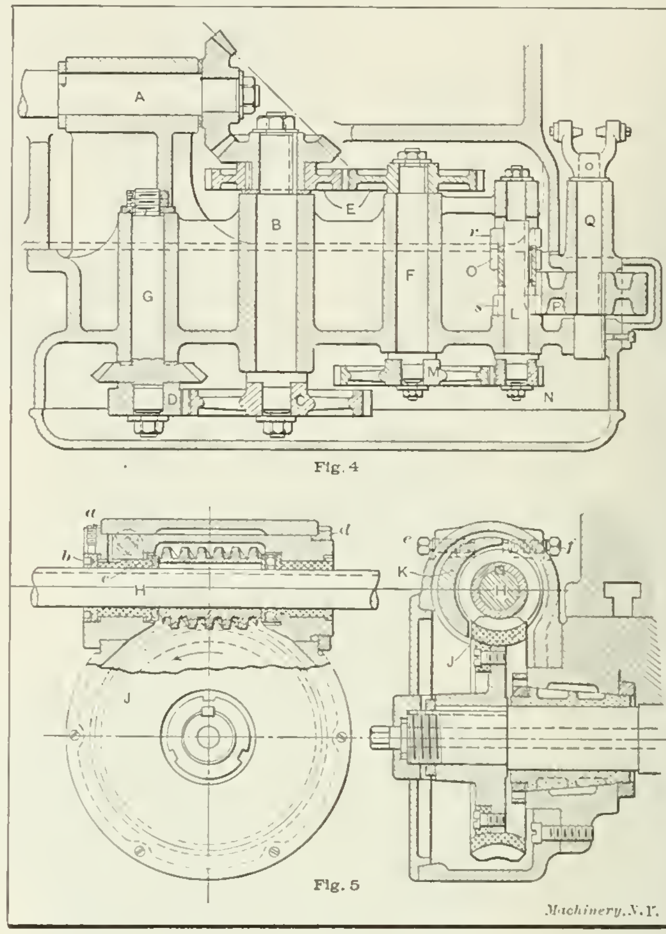


Fig. 4. Sectional View of Speed and Feed Change Mechanism. Fig 5. Worm Gear Drive for Spindle

wheel) until it is in mesh with gear r. Gear s, which is on the same shaft with r transmits the movement to the gear P and shaft Q. For feeding in the opposite direction, gear O is brought into mesh with gear P, thus giving a direct drive.

Speed and Feed Changes

The variations in both spindle speeds and table feeds are obtained by means of change-gears, which, when not in use, are kept in a wooden cabinet in the base of the machine. The tables of speeds and feeds, together with directions for making the changes, are cast in the case cover, which is shown open in Fig. 3. Particular attention has been given in the design to the matter of attaching the change gears for obtaining speed variations, the gears being held in place by clutched hubs and split washers, which enables them to be readily removed without taking off the nuts. Eight changes of spindle speed are available, ranging from 20 to 124 revolutions per minute and varying practically in geometrical progression. There are also eight feed changes ranging from 3/4 inch to 9 inches per minute. These are independent of the spindle speeds and also vary practically in geometrical progression.

Miscellaneous Features

A vertical adjustment is provided for the spindle head, which is operated by the handwheel seen on the top of the upright. This handwheel has a graduated collar reading to thousandths of an inch. The spindle head slides in dovetailed ways and can be rigidly clamped to the upright by the four bolts shown. The overhanging arm is a solid, accurately ground steel bar, which can be pushed back out of the way when not in use. There is an arm support especially designed to secure rigidity, and an arbor support that can be used at

any intermediate point near the cutter. Both of these supports are fitted with bronze bushings which furnish bearings for the arbor. In addition to the graduated collar on the handwheel for the vertical adjustment, there is a dial graduated to thousandths of an inch for indicating the transverse movements of the work table.

The base of this machine is heavily built to insure rigidity and it rests on two legs in front and a cabinet pedestal at the rear. There is an oil pan extending around the base to catch waste oil, which drains into a tank large enough to provide an ample supply of lubricant. A pump is included in the equipment and the channels in both the table and saddle for catching the lubricant have been made extra large, as shown in the different views.

The general specifications of this machine are as follows: Longitudinal feed, 34 inches; transverse feed, 6 inches; vertical adjustment, 12 inches; distance from center of spindle to under side of arm, 5½ inches; maximum distance from end of spindle to arbor bushing with arm support in position, 22½ inches; working surface of the table, 12½ by 40 inches. A flanged vise having jaws of hardened tool steel, 6⅛ inches wide, 1 9/16 inch deep, and a maximum opening of 3⅝ inches, is included in the equipment. The net weight of the machine is about 3800 pounds.

NEWARK AUTOMATIC SPUR GEAR CUTTING MACHINE

An automatic spur-gear cutting machine that is manufactured by the Newark Gear Cutting Machine Company, 66 Union St., Newark, N. J., for heavy spur-gear work, is shown in Figs. 1 and 2. This machine has a capacity for gears up to 84 inches in diameter, 24-inch face, and it will cut teeth having a circular pitch of 6 inches. This is the largest and most powerful machine of the horizontal cutting type made by this company, and a good idea of both the size and general construction can be obtained by reference to the illustrations.

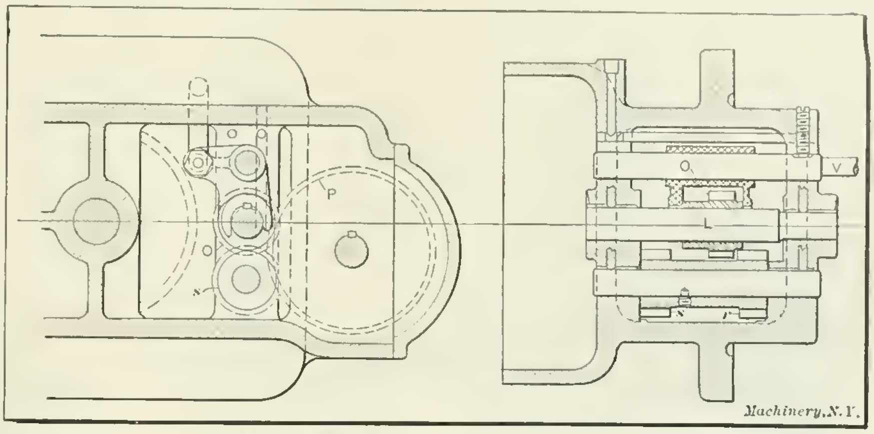


Fig. 8. Detail of the Table-reversing Mechanism

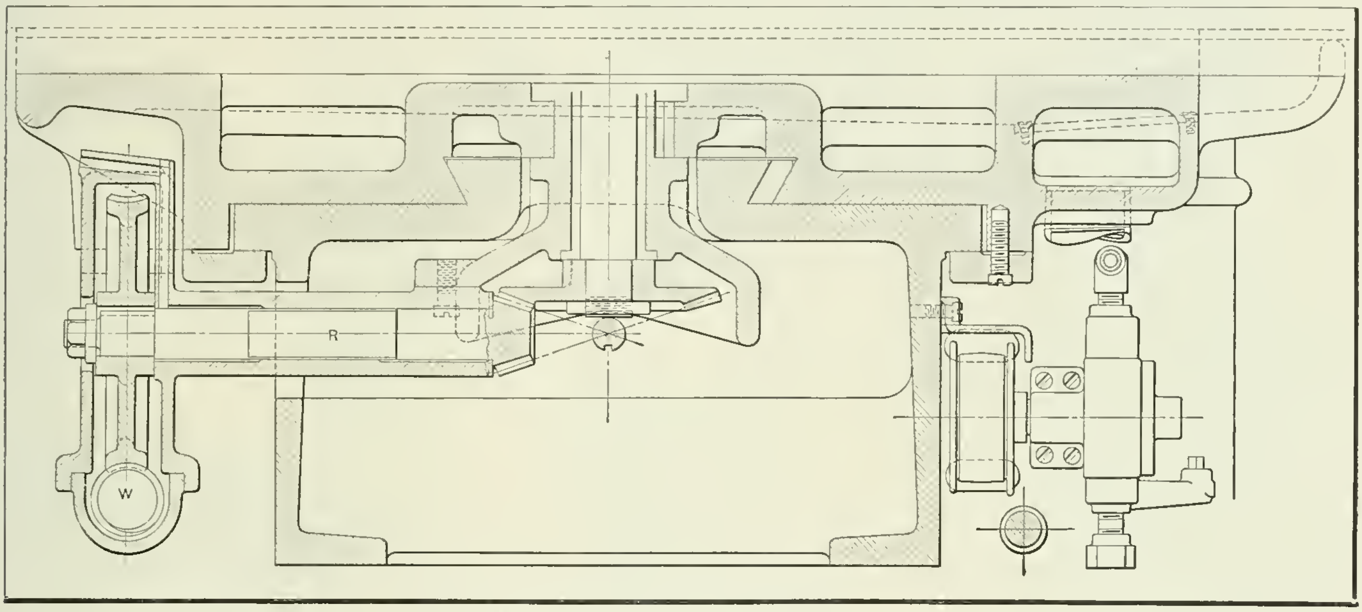


Fig. 6. Longitudinal Section showing Table Drive and Hand Feed

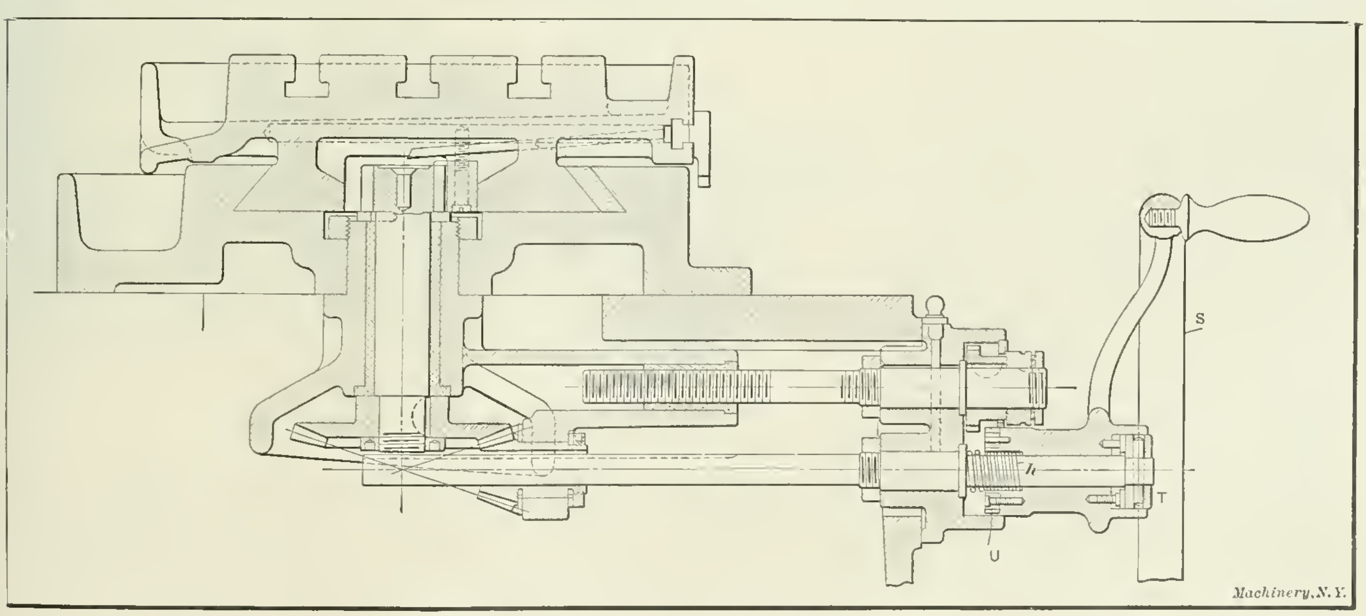


Fig. 7. Transverse Section showing Table Drive and Hand Feed

The machine is driven by a single pulley which runs at a constant speed of 300 revolutions per minute. The cutter spindle, which is a crucible tool steel forging, is provided with a taper hole to receive cutter arbors. The arbor is drawn into and forced out of the spindle by means of a draw-in bolt, positively, without hammering. The spindle and arbor are amply heavy to permit the use of a gang of finishing cutters, or a gang of finishing and roughing cutters side by side on the arbor. The spindle is driven by means of a powerful spur-gear train, and various speed changes are obtained by means of change gears placed as near the last driver as possible. This allows the driving shafts to rotate at constant speed, and avoids undue strains in the shafts when the cutter is running at a slow speed on heavy pitches.

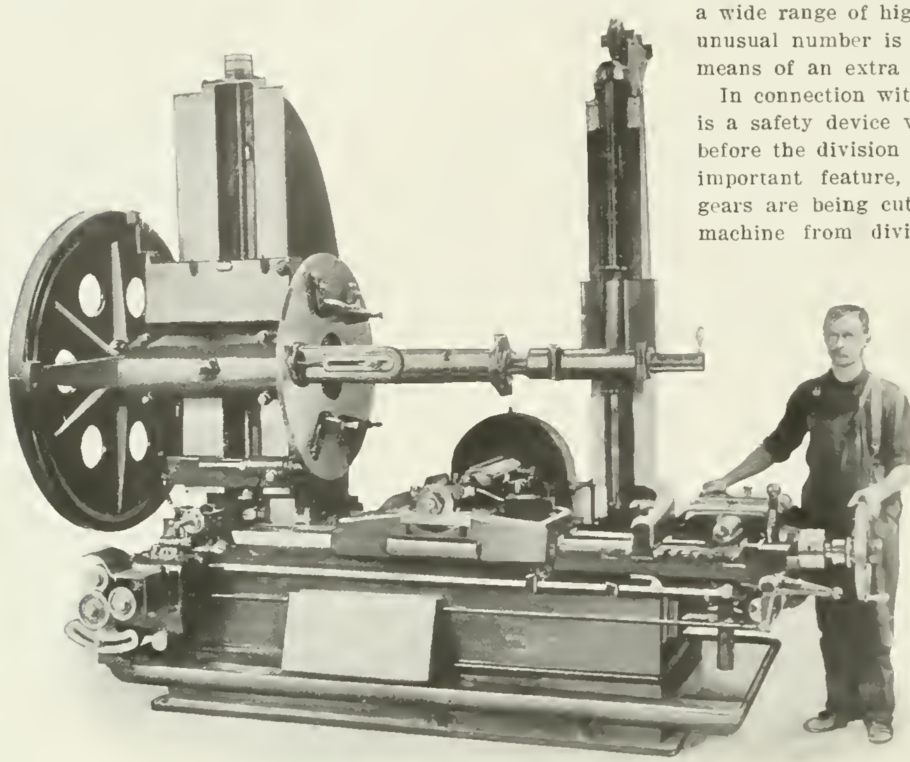


Fig. 1. 84- by 24-inch Automatic Spur-gear Cutting Machine built by the Newark Gear Cutting Machine Co.

The changes in the feed of the cutter carriage, are also obtained by means of change gears; but the rate of the cutter speed and the rate of the carriage feed are independent of each other, so that one may be changed without affecting the other. The carriage quick-return is constant, not being affected by the feed or speed of the cutter. The carriage feed-screw operates on the draw principle, the thrust collars being placed so that the screw is not subjected to compression strains, either when feeding or returning the carriage. This drawing action insures a smooth uniform feed to the carriage, with freedom from vibration. By referring to Fig. 1 it will be seen that the carriage is especially long, and that the cutter spindle bearing is in the center of its length. This construction prevents chattering or vibration, and as the bearings are long, with narrow guides, the action of the carriage is smooth, even when operating under severe duty.

The indexing or dividing mechanism comprises a large master-wheel and a positive actuating mechanism. The master is a worm-wheel that is generated in place on each machine. It is made in sections, there being a wheel proper and a ring, which construction is used to insure accuracy. The master-wheel receives its movement through a positive indexing mechanism which embodies a very simple clutch mechanism, requiring no adjustment. The various divisions for different numbers of teeth are obtained by means of change gears, which provide for cutting all numbers of teeth up to 100, and all numbers from 100 to 450, except prime numbers above 100; a wide range of higher numbers can also be cut. When any unusual number is required to be cut, this can be done by means of an extra change gear.

In connection with the positive indexing mechanism, there is a safety device which prevents the carriage from feeding before the division has been correctly completed. This is an important feature, particularly when large and expensive gears are being cut. A safety mechanism also prevents the machine from dividing when an obstruction on the gear blank, such as a lug or flange, would collide with the rim support and injure the gear or the machine, were it not for the safety device. This mechanism is entirely automatic, and does not require any setting or adjustment, as it operates regardless of the size of the gear or the number of teeth being cut. It also is valuable because of the interlocking feature which prevents the operator from engaging the feed mechanism while the machine is dividing.

The work spindle is of large diameter and is accurately ground. It is provided with a taper hole to receive work arbors, and a draw-in bolt acts to draw the arbor in and force it out, positively. The work head is of massive proportions, and is so gibbed to the head that the alignment is maintained without regard to which clamping bolt is tightened first. The head is provided with a screw and micrometer dial graduated to read to thousandths of an inch. Power mechanism is provided for quick adjustment of the head, either up or down.

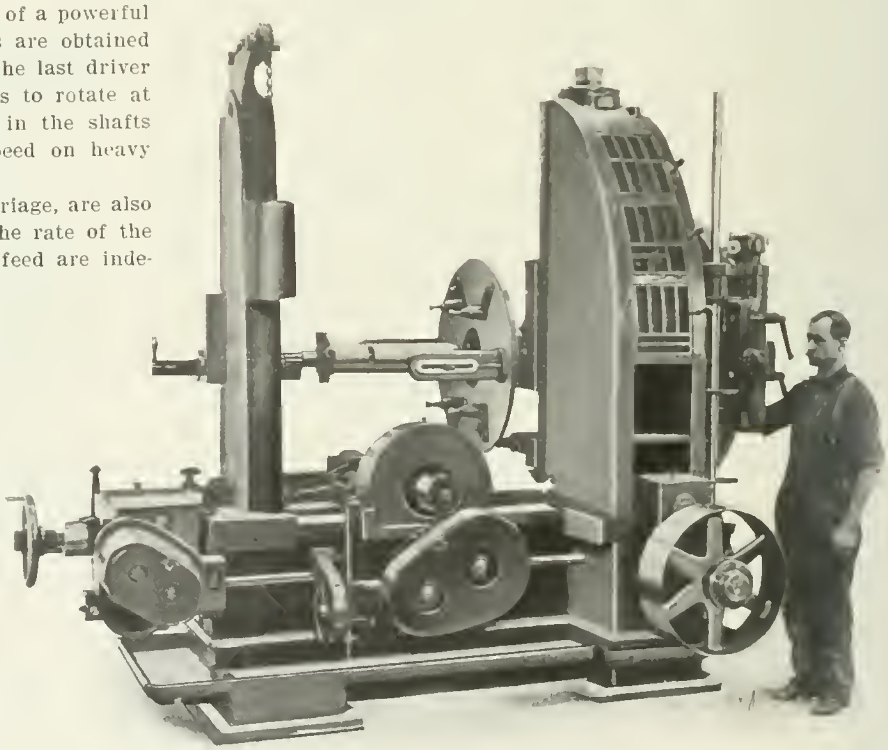


Fig. 2. Rear View of Newark Gear-cutting Machine

In the design of this machine, the convenience of operation has been given special attention. The operating levers are placed on the operating side of the machine, so that they are instantly under the control of the workmen. A conveniently

located lever controls the engagement of the power feed to the cutter carriage, and an index lever is used to trip the indexing mechanism, when setting the machine, or to set the machine to rotate the blank continuously. If desired, the feed can be set so that the carriage will feed and return, without having the blank indexed; this is useful when setting. The carriage handwheel is self disengaging, so that it does not revolve when the power feed is engaged. An oil pump is supplied for furnishing an ample supply of cutting fluid, when cutting steel gears.

W. E. GANG CO.'S RADIAL DRILL

A design of radial drilling machine that is now being manufactured by the Wm. E. Gang Co., of Cincinnati, Ohio, is shown in Fig. 1. This machine has all the modern improvements which are considered essential to accuracy and rapid production, and the design is symmetrical and pleasing in appearance. As the illustration shows, the matter of convenience in the location of the various controlling levers has also received careful attention. Hardened steel gears are used in both the driving and feeding mechanism wherever severe duty is encountered, and all journals are bronze bushed. The splash system of lubrication and direct oiling devices, are used throughout. All gears are encased by housings which are built in the design, retaining the lubricant, excluding the dust, and protecting the workmen from injury. All shafts are supported by bearings at each end, which construction insures durability as well as rigidity, and holds all running parts in alignment.

The base of the machine, which measures 6 feet 3 inches by 28 inches, is deep, heavy, and well ribbed. The arm which has a radius of approximately 4 feet, is also rigid, being heavily webbed and of the D section. This arm is raised and lowered by power, the movement being controlled by the lever seen at the top of the column. The speed box is of the selective type and consists essentially of a cone of six gears running in oil, and a lever carrying a tumbler gear which transmits the power from the constant-speed pulley shaft to the cone of gears. There are twelve changes of speed available, six of which are obtained from the change-gear box, which number is doubled by the back gears located in the head. The speed variations range from 39 to 280 revolutions per minute, and are suitable for drills varying in diameter from ½ inch to 2¾ inches in cast iron, and from ⅜ inch to 2 inches in steel. The correct position of the speed box lever for drills of different sizes, when drilling either cast-iron or steel, is shown by a plate attached to the speed box.

Tight and loose pulleys are provided on the machine, so that it can be driven direct from the line shaft, and the band shifter rings used, permit the belt to be delivered to the pulley at any angle. These pulleys are intended for a 3-inch belt, and the speed is 350 revolutions per minute. The column revolves upon a stationary pedestal which forms practically a double column, there being a bearing both at the top and base. The weight of the column is taken by a roller thrust bearing which gives a free swinging movement, and the column is securely clamped by the slight movement of a lever that lifts it away from the rollers so that they cannot be embedded in their race.

The construction of the head and the location of the various controlling levers is more clearly shown in the enlarged view, Fig. 3. The head is adjusted on the arm by a rack and pinion actuated by handwheel *A*, and it is clamped by lever *B*. The spindle can be quickly advanced and returned by using the lever *C* and it is provided with a reverse motion for tapping that is controlled by lever *G*. The spindle is counterbalanced by a slide or weight *D* which has a rack on one side that engages with a pinion meshing with the spindle rack (as indicated more clearly in Fig. 5) so that the two parts move in unison. The back gears are located in the head between the friction reversing clutch and the spindle, as shown in the sectional view, Fig. 6. When the drive to the spindle is direct, the power is transmitted from the vertical shaft *N* through the gears *A*, *D* and *E*, the clutch *O* which is operated by a small lever at the side of the head being engaged with gear *A*. When the drive is through the back gears, the clutch *O* is engaged with gear *B* which transmits the movement through gears *C*, *D* and *E* to the spindle. The clutch *O* is indexed by a spring plunger that engages suitable holes for either of its two positions.

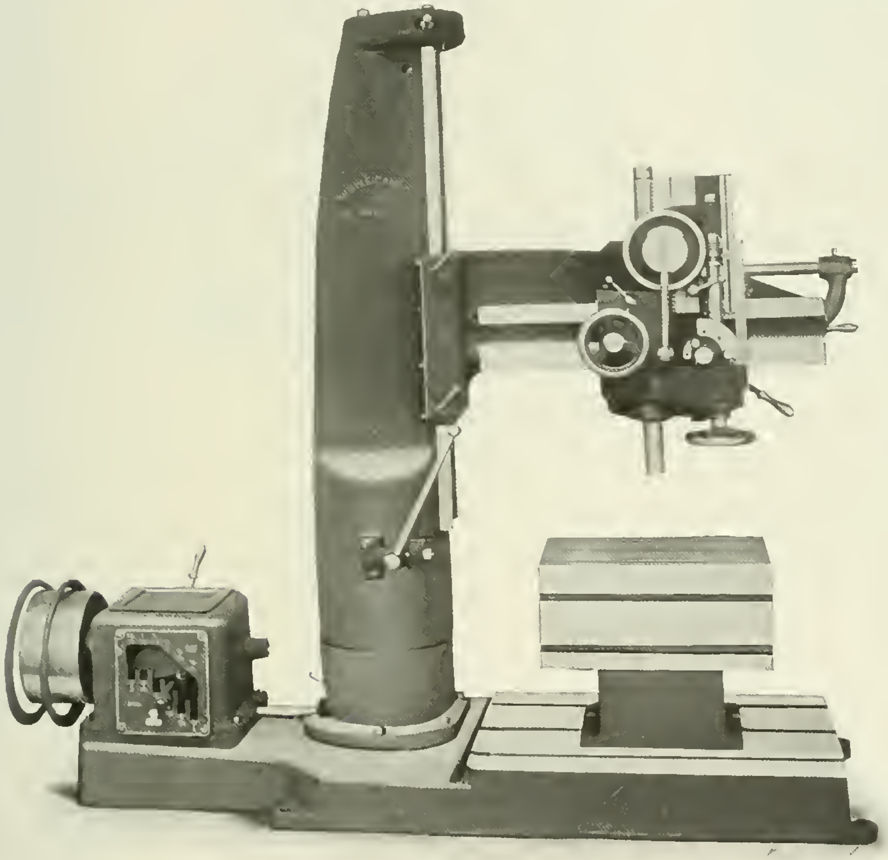


Fig. 1. Radial Drill built by the Wm. E. Gang Co.

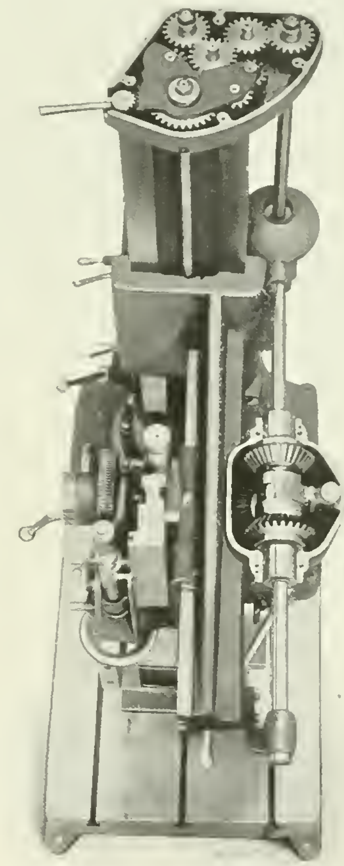


Fig. 2. Plan View of the Gang Radial Drill

The feed-changing mechanism located in the head, provides

variations ranging from 0.007 inch to 0.036 inch per revolution of the spindle. Any of these changes can be instantly obtained by shifting the levers *E* and *F*, Fig. 3. The feed, in thousandths of an inch, obtained for the different positions of these levers, is shown on the index plate, and both levers are positioned by a spring plunger, as the engraving indicates. The way the feeding movement is transmitted from the spindle

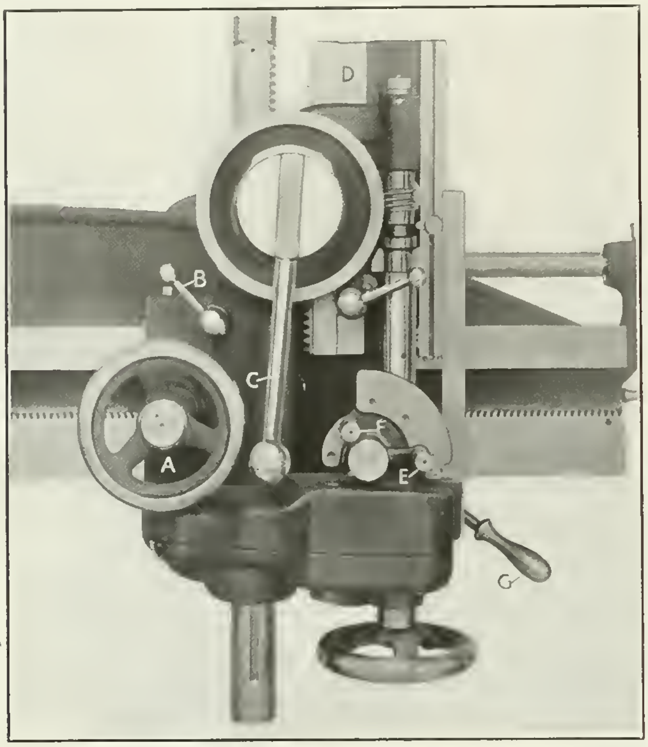


Fig. 3. Enlarged View of Head showing Controlling Levers

to the driving worm shaft, is clearly shown in Figs. 4 and 5. Fig. 4 shows the lower case dropped down, thus exposing the gears and clutches, and Fig. 5 is a diagrammatical section of the head. The same reference letters are used in both these illustrations for corresponding gears, and the order of the

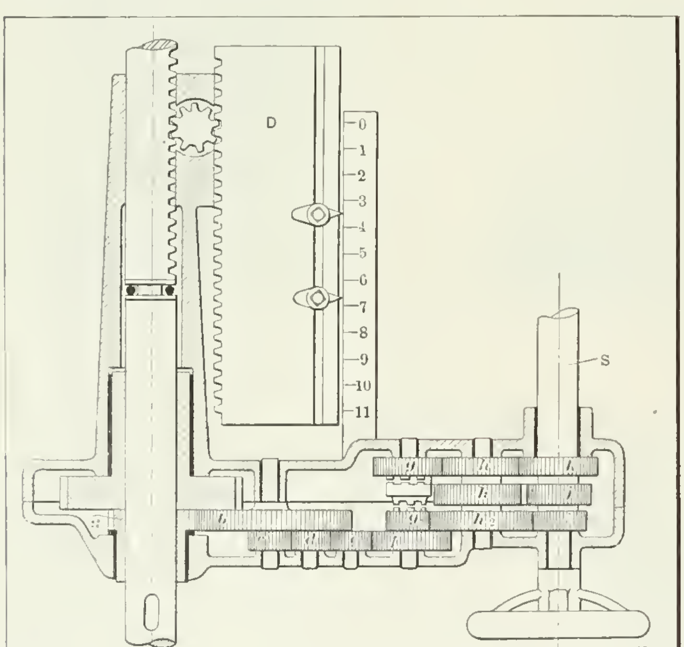


Fig. 5. The Feed-change Mechanism and Spindle Counterbalance

letters indicates the way the power is transmitted. The gear *a* on the spindle, drives, through a train of intermediate gears *b*, *c*, *d*, *e*, and *f*, either gear *g* or g_1, depending upon the position of the clutch between them, which is controlled by the lever *F*, Fig. 3. Either gear *g* or g_1 drives, in turn, a solid cone of gears *h*, h_1 and h_2, meshing with the gears *i*, *j* and *k* that rotate the driving worm shaft *S*. By connecting either of these latter gears with shaft *S*, three feed changes are obtained, which number is doubled by operating the clutch connected with *g* and g_1.

A depth gage is provided on this machine which consists of a graduated scale mounted on the head just to the right of the counterbalance, as shown in Fig. 5. The counterbalance carries an adjustable pointer (or several pointers if desired) which is set to the required depth rather than at zero, so that

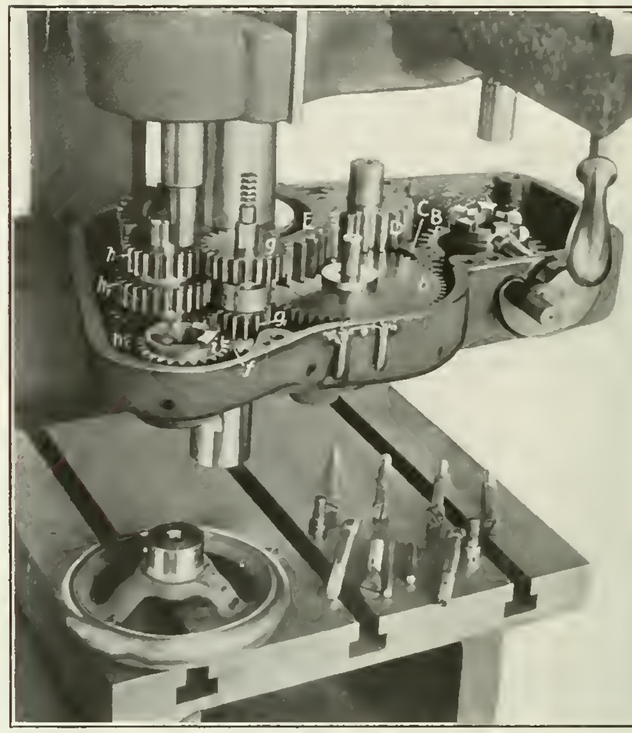


Fig. 4. Case lowered to expose Feed-change and Spindle-driving Gears

the pointer moves upward toward the zero mark as the hole is being drilled. With this arrangement, the workman sets the gage to the depth required before beginning to drill, and the coincidence of the pointer with the zero mark, shows when the depth has been reached. The advantage in having the pointer move *toward* the zero mark is that it is not necessary for the workman to keep in mind what the depth is, as would be

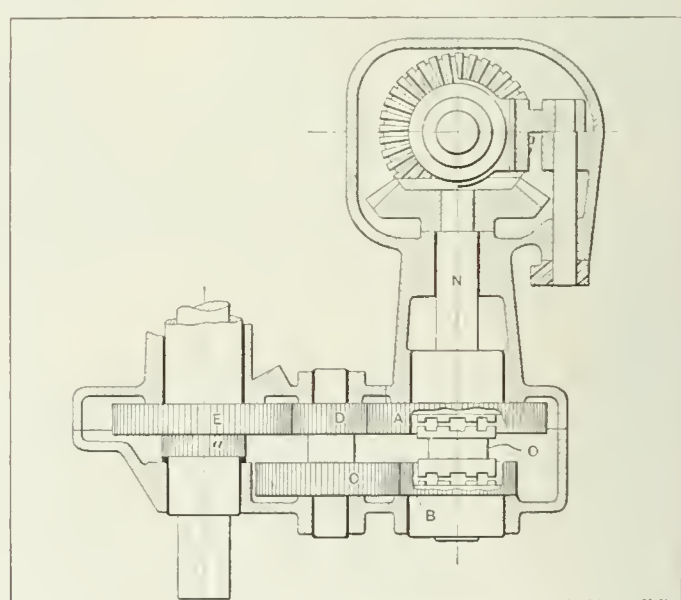


Fig. 6. Transverse Section showing Drive to Spindle and Back Gears

the case if the pointer moved *from* the zero position to the depth graduation. The feeding mechanism is provided with automatic trips which may be set to operate at different depths. These trips do not interfere with the movement of the spindle, which can be adjusted up or down irrespective of their position. Provision is also made for automatically tripping the feed when the spindle reaches the limit of its movement.

By referring to the plan view of the machine, shown in Fig. 2, the position of the spindle reversing gears and their clutch, and the gears for operating the elevating screw, as well as the relative positions of the levers and other parts, may be seen. These machines are equipped with a 16- by 24-inch plain box table, or, if desired, with a tilting table on the base. They are built in 2½-, 3- and 3½-foot sizes. The particular machine illustrated is the 2½-foot size, and it has a net weight of 3600 pounds.

FOX MULTIPLE-SPINDLE DRILLING MACHINE

The Fox Machine Co., 1612 N. Front St., Grand Rapids, Mich., has redesigned its No. 3 multiple-spindle drilling machine, as shown by the accompanying engraving. This machine is intended to handle a class of work of medium weight, requiring neither very light nor very heavy drilling operations, such as automobile engine bases and similar parts. The driving pulleys on this design are located on the base at the rear, as shown, and transmit power to a single pulley at the top of the column which drives the drill spindles through a change gear mechanism. By having the main driving pulley located on the base instead of at the top, the vibration when drilling, is reduced to a minimum. The pulleys are of large diameter and have broad faces, thus insuring ample power. All drill speed changes are obtained through a system of sliding gears,

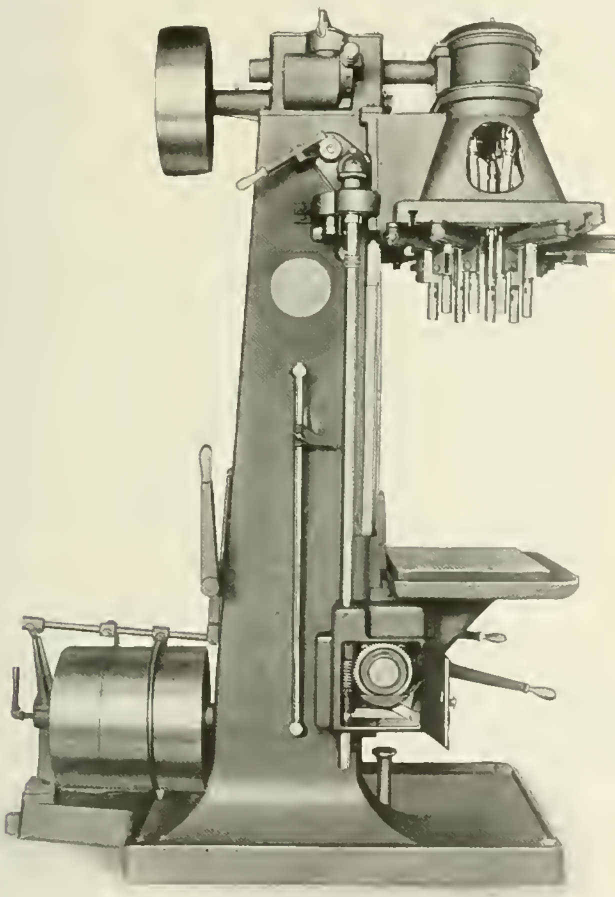


Fig. 1. Fox No. 3 Multiple-spindle Drilling Machine

and the feed changes for the drilling table are effected in the same way. Four changes of drill speeds are available and six changes of drill feeds. The column of this machine has been made extra tall to permit the use of high jigs on the table. The maximum distance from the surface of the table to the under-surface of the head, is 43 inches, and the travel of the table is approximately 30 inches. All the main bearings are of special bronze and are provided with ample means for oiling. The principal gears are of chrome-nickel steel and have broad faces. The gears in the head are encased and run in an oil bath. This machine is equipped with drill spindles and bearings of special construction which allows the drilling of holes having the same center distances as the diameter of the drill spindles. One of these spindles and its adjusting arm is shown in detail in Fig. 2. The universal joints used are the company's own construction. This type of machine can be furnished for drilling holes as follows: Ten ¾-inch holes; eight ⅞-inch holes; fourteen ½-inch holes; sixteen ⅜-inch holes; twenty ¼-inch holes, and twenty-four 3/16-inch holes. These holes can be drilled in either aluminum, cast iron, or steel. The drill table on this machine measures 17 by 22 inches. The drill head can be furnished in either round or rectangular shapes. The machine occupies a floor space of 6 feet by 2½ feet and its overall height is 7 feet 8 inches.

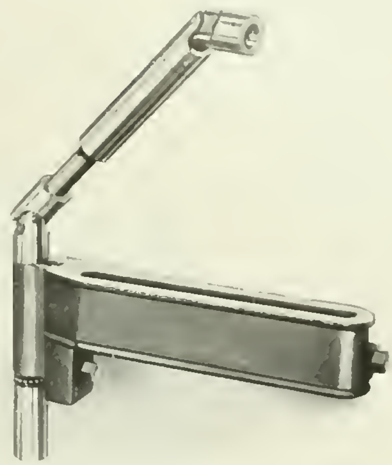
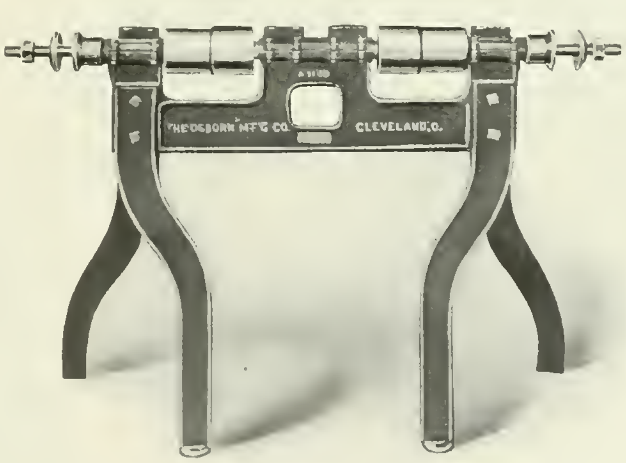


Fig 2. Spindle and Adjusting Arm of the Fox Multiple-spindle Drilling Machine

OSBORN DOUBLE-SPINDLE GRINDING OR POLISHING MACHINE

The grinder or polisher shown in the accompanying engraving, which is a recent product of the Osborn Mfg. Co., of Cleveland, Ohio, is provided with two independently-driven spindles, so that it is practically two machines in one. This feature makes it possible for two operators to work at the machine at the same time without interfering with each other as the independent drive enables one workman to change his wheel, or to stop the machine for any other purpose, while the man on the opposite side continues his work.

This machine is adapted to the polishing and buffing of large work, and it is especially adapted for the work of the stove manufacturer. It is strongly constructed throughout, and the spindles are of steel and ground. The diameter of the spindles in the bearings is 1½ inch, and the length of the bearings, which are babbitted, is 9 inches. The entire length of both spindles is 62 inches, and the distance from the inside of the collars to the extreme ends is 7 inches. The height from the floor to the center of the spindles is 38 inches. Either tight or tight and loose pulleys will be furnished.



Osborn Polishing or Grinding Machine with Independently-driven Spindles

As will be noted by referring to the illustration, the front legs bend inward, which not only gives convenient standing room for the workmen, but also increases the rigidity of the machine as a whole. A floor space of 60 by 32 inches is required for this lathe, and its approximate weight, when packed for shipment, is 300 pounds.

BLISS STRAIGHT-SIDED PRESS OF UNUSUAL PROPORTIONS

A straight-sided single-crank press that is of unusual interest because of its great size has recently been built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. It is the largest press of this type that has been built by this company, and, as far as we know, it is the largest of this type built by any press concern. It shows the continually increasing tendency toward the building of larger and heavier presses for the manufacturing of heavy sheet-metal stampings to replace articles previously made of castings, or for such heavy stampings as were heretofore made by hydraulic presses, the crank press method giving a more uniform production in addition to effecting considerable economy in manufacture.

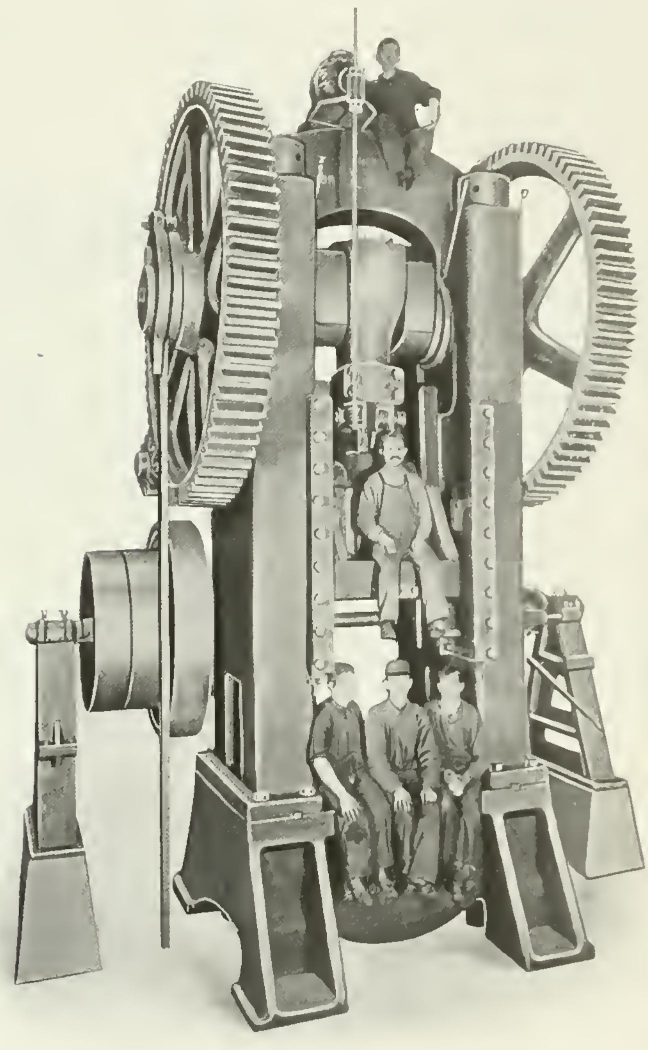


Fig 1. Front View of Large Bliss Press

Fig. 1 shows a front view of the press, which is of the built-up type construction, in which four large vertical tie-rods receive all the strain and relieve the frame columns of the pressure exerted when the press is in operation. The frame columns are of very large cross-sectional area, imparting great rigidity to the entire press. The crankshaft is 16 inches in diameter and weighs 9500 pounds. Power is transmitted to it at both ends which greatly reduces the torsional strain on the shaft and equalizes the pressure on the journals and gears. The slide, which is guided for practically its entire length in the gibs when the tools are doing their work, is, owing to its great size and weight, raised and lowered by a 4 horsepower motor mounted on top of the press, as shown. The power is transmitted from the motor to the worm and the worm-wheel adjustment through a vertical shaft.

Fig. 2 shows the rear of the press and gives a good idea of the gearing. The machine is triple geared and the entire train is made up of cut steel gears and pinions. The large main gears each weigh about 13,000 pounds.

This press is controlled by a hand lever operating a powerful friction clutch of a new type, designed especially for heavy duty. By means of this clutch the machine is always under instant control, and it may be stopped and started at any part of the stroke. Attached to the wheel is a safety coupling, which acts as a safety guard in case the press, through carelessness or otherwise, is subjected to a pressure greatly in excess of that for which it is designed. The total weight of the press is 190,000 pounds.

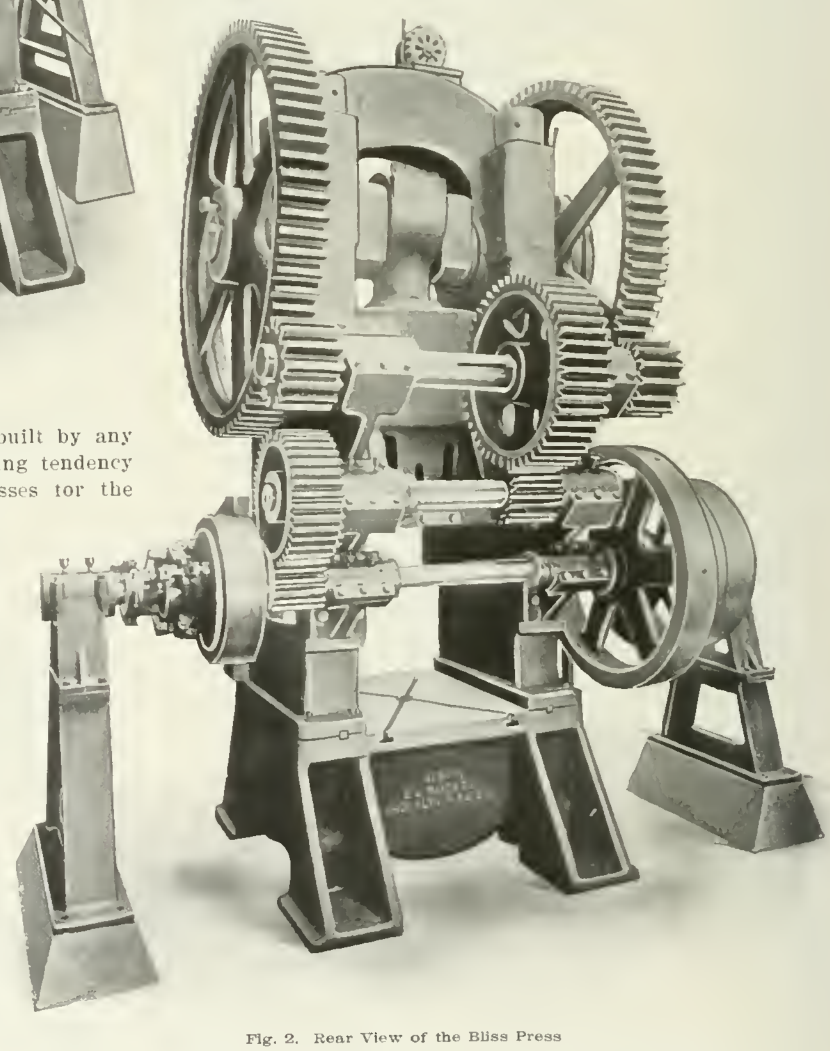


Fig. 2. Rear View of the Bliss Press

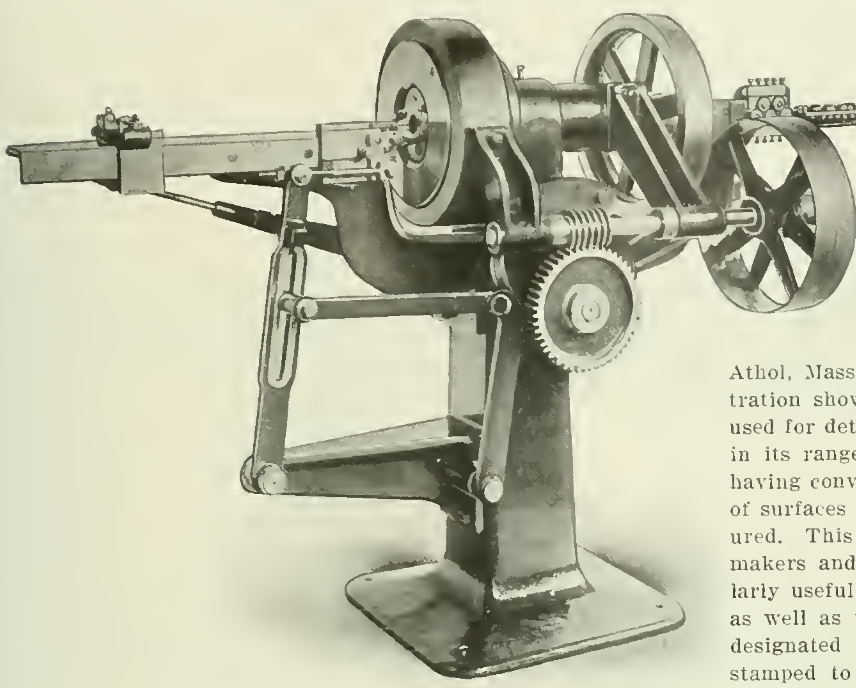
MANVILLE AUTOMATIC SWAGING MACHINE

A swaging machine recently brought out by The Manville Brothers Co., Waterbury, Conn., is shown in the accompanying engraving. This machine has a full automatic feeding and cutting-off mechanism for handling such work as bicycle spokes and similar articles. The swager proper is the same as that found on the well-known rotary machines now on the market, the work being done by a series of rolls mounted in a cage rotating at high speed. The wire enters this machine through the double roll straightener shown to the right, passes through the hollow spindle in the center of the swager, and through the feed grip and cut-off quill at the extreme left where the wires are cut off to the proper length and dropped.

The main swaging spindle is driven by a belt on a heavy pulley fastened to the rear end of the spindle. The other mechanism is driven by the pulley, worm shaft and worm shown, which meshes with a worm-wheel on the main camshaft passing through the pedestal. This shaft carries four cams which operate, respectively, the feed, cut off, binder and die-controlling mechanism.

The feed consists of a short lever with a roll engaging the

large feed cam; a link connecting this lever with the long, slotted lever, shown to the left; and an adjustable link connecting the slotted lever to the feed grip lever, mounted on a slide which travels back and forth on a dovetailed slide way. The length of the swaged portion of the wire is regulated by adjusting the horizontal link in the vertical slotted lever. The length of the unswaged portion depends upon the throw of a



Manville Swaging Machine with Automatic Feeding and Cutting-off Mechanism

cam-piece set into the main feed cam, different pieces being set in for different work.

The cut-off mechanism consists of a forked connection having a roll engaging the cut-off cam, this connection terminating in a threaded rod passing through a swivel on the end of a swinging lever. This lever carries a miter segment meshing with a corresponding one on the horizontal lever shown, which carries the cut-off knife. These short levers, knife, etc., are mounted on a casting which is adjustably clamped on the same dovetailed slide way that carries the feed

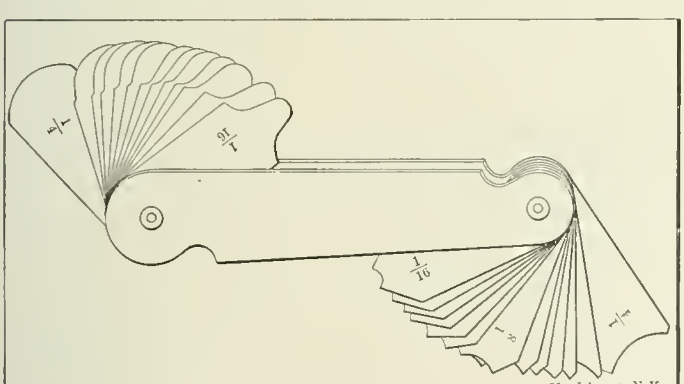


Fig. 1. Starrett Fillet or Radius Gage

slide. It will thus be seen that the bracket and its immediate mechanism, may be adjusted for cutting shorter or longer wires.

The binder which holds the wire in place while the feed grip is returning for another stroke, consists of a lever with a roll engaging the binder cam within the pedestal, and having a set-screw adjustment at its outer end. This screw operates upon a vertical rod, which it forces against the wire at the top of the bracket carrying the straightener.

The die-controlling mechanism consists of a lever at the rear of the machine, which carries a roll, engaging a cam on the main shaft. This lever has a vertical member, carrying a second roll, which operates between the two flanges of a grooved collar adjustably mounted on a hollow spindle extending through the center of the main swaging spindle. On the forward end of this hollow spindle are hinged two wedges which are free to reciprocate between the swaging dies and the backing pieces which take the thrust of the swaging rolls. When the hollow spindle with its wedges is thrust forward, the dies are closed upon the wire and are swaging; when drawn back, the wire is left unswaged and of its full original diameter.

With this machine a great variety of work may be accomplished, with a minimum of labor cost, as the wire can be taken directly from the coil, straightened, swaged, cut to length, and dropped out complete without handling.

STARRETT RADIUS GAGE AND PLIERS

Recent additions to the line of small tools manufactured by the L. S. Starrett Company, Athol, Mass., are shown in Figs. 1 and 2. The first illustration shows a radius gage that, as the name implies, is used for determining the radius of any curved surface within its range. There are two sets of leaves or gages, one having convex and the other concave ends so that the radii of surfaces having either of these formations can be measured. This tool is adapted for the use of machinists, toolmakers and patternmakers, and it will be found particularly useful for laying out special forming tools, dies, etc., as well as for measuring fillets. It is made in two sizes designated as A and B. Size A has 26 leaves that are stamped to indicate the radii which vary by 64ths from 1/16 inch to 1/4 inch. Size B is made with 32 leaves which are also stamped to show the radii which vary by 64ths from 17/64 inch to 1/2 inch.

Fig. 2 shows a pair of pliers which, as the engraving indicates, have a wide range of adjustment. The lower jaw may be moved in or out by turning the knurled worm shown which engages a rack cut on one side of the jaw. The handles are pivoted to each other and move together so that they are

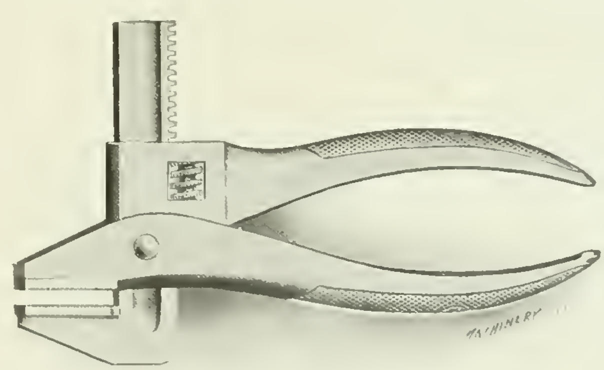


Fig. 2. Starrett Expansion Pliers

always the right distance apart to grip with the hand. The jaws have a capacity for pieces ranging from 0 to 1¼ inch, and they can be adjusted to grip evenly either a straight or taper surface. As the pivoted jaw has a short fulcrum, the pliers have considerable gripping power. They are made from drop forged steel with handles struck up from heavy stock to give ample strength for all requirements.

SCHELLENBACH GEARED HEAD LATHE

The John B. Morris Machine Tool Company, Cincinnati, Ohio, is now manufacturing the design of Schellenbach geared head lathe, shown in Fig. 1, which illustrates the standard 16 inch by 8-foot lathe arranged with what is known as a semi-quick-change gear-box. This gear-box is made to interchange with the quick-change screw-cutting attachment, and either the semi quick-change gear-box or the quick-change screw-cutting attachment may be applied at any time after the lathe leaves the factory, should a change be desired. The semi-quick-change gear-box provides three changes of feed for every

change of gears, and, as will be noted by referring to the illustration, the change-gear quadrant is mounted upon and swings directly from the gear-box, thus permitting this part to be manufactured as an independent unit.

The apron feed is through a splined screw and a steel sliding double bevel pinion. Both cross and longitudinal feeds are driven through frictions and are reversible in the apron. A positive feed is provided which permits of the use of the rack for rough chasing all screw pitches shown in the index, thereby relieving the lead-screw of excessive wear. Means are provided for disengaging the rack pinion from the rack, and there is also an adjustment of the rack pinion to compensate for wear. The eccentric lever at the right end of the apron enables the operator to lock the carriage to the bed for facing. The chasing indicator is located at the right end of the carriage and is made so that its worm-wheel may be swung out of engagement with the threads of the lead-screw when not in use. The apron handwheel, as well as that of the tailstock, is counterbalanced. The steady-rest is arranged to be faced in either direction.

Fig. 2 shows a sectional plan and an end elevation of the geared headstock, and a sectional view of the friction for driving the spindle when the back gears are not used is shown to the extreme right in this illustration. The driving pulley *A* is keyed to a bronze sleeve which bears directly upon the lathe spindle. This bronze sleeve has a hardened nickel steel pinion *B* keyed to it, the outside diameter of which is the same as that of the bronze sleeve referred to. Splined to slide upon this bronze sleeve and pinion *B*, is the hardened nickel steel cone gear *C*, the longitudinal movement of which is controlled by the handle *D* on shaft *E*, sector *F* and sliding fork *G*. The desired longitudinal position of cone gear *C* is determined by the pointer of handle *D* and the index plate located just below it, as shown in Fig. 1. This index plate provides a list of diameters to be turned at various cutting speeds in feet per minute and these diameters correspond, of course, to the various gear combinations of the driving train. The range of speeds and diameters given on this plate is indicated by the table Fig. 3. The four vertical columns of the index plate correspond with the four longitudinal positions of the cone gear *C* which is shown in the illustration at its farthest position to the left, thus exposing the pinion *B* and allowing one of the rocker-gears *H* to be meshed with it. The second and third positions of cone gear *C* to the right bring these cone gears into proper alignment with the rocker-gears *H* the pinions of which mesh with internal gear ring *M*. The fourth or last position of cone gear *C* to the right clutches it positively to sleeve *I* which revolves loosely upon the lathe spin-

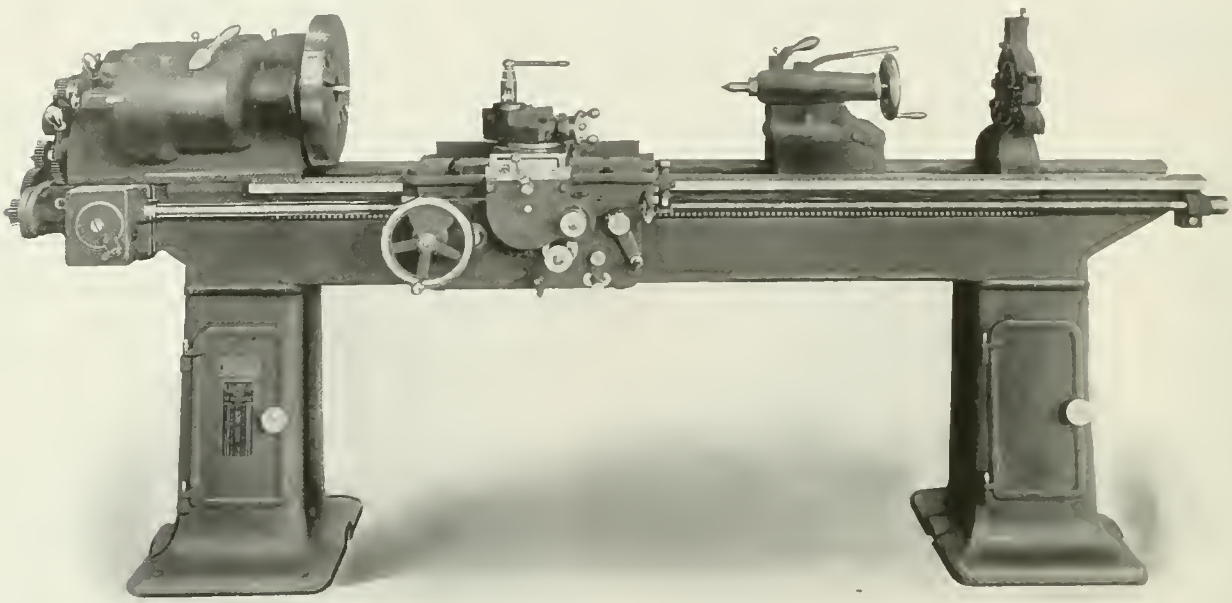


Fig. 1. Latest Design of Schellenbach Geared Head Lathe

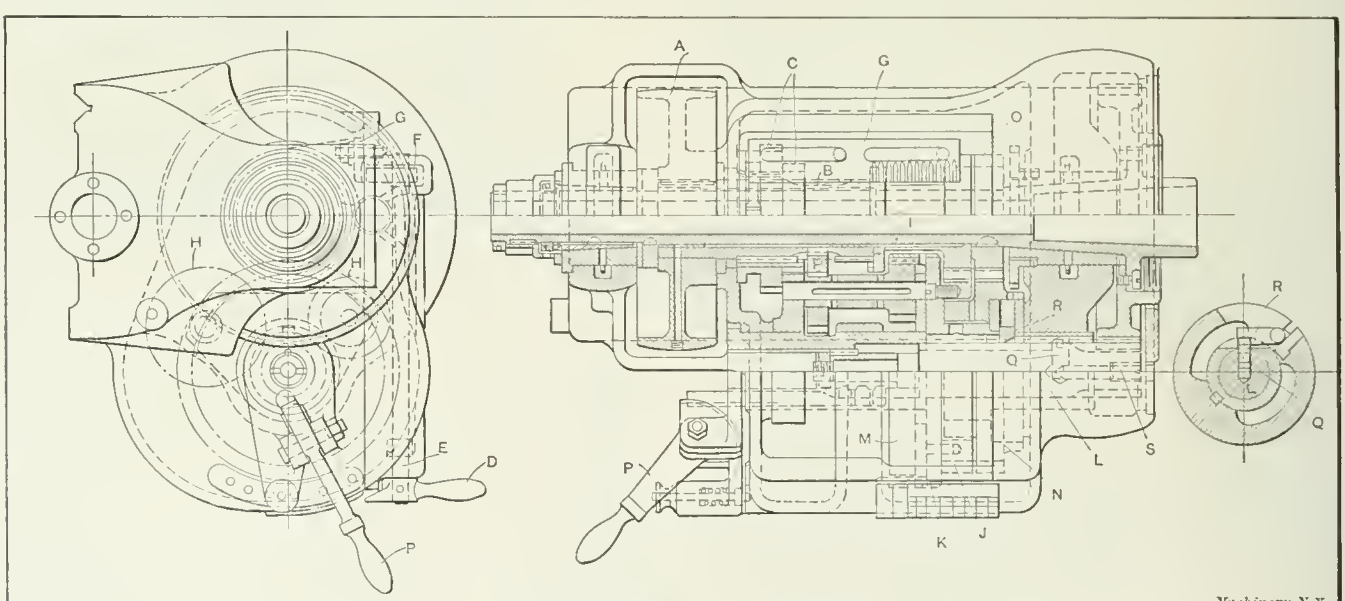


Fig. 2. Mechanism of the Geared Head

dle. The clutch teeth on sleeve I are made to receive the teeth of the small gear of the cone C. Sleeve I has a gear formed upon it and this gear meshes with gear J which is doweled and screwed to flanged casting K. Flange K is splined to main driving pinion L and carries the internal gear ring M previously referred to. Flange K also drives the friction ring shown in section to the right, and this ring locks gear N to gear J by the longitudinal movement of driving pinion L through rack and lever P seen at the left end of the headstock housing. Gear N meshes with gear O which is keyed to the spindle, and it has the same number of teeth as the loosely mounted gear I; thus when cone gear C is clutched to gear I and gears J and N are locked together by the friction ring, the spindle will be driven at its maximum speed which is the driving pulley speed. When the lever P is moved to the left, the friction becomes disengaged and the pinion L slides on and engages the steel face gear mounted on the outside of the front spindle bearing; the drive is then positive. The friction is operated by a dog or plug Q in pinion L, and this plug engages the lever R in the friction. Adjustment of this friction is provided by the screw S which may be adjusted from the front of the headstock.

Cutting Speed in Feet per Min.	Position for Back Gear Lever	The Schellenbach Lathe, Patented Feb. 19, 1907; May 4, 1909							
		Lever	Dia.	Lever	Dia.	Lever	Dia.	Lever	Dia.
30	Left	Down Up	12 $5\frac{1}{4}$	Down Up	9 $4\frac{1}{16}$	Down Up	$6\frac{11}{16}$ $2\frac{15}{16}$	Central	$2\frac{3}{16}$
	Right	Down Up	$1\frac{9}{16}$ $\frac{11}{16}$	Down Up	$1\frac{3}{16}$ $\frac{1}{2}$	Down Up	$\frac{7}{8}$ $\frac{3}{8}$	Central	$\frac{9}{32}$
40	Left	Down Up	$15\frac{15}{16}$ 7	Down Up	$11\frac{13}{16}$ $5\frac{7}{16}$	Down Up	$8\frac{15}{16}$ $3\frac{15}{16}$	Central	$2\frac{15}{16}$
	Right	Down Up	$2\frac{3}{32}$ $\frac{15}{16}$	Down Up	$1\frac{9}{16}$ $\frac{11}{16}$	Down Up	$1\frac{3}{16}$ $\frac{1}{2}$	Central	$\frac{3}{8}$
50	Left	Down Up	20 $8\frac{3}{4}$	Down Up	15 $6\frac{3}{4}$	Down Up	$11\frac{3}{16}$ $4\frac{15}{16}$	Central	$3\frac{5}{8}$
	Right	Down Up	$2\frac{5}{8}$ $1\frac{3}{16}$	Down Up	$1\frac{15}{16}$ $\frac{7}{8}$	Down Up	$1\frac{7}{16}$ $\frac{5}{8}$	Central	$\frac{15}{32}$
60	Left	Down Up	$23\frac{15}{16}$ $10\frac{9}{16}$	Down Up	$17\frac{7}{8}$ $8\frac{1}{8}$	Down Up	$13\frac{3}{8}$ $5\frac{15}{16}$	Central	$4\frac{7}{16}$
	Right	Down Up	$3\frac{1}{8}$ $1\frac{3}{8}$	Down Up	$2\frac{5}{16}$ $1\frac{1}{16}$	Down Up	$1\frac{3}{4}$ $\frac{3}{4}$	Central	$\frac{9}{16}$
70	Left	Down Up	$27\frac{7}{8}$ $12\frac{5}{16}$	Down Up	$20\frac{7}{8}$ $9\frac{1}{2}$	Down Up	$15\frac{5}{8}$ $6\frac{7}{8}$	Central	$5\frac{1}{16}$
	Right	Down Up	$3\frac{5}{8}$ $1\frac{5}{8}$	Down Up	$2\frac{3}{4}$ $1\frac{3}{16}$	Down Up	$2\frac{1}{16}$ $\frac{15}{16}$	Central	$\frac{11}{16}$
80	Left	Down Up	$31\frac{7}{8}$ $14\frac{1}{16}$	Down Up	$23\frac{7}{8}$ $10\frac{13}{16}$	Down Up	$17\frac{7}{8}$ $7\frac{7}{8}$	Central	$5\frac{13}{16}$
	Right	Down Up	$4\frac{3}{16}$ $1\frac{7}{8}$	Down Up	$3\frac{1}{8}$ $1\frac{3}{8}$	Down Up	$2\frac{3}{8}$ $1\frac{1}{16}$	Central	$\frac{3}{4}$

Fig. 3. Diameters of Work and Cutting Speeds given on Headstock Index Plate

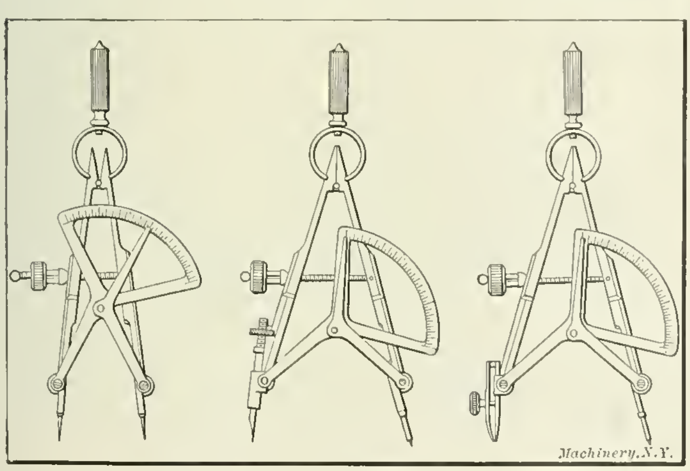


Fig. 1. Bows with Attached Scales

When cone gears C are disengaged from the clutch of gear I, the rocker-gears H may be engaged to the selected gear of the cone. The end elevation shows the two rocker-gears H and the method of mounting them upon the rocker casting. When the drive is through the cone gear C to either of the rocker-gears H, it is transmitted to the spindle either through gears N and O or through pinion L and the face gear. The headstock, as shown, provides fourteen changes of speed, running the driving pulley at a constant speed.

This design permits of an oil bath for the gears, and all of the gears which are thrown in and out of engagement are made of nickel steel and are hardened. All speed changes, whether in back gear or out of back gear, may be made while the machine is running. There are no loose gears and no gears are exposed. When providing this machine with a motor drive, a bracket is mounted upon the headstock and a gear is provided in place of the pulley A. The lathe is also arranged so that the drive may be obtained with a silent chain driven from a motor mounted underneath the headstock. This style of headstock is also applied to the 18- and 20 inch lathes.

"PRESTO-SET" BOWS FOR DRAFTSMEN

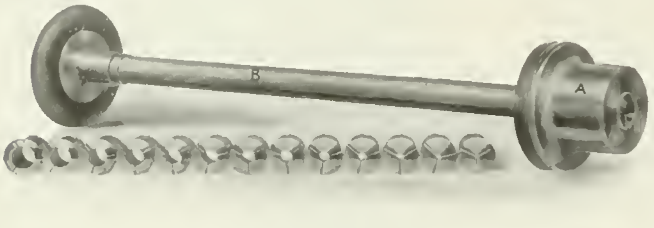
A unique form of draftsman's bow, in the divider, pencil, and pen types, is illustrated in Fig. 1. This bow has a graduated arc or scale attached to it and an indicating point which shows the radius to which the instrument is set. This feature eliminates the inconvenience of using an ordinary scale and effects a considerable saving in time. The scale on the instrument is graduated to read in thirty-seconds of an inch and each instrument is carefully adjusted before leaving the factory. The graduations are larger than actual size and therefore easily read. When making adjustments, no spinning of the nut is necessary, as a shifting and self-clamping type of adjusting nut is provided, so that the instrument can be quickly set to any radius within its range. When making adjustments, the legs are pressed slightly together to release the nut, after which they are opened or closed until the pointer is approximately over the desired graduation. The

Fig. 2. Setting the "Presto-set" Bow

nut is then placed in position with the right hand and turned until the instrument is accurately set as determined by the scale. With a little practice this type of bow can be set with ease and rapidity. It is claimed that these instruments will maintain their accuracy indefinitely, though it is, of course, essential that the lengthwise adjustment of the needle points be not disturbed. The pencil point, which is continually wearing away is provided with a special screw adjustment, as shown, so that it can be lengthened after sharpening. These instruments are furnished either single or in combination of two or three and with or without a case. They are the product of the Eugene Dietzgen Co., Chicago and New York.

LATHE DRAW-IN ATTACHMENT AND SPRING COLLETS

The accompanying half-tone shows a draw-in attachment and spring collets made by The John B. Morris Machine Tool Company, of Cincinnati, Ohio. This attachment may be applied to the lathes built by this company. The set of collets shown are for the 14-inch lathe, and on this particular size the holes in the collets range from ⅛ inch to 1 inch and vary by sixteenths. The bore of chuck *A* fits the nose of the lathe spindle, and the threads on the periphery of the chuck, screw directly into the face gear which is mounted outside of the front spindle bearing. A hardened and ground tool steel ring is forced into a counterbore in the front end of chuck *A* and

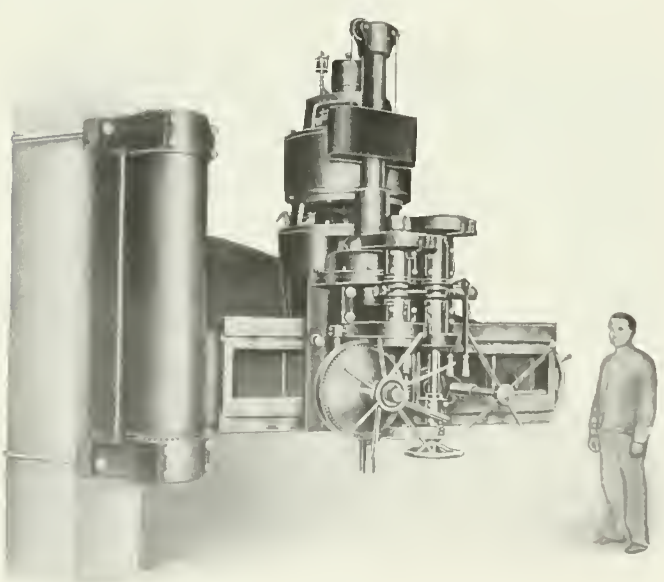


Lathe Draw-in Attachment and Collets

this ring receives the tapers of the collets. The collets are tightened on the stock by the tube *B* which extends through the spindle and has a hard-wood handwheel keyed to it, as shown. The collets are secured from turning by a bushing fitted into the spindle taper, which contains in its bore a key receiving the keyseats of the collets. This device is supplied as an extra attachment and on all sizes of the lathes built by this company. The larger machines, of course, permit the use of larger sizes of collets, than those here shown.

DETRICK & HARVEY HEAVY-DUTY RADIAL DRILL

A powerful radial drill that may be attached to the cross-head of a gantry, or to a heavy building column, as shown in the illustration, has been brought out by the Detrick & Harvey Machine Company, of Baltimore, Md. The spindle of this machine is driven by a vertical type, variable speed motor



Large Radial Drilling Arm that may be attached to a Building Column, etc.

giving spindle speeds ranging from 100 to 400 revolutions per minute. The motor is mounted on the drilling head and it drives the spindle direct through spur-gearing having a ratio of one to four, giving practically the full output of the motor to the spindle. This direct drive has been found economical from the standpoint of power, as it eliminates the multiplicity of gearing and transmission parts found in standard radial drills.

The spindle of this drill is 3½ inches in diameter, and it has a vertical movement of 18 inches that may be effected by hand or power. There are four changes of power feed varying from 0.0076 inch to 0.0625 inch per revolution of the spindle. The radial arm is of box shape construction and it has a vertical face 24¾ inches wide. It is heavily braced to a cylindrical vertical portion which rests upon a ball-bearing seat in a pivot bracket. The vertical bearings provided at the top and bottom are equipped with roller bearings. The minimum and maximum radial drilling capacities of this machine are, respectively, 2 feet 6 inches and 6 feet 6 inches, though this capacity can be increased if desired. The weight of this drill complete with the motor as illustrated, is 16,000 pounds.

BRISTOL'S COMPENSATED RECORDING THERMOMETER

The recording thermometers manufactured by the Bristol Co., of Waterbury, Conn., have been constructed in various different forms, depending for their operation on the expansion of a liquid, the expansion of the vapor of a liquid, or the expansion of a gas. These thermometers have been used extensively for ranges of thermometers up to 800 degrees F., but the models equipped with flexible connecting tubes between the sensitive bulb and recording instrument and depending for their operation on the expansion of a vapor or a gas, have not, until recently, been adapted for recording the lower ranges of temperatures.

A new compensated gas-filled recording thermometer, has recently been developed by the Bristol Co., for recording comparatively low temperatures, such as the temperature of the atmosphere, of water, or of brine in refrigeration systems, etc. The important new feature of this thermometer is the patented compensating attachment with which it is equipped, that automatically corrects any changes of temperature in the recording instrument. A sensitive bulb is placed in the element the temperature of which is to be measured, and this bulb is connected with the pressure tube of the instrument by a flexible capillary tube, as shown in Fig. 1, which is a view of the instrument with the case removed to show the interior mechanism. The sensitive bulb, the flexible connecting tube, and the spiral pressure tube are all filled with an inert gas under pressure. The changes of temperature in the element surrounding the sensitive bulb cause corresponding changes in the pressure of the confined gas, and these pressure changes are measured and recorded by the instrument. The sensitive bulb is ordinarily about 10 inches long and ¾ inch in diameter, and the volume of gas contained in it is very large in proportion to the volume contained in the fine capillary tube connecting the bulb and the recording instrument, so that the error due to changes along the connecting tube are negligible.

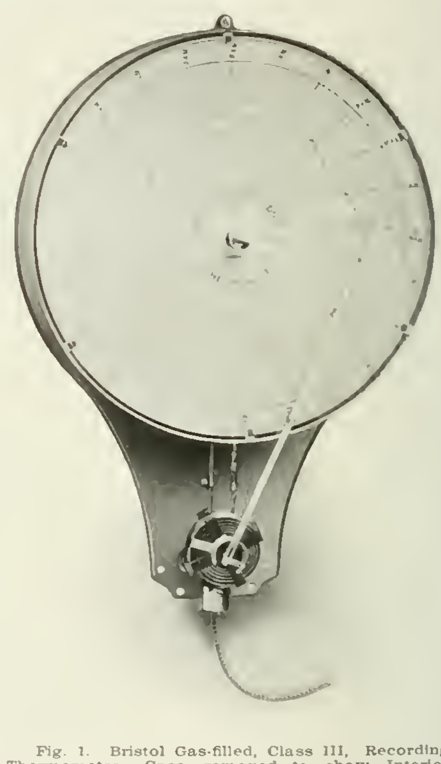


Fig. 1. Bristol Gas-filled, Class III, Recording Thermometer — Case removed to show Interior Mechanism

It has long been recognized that an air or gas thermometer is the ideal type for measuring low temperatures, provided such an instrument can be used in the laboratory where it is

possible to make the various corrections. It is in this connection that the value of the compensating attachment for the spiral pressure tube, with which this new instrument is equipped, is apparent as it causes the same readings or records when the temperature at the recording instrument changes as it would if the temperature at the instrument remained constant. The need for such a compensator can be illustrated by considering the application of a thermometer of this type, for recording the temperature of brine in a refrigeration system. The temperature of the atmosphere at the point where the recording instrument was installed might, of course, change, although the temperature of the brine at the point where the sensitive bulb was installed might remain constant; in such a case, the thermometer, inasmuch as it is used

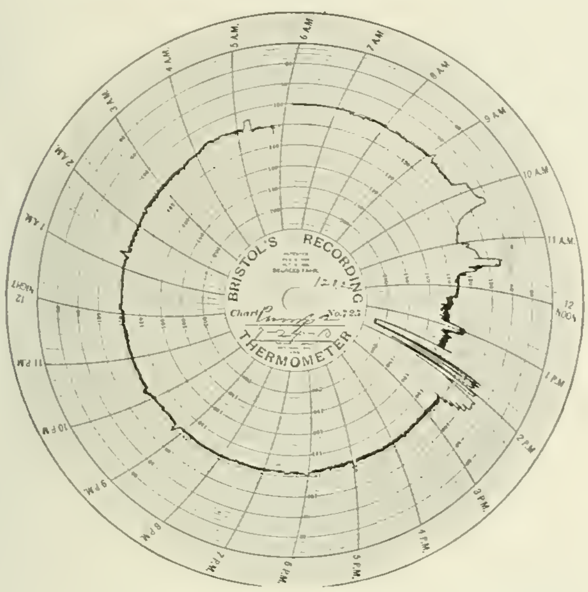


Fig. 2. Chart giving Record of Condenser Water Temperatures

to record brine temperatures should be so constructed that it would be effected only by the temperature changes at the sensitive bulb.

Fig. 2 shows a record of condenser water temperatures as recorded by one of these thermometers on a chart having a range of from 40 to 220 degrees Fahrenheit. It will be noted that this chart has a reversed scale of uniform graduations, the temperature increasing toward the center. For condenser water temperatures, the reversed scale is a desirable feature, as the average temperature is usually lower than 125 degrees, whereas the temperature is likely to reach the boiling point occasionally when the vacuum in the condenser is lost, as shown by the record made between 1:30 and 1:45 P. M. on the chart illustrated.

WORM SWIVELING TABLE FOR MORRIS RADIAL DRILL

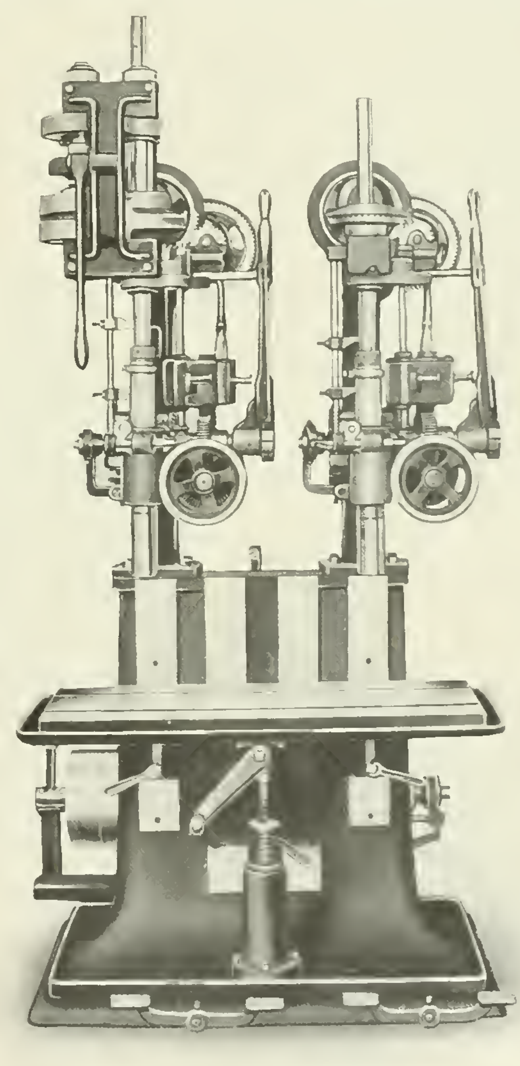
A worm swiveling table that is supplied as an attachment to the line of plain radial drills manufactured by the John B.

Swiveling Table Attachment for Morris Radial Drills

Morris Machine Tool Company of Cincinnati, Ohio, is shown in the accompanying engraving. The upper lug of the forked-shaped casting *A* is bored to fit onto, and is supported by, the lower end of the column of the radial drill. The lower end of *A* is supported on the plug *B* which is doweled and bolted to the base of the machine in correct alignment with the column. That portion of casting *A* which bears upon the column of the radial and on plug *B*, is made in halves and is bolted together and the stud and lever *D* clamp *A* from swinging with the column. The box table *E* swivels upon *A* and is adjusted by a worm formed upon *F*, which worm engages a worm-wheel secured to the box table. A circular portion of the table is graduated from both sides of zero to 90 degrees. This swiveling table has a V planed in one side for convenience in clamping cylindrical work, and the top of the table is bored in the center to receive a circular revolving table when this is required. The swiveling table may be securely locked, after being set, by the clamp-handle shown to the right. The stand *H* bears upon the base of the machine and prevents the outer end of the table from deflecting when heavy strains are imposed upon it. This table is furnished with the 2½-, 3-, and 3½-foot radial drills manufactured by this company.

SUPERIOR 22½-INCH AUTOMATIC HIGH-SPEED DRILL

An interesting development in drilling machinery is illustrated herewith. This machine, which is a 22½-inch size and fully automatic in its operation, is a recent addition to the



Automatic High-speed Drilling Machine, built by the Superior Machine Tool Co.

line of upright drills manufactured by the Superior Machine Tool Co., Kokomo, Indiana. It is designed to handle high-speed steel drills and it has a tapping capacity for machine or pipe taps up to 1½ inch.

As the illustration shows, the left-hand spindle is equipped with a tapping attachment. The machine can be set to drill

to any depth up to 8 inches, and by means of adjustable dogs, the spindle can be automatically tripped at any predetermined point, after which it backs out and goes forward again in about one-tenth of a second; in other words it takes about that long for the spindle to come out, return to its original position, and start downward. By adjusting a set-screw in the trip lever, the spindle can be made to feed downward, automatically trip itself, and run back to its upper position and stop; it may then be started downward by the throwing of a lever that is operated from the front of the machine.

This drilling machine has positive geared feeds, and all gears are heat treated and ground. The spindles have ball thrust bearings and the sleeves are graduated. The table, which is of the knee type construction, is heavy and rigid. It is raised and lowered with a telescoping screw, and it has a working surface of 40 by 17 inches. The machine can be started or stopped by a shifter lever, or each spindle can be controlled independently by the two foot pedals shown in the front of the base. All operating levers are so positioned that they may be controlled without the workman changing his position. The face width and diameter of the tight and loose pulleys is 4¼ by 10 inches, and the three-stepped cone pulleys are designed for a 3-inch belt. This machine is built in several different styles, having from one to four spindles. Either the wheel-and-lever plain type with or without back gears, or a wheel-and-lever, back geared, power-fed machine with automatic stops, can be provided.

DETRICK & HARVEY HEAVY-DUTY PLANER

The Detrick & Harvey Machine Company of Baltimore, Md., has added to its line of planers the design of heavy-duty forge planer shown in Fig. 1. This machine is of the beltless type, it being driven by a 50 horsepower motor which transmits the power through a Wheeling Mold & Foundry Co. induction clutch reversing drive. By means of this drive, cutting speeds ranging from 35 to 50 feet per minute, and return speeds varying from 65 to 100 feet per minute are obtained. Provision is also made for changing the cutting and return speeds quickly and independently of each other.

This planer, while a 48-inch pattern, has a maximum capacity for work 50 inches wide and 48 inches high. The table, which has one flat and one V way, is 43 inches wide and 12 inches deep over the ways. The bed is 22 inches deep, and it has three vertical webs of metal which insure rigidity. The housings, which are secured at the top by a tie-piece extending from the front to the rear, are of rectangular box shape and have faces 16¼ inches wide. The cheeks for the housings have a vertical depth of 32 inches and are 55 inches long. The cross-rail, which is raised and lowered by an independent motor, has a vertical face of 19 inches and a depth of 20 inches between the housings. The tool-heads are of extra heavy pattern and have steel aprons and holders. All gearing is of steel, cut from the solid, except the driving worm (the Sellers drive being employed) which is made of phosphor bronze. This driving worm has six teeth in engagement with the table rack, which has a 9-inch face and is cut from solid forged bars.

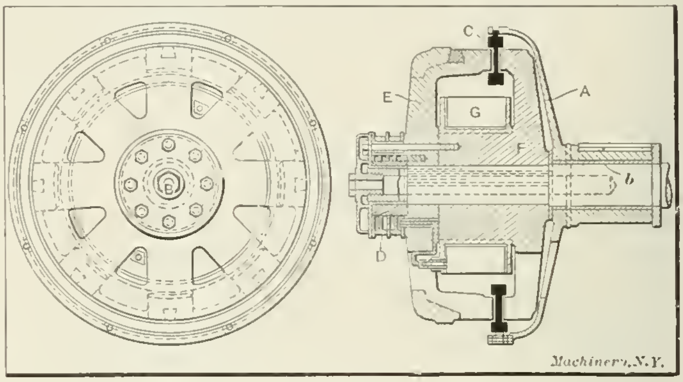


Fig. 2. Induction Clutch which operates on the Principle of the Induction Motor

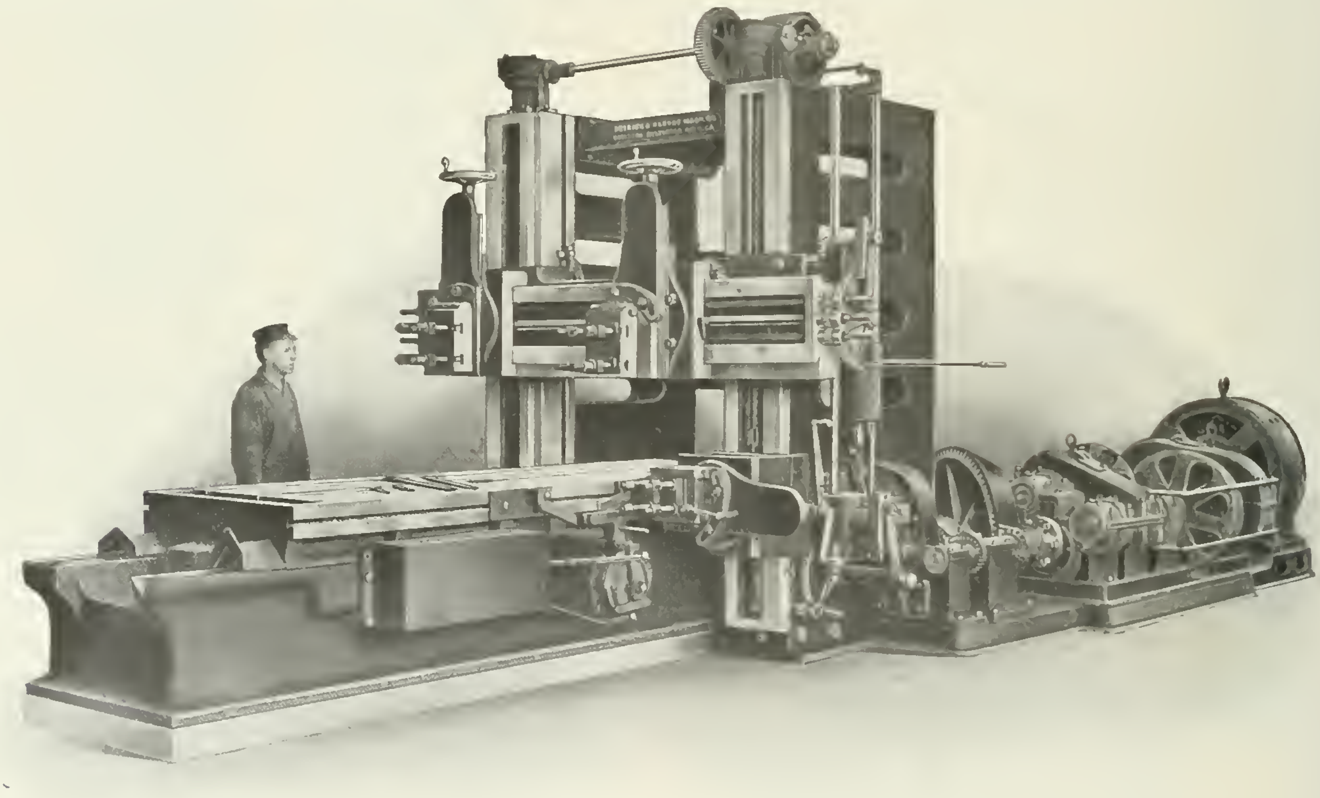


Fig. 1. Detrick & Harvey Heavy-duty Planer with Induction Clutch Drive

In Fig. 2 a section of one of the induction clutches is shown, for the benefit for those not familiar with this type of drive. This clutch, in its operation, is similar to an induction motor. The copper ring *C* is the driven member and it is held by a spider *A*, the hub of which contains the bushing *b*. This spider runs loose on the shaft and its hub carries a pinion through which power is transmitted. All the other parts shown belong to the driving member which is keyed to the continuously-running motor shaft. This driving member, which acts also as a flywheel, consists of the two-part steel casting *E* and *F*, the coil *G* and the collector rings *D*. The

copper ring C has running clearance between castings E and F, and since it is non-magnetic, it has no tendency to be drawn over towards the poles on either side. This ring has, however, a high conductivity and because of this fact and its position with relation to the revolving magnetic driving member, it is pulled along by this driving member on the same principle as that of the induction motor. Two of these clutches are employed, one for the cutting and the other for the return stroke, and a switch worked by dogs admits a small current to one clutch on the cutting stroke and to the other clutch on the return stroke. It will be seen that the induction clutch transmits power without contact between its driving and driven members.

The weight of this planer, exclusive of the motor and induction drive, is 53,000 pounds, and some of the weights of the principal parts are as follows: Table, 9100 pounds; bed, 14,500 pounds; each housing, 9300 pounds; cross-rail, 3800 pounds; each cross-rail head, 1400 pounds; each side head, 1300 pounds.

This planer can also be furnished for a belt drive direct from the line-shaft or, if desired, it can be driven by a belt-connected motor.

MOLINE SPECIAL DUPLEX DRILLING MACHINE

The duplex drilling machine shown in the accompanying halftones is intended, principally, for drilling pipe and also

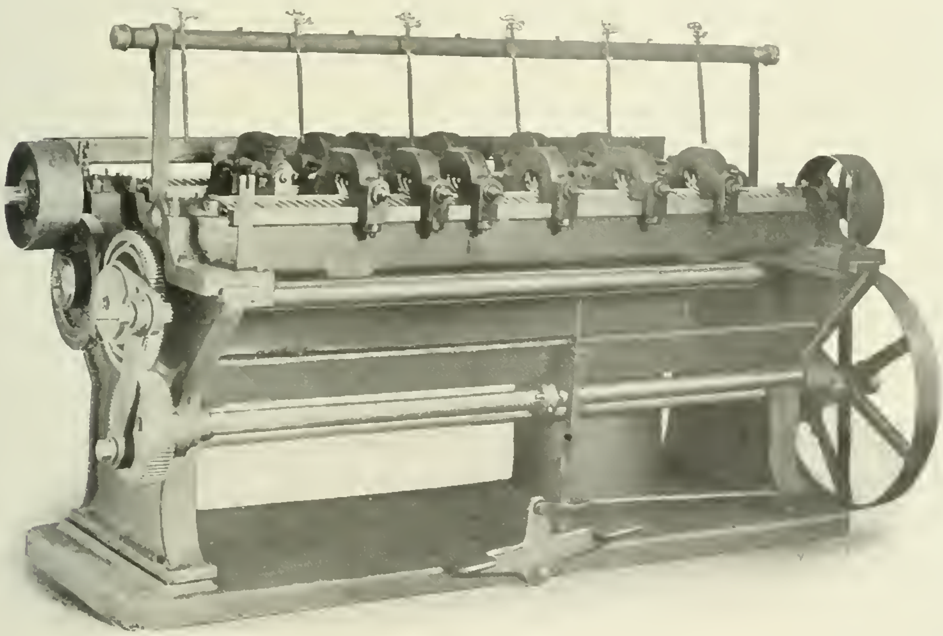


Fig. 1. Multiple-spindle Duplex Pipe and Bar Drilling Machine, built by the Moline Tool Co.

for bar drilling when the holes are so closely spaced that they cannot be drilled at one setting. When drilling pipes with a machine of the ordinary type, there are several difficulties: One is the time lost when the drill is passing from one wall of the pipe to the other; another is the breakage of drills, caused either by fins or burrs or the striking of the drill against the further wall; and the large burr made when the drill comes through, has also been an undesirable feature. In addition, it has been impossible to use short drills owing to the lengths required when the drill had to pass through both the guide bushing and the pipe.

With this new duplex type of machine, which is a recent design built by the Moline Tool Company, Moline, Ill., these difficulties have been overcome. As the illustrations indicate, the pipe is drilled from each side, thus eliminating the time required for feeding the drill through the hole of the pipe, and the burrs are all on the inside where they are not, as a rule, objectionable. The breakage of drills is prevented in two ways: The drill does not go through and strike the opposite wall of the pipe where practically all breakage occurs, and, in

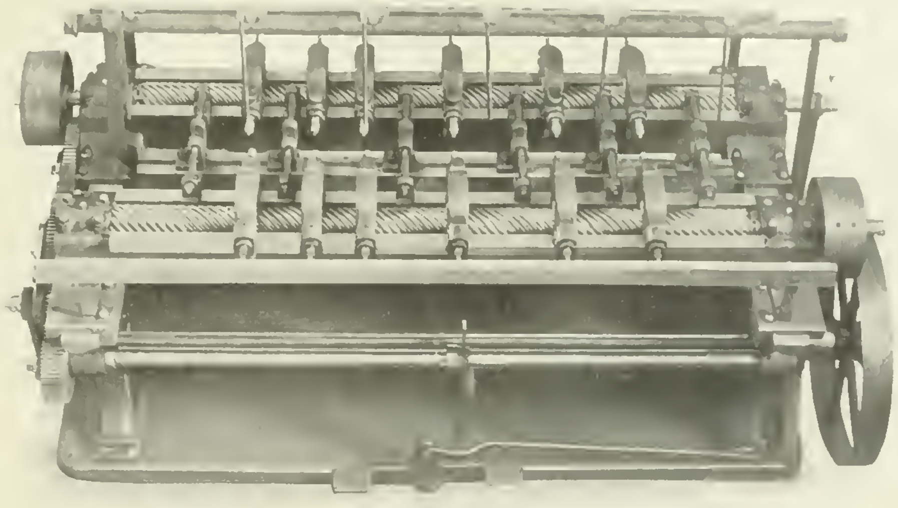


Fig. 2. Front and Top View of the Duplex Drilling Machine

addition, a hollow spindle, a special chuck, and a straight grooved drill are used, the latter projecting beyond the chuck just far enough to pierce one of the pipe walls. The drill is positively driven by the jaws of the chuck and it is kept from slipping by a threaded rod shown in Fig. 3. By supporting the drill close to the point, drill bushings or guides are not needed and special jigs, bushings, etc., for different sizes of drills are unnecessary.

The pipe is held in adjustable V-blocks and it is clamped by plunger-rods which are connected to the rails. These blocks and plunger-rods may be readily removed, if it is desired to use any other type of jig. The heads are adjustable anywhere along the rails and they have the spiral drive regularly employed by this company. The spindles have ball-thrust bearings, and means are provided to compensate for wear. The feed is obtained by causing the rails to approach and recede from each other, and, under ordinary circumstances, this movement should be continuous, the number of strokes being so timed that the operator can remove and replace the work while the plungers which hold it are withdrawn. An automatic stop is provided, however, which will disengage the feed at the back end of the stroke. The feed can be thrown in or out at any point by the double-ended foot treadle shown.

This machine is furnished complete with a pump, tank and piping, and requires practically no special appliances for any work within its capacity. It is built in several sizes, capable of driving drills from 3/16 inch up, and any number of heads are provided.

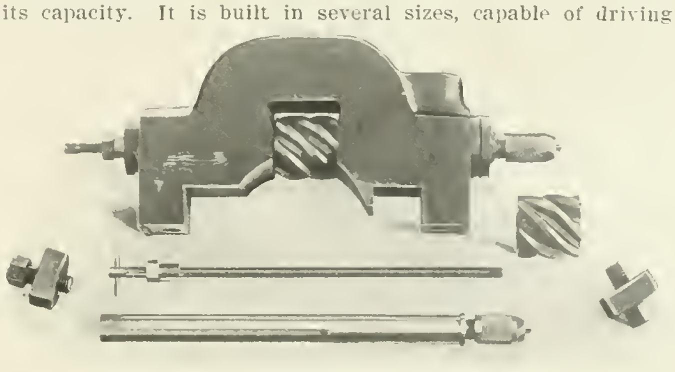


Fig. 3 Spindle Head and Details

TURRET AND TURRET SLIDE FOR MORRIS LATHES

A turret that can be applied to the carriage of the engine lathes built by The John B. Morris Machine Tool Company, Cincinnati, Ohio, is shown in Fig. 1, and in Fig. 2 a turret slide is illustrated which is also applicable to the various sizes of lathes built by this company.

The turret, Fig. 1, is made interchangeable with the compound rest and it contains a bronze nut that engages the cross-feed screw of the carriage. A bracket is provided which can be bolted to the back of the carriage and this bracket has an adjustable stop-screw that serves as a positive stop for the turret. The locking-pin, which is of tool steel, is controlled by the lever *A* and this pin engages a hardened tool-steel

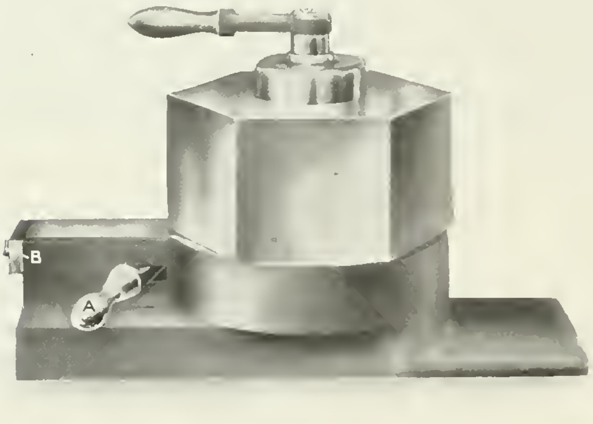


Fig. 1. Turret for Carriage of Lathes built by the John B. Morris Machine Tool Co.

indexing ring. The wear of the locking pin is taken up by a taper gib that is adjusted by screw *B*. The flats on the turret, which is hexagon in shape, measure 9 by 5 inches and holes up to 2¼ inches in diameter may be bored.

The turret and slide shown in Fig. 2 is without power feed, the movement of the slide being by hand through a pilot shaft and pinion in the ordinary manner. The hexagon turret itself is revolved and locked automatically or by hand, as desired. Provision is made for disengaging the devices for automatically revolving the turret, when it is to be operated by hand.

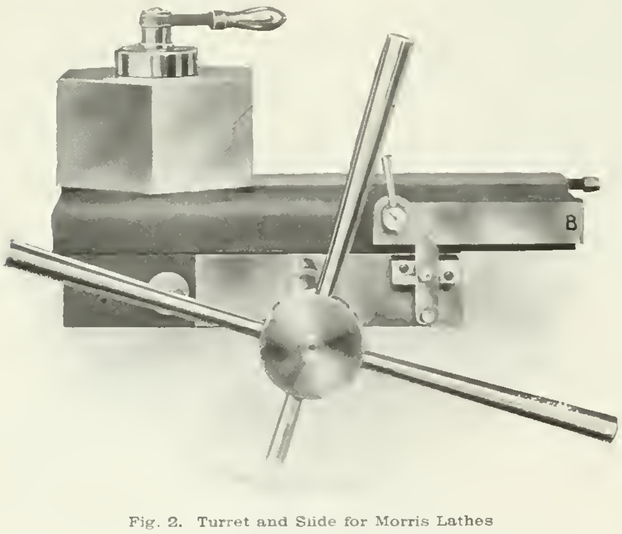


Fig. 2. Turret and Slide for Morris Lathes

This turret slide is also supplied with power feed and an automatic stop, and when arranged in this way a gear box is secured to it. This attached gear box contains a train of gears, the driven one of which is keyed to the pilot shaft the driving gear being splined to the lead-screw. This arrangement gives as many rates of speed as there are changes for feeding or screw cutting. The automatic stop is always supplied with the power feed, and in such cases the top slide is equipped with a T-slot at *B* which receives an adjustable stop dog. This dog operates a latch which disconnects the gear feed train previously referred to. The particular turret slide illustrated is for a 16-inch lathe. It has a 9-inch traverse when revolved automatically, and a 12-inch traverse when operated by hand. The turret will clear tools which do not exceed 5½ inches in diameter.

LOXON REFLECTOR LAMP GUARD

The McGill Manufacturing Company, of Valparaiso, Indiana, is now manufacturing the improved form of electric guard, illustrated herewith, which is especially adapted for use around machinery. As the engraving shows, this is a combined guard and reflector so that it not only gives protection to the lamp, but enables light to be reflected at any given point. This reflector is also useful as a shade for protecting the workman's eyes, particularly on machine tool lights, and its usefulness in this connection, as well as a reflector and guard, will doubtless appeal to machinists in general. The guard is locked on the socket of the lamp with a key, so that the lamp is not only protected from breakage, but from petty theft, as the guard cannot be removed without considerable difficulty, unless the key is employed. Another advantage claimed for this guard is that it enables the use of smaller lamps than would ordinarily be necessary, thus reducing the light bills.

Combined Lamp Guard and Reflector for the Shop

NEW MACHINERY AND TOOLS NOTES

Ellipsograph: J. T. Kelley, West Rush, N. Y. Instrument for drawing ellipses, which enables ellipses covering a wide range of axes to be drawn. A compass forming a part of the ellipsograph, may be detached, when desired, and used as ordinary dividers.

Combination Pliers: Medhus-Pihl Co., Hastings, Mich. Combination pliers having double-ended jaws for regular plier work and for cutting. The jaws have a square recess fitting a projection of similar shape on the handles which enables the jaws to be placed in four different positions with relation to the handle, thus adapting the tool to a variety of uses.

Molding Machine: Union Foundry & Machine Co., Pittsburg, Pa. Molding machine of the combined jar and squeezing type. It is adapted for making light castings, such as are made in snap flasks, and also deep and heavy castings. When making deep molds, the squeezing head is pushed back and the machine converted into one of the jarring type.

Vernier Caliper and Depth Gage: Schuchardt & Schutte, Cedar and West Sts., New York. Combination vernier caliper and depth gage so designed that the inside jaws and depth gage are simultaneously set to coincide with the outside measurements. The tool has two sets of graduations which, by means of verniers, give minimum readings of 1/128 inch and 0.001 inch, respectively.

Thread Gage: William Avery & Co., Foxboro, Mass. Thread gage with attachment for setting an internal threading tool after grinding. This gage has an end which fits the partly finished thread, and a V-groove near the other end by which the tool is set. As this V-groove is located just one inch from the end that fits the thread, the tool will "pick up" the partly finished thread, provided it is not fractional.

Welding Outfit: Alton, Laine & Co., Long Island City, N. Y. Oxy-acetylene welding outfit comprising oxygen and acetylene storage tanks, with keys and valves; oxygen and acetylene reducing regulators with two gages each; oxygen safety device; acetylene safety and purifying device; welding torch with 10 tips; 24 feet of high-pressure hose; and one pair of Hallau chemical-ray goggles, and the required wrenches.

Screw-Driver: Kinckiner & Scott, 626 North 12th St., Philadelphia, Pa. Screw driver having blades of 3-, 6- and 8-inch lengths which interchange with a brass mahogany-covered handle. These blades are of tool steel and have a tempered cross-pin which engages a slot in the end of the handle to take the torsional strain. The handle end of the blade is threaded to fit the cap-nut which retains it in position.

Combination Shear: McSherry Mfg. Co., 122 Ninth St., Pittsburg, Pa. Combination shear, punch, and bending press adapted for cutting, punching, and bending rounds, squares, flats or angles. This tool is hand operated, and it will punch a 5/16-inch hole through 1/4-inch steel; shear 1/4 by 2-inch steel, or ½ inch rounds; and bend ¼ by 2-inch steel. Interchangeable punches and dies are furnished which adapt this tool to a wide variety of work.

Oil Furnace: Bellevue Furnace Co., Detroit, Mich. Fuel-oil muffle furnace for high-speed steel, in which the flame is conveyed from the inlet to the furnace outlet through a continuous spiral groove formed in the brick lining. The muffle itself is supported by the spiral remaining between these grooves. When steels which cannot be safely treated in a horizontal furnace, are to be heated, the furnace can be easily changed to a vertical position.

Valve Grinder: J. F. Higbee, Muncie, Ind. Machine for grinding gas-engine or other valves mechanically. The valve being ground is given a progressive rotary movement combined with an occasional vertical movement to allow new grit to enter the seat. The cylinder castings are placed on the machine base and the valves to be ground are connected with the spindles. It is claimed that one man, with this machine, can grind from four to eight valves in 10 or 12 minutes.

Thread Milling Attachment: Garvin Machine Co., Spring and Varick Sts., New York City. Thread milling attachment for milling machines, adapted to cut either single or multiple threads within a wide range. The milling cutter is mounted on the face of the column and is driven by the spindle, while the work holder is placed on the table and is rotated through change gears. This attachment has been used successfully for threading such work as milling machine and lathe spindles and similar parts.

Double Spindle Milling Machine: Beaman & Smith Co., Providence, R. I. Double, vertical-spindle milling machine with minimum and maximum adjustments between spindle centers of 24 and 40 inches, respectively. Adjustable supports are attached to the housings on either side for steadying the lower ends of the cutter spindles. The table is 36 by 48 inches and it has a travel of 52 inches. The housings are 46 inches apart, and the spindles have a vertical adjustment of from 3 to 9 inches above the table. Two conveniently located levers control the nine available feed changes.

Rotary Cleaner: Brown Hoisting Machinery Co., Cleveland, Ohio. Rotary cleaner for removing rust and scale from structural material, etc. It consists of two disks mounted on a hub and containing near their peripheries a series of pins upon which are carried a large number of steel blades or cutters. These blades are rectangular in shape and the holes by which they are supported on the pins, are elongated so that the blades have considerable freedom of movement. This tool is directly driven by a high-speed pneumatic or electric grinder, and its effectiveness is due to the chipping action of the rapidly revolving blades.

Vertical Boring Milling Head: J. Morton Poole Co., Wilmington, Del. Boring, drilling, milling, and tapping head for the vertical boring mill. This head will take milling cutters up to 12 inches in diameter, and it is driven either by a 5 horsepower variable speed reversing motor, or by a two-speed countershaft and a three-step cone pulley. There are 12 spindle speeds ranging from 8 to 96 revolutions per minute; 4 boring feeds varying from 1/64 to 1/8 inch per revolution of the spindle; and a similar number of milling feeds varying from 1/80 to 1/10 inch per revolution of the spindle. This head has the same number of feeds for facing and turning as the standard type.

Horizontal Boring, Drilling and Milling Machine: Franklin Machinery Co., Franklin, Pa. Horizontal boring, drilling and milling machine equipped with an overhead steady-bar in addition to an outboard bearing, for use when a long span is necessary. The drive of this machine is of the all geared type, giving twelve speed changes. There are six changes of feed. Both the drive and feed gears are immersed in oil. The automatic feed may be applied to the boring bar saddle, the outboard bearing, or the table in both directions. The maximum distance from the bar to the table is 36 inches; there is a continuous feed for the bar of 36 inches, and the horizontal capacity is 72 inches.

Multiple Spindle Drilling Machine: Langelier Mfg. Co., Providence, R. I. Special multiple-spindle drilling machine and three drill heads containing 16, 24 and 44 spindles, respectively. The main spindle of this machine is driven by a quarter-turn belt connecting with a driving pulley at the rear. A stepped cone provides three speed changes which are sufficient for the drill combinations used. The work is fed by raising the table by means of a large pilot wheel connected through reducing gears with the rack-and-pinion movement. The table has a working surface of 18 by 26 inches, and a vertical adjustment of 4½ inches. It slides in a knee that can be adjusted and fastened in different positions.

Friction Clutch: Hilliard Clutch & Machine Co., Elmira, N. Y. New type of friction clutch in which the two friction plates are drawn against the friction ring by screws that are operated through spiral gears and racks attached to the sliding collar. The friction ring contains a number of hard-wood inserts and when these are worn, adjustments to compensate for wear may be easily made. One of the advantages claimed for this clutch is that the friction may be gradually applied and the load "picked up" smoothly and without any sudden shock. This feature adapts the clutch to delicate machinery, such as is found in textile mills, but it is also used with satisfactory results on large machine tools.

Crank Shaper: C. S. Dodge, Lowell, Mass. Twenty-four inch heavy-duty crank shaper, having V-shaped ram guides to insure accurate alignment. The ram is actuated by a back-geared crank with a quick return. Changes in the stroke can be instantly made with the machine in motion or at rest, and the length of the stroke is indicated by a stationary index. The feed-screw is provided with a dial, reading to thousandths. The table, which is of the box form, can be swiveled to any angle so that either of its sides may be used. This table can also be removed when it is desired to attach work directly to the apron. The column is so designed that shafts up to four inches in diameter may be passed under the ram for keyseating.

Sheet Metal and Wire Reels: Baird Machine Co., Oakville, Conn. Wire reels for wire forming machines or presses, and sheet metal reels also adapted to press work. The sheet metal and scrap reels are adjustable so that coils of varying inside diameters can be quickly accommodated; the outer flange is also adjustable for different widths of metal. These reels are interchangeable on the stud or shaft so that in case it is necessary to run the metal through the press a second time, the empty metal reel and the scrap reel can be interchanged, thus saving considerable time. The wire reels also have adjustable arms, the ends of which turn inward so as to catch the loose inner coils of wire and force them into place as the coils are placed on the reel.

Roller-Jaw Drill Chuck: Weaver Manufacturing Co., Springfield, Ill. Drill chuck composed principally of a heavy outer rim or shell on the inner wall of which there are three cam faces, against which a similar number of hardened steel rolls operate. These rolls are contained in a cage that may be rotated by means of a key, thus causing the rolls, as they ascend the cam surfaces, to grip the drill shank at three points 120 degrees apart. With this construction, the resistance of the drill to turning and the grip, increase simultaneously, as the resistance causes the hardened roller jaws to move further along the cam surfaces so that they are automatically tightened. This chuck is simple in construction, and it is claimed that it will not mar or injure the drill shank, no matter how severe the strain may be.

Trolley Wheel Lathe: Garvin Machine Co., Spring and Varick Sts., New York. Lathe especially equipped for rapid production of trolley wheels for electric railways. The grooves in these wheels, which are made from material varying from hard-bronze to pure copper, are finished by two tools mounted on the cross-slide, each of which forms half the groove. These tools are fed nearly to the bottom of the groove without touching the metal; then by a sudden movement of the carriage to the right and left, they are made to remove the hard scale without the wear on the cutting edge that would take place if they were fed in slowly by means of the cross-feed. The work while being machined is held in a Garvin pneumatically-operated chuck. With this machine a hard-bronze wheel 4 inches in diameter can be finished in 2 minutes.

Metal Sawing Machine: Taylor-Shantz Co., 230 Mill St., Rochester, N. Y. No. 2 metal-sawing machine designed to meet the demand for an accurate and rapid cutting-off tool for light work. The construction is simple and compact. The drive to the saw is through cut bevel gears, a large worm, and a hobbed worm-wheel, all of which are pack-hardened to insure long life. The feed is by gravity, there being a lever and an adjustable weight which can be moved to different positions as the saw becomes dull, or to apt the feed to different stock. The vise is of the V-block pattern and the stock is clamped in position by a hardened screw. The saw blade, which is 8 inches in diameter, is made of a special semi-high-speed steel, and it has a constant relief from the rim to the center. This saw runs in an oil bath and the machine is equipped with an adjustable gage.

Power Press: Manville Bros. Co., 27 Benedict St., Waterbury, Conn. New line of single-acting open-back power presses. The frames of these presses are well reinforced

where necessary; the beds are deep; the shaft is of hammered steel; and the slide strong and well braced at the back. At the front and sides of the bed there are finished surfaces for attaching feeds and fixtures. The clutch is of the well known Johnson type, and the press is arranged either to run continuously as long as the treadle is depressed, or, in special cases, it can automatically be thrown out of engagement at each revolution. The friction is a new automatic releasing type which releases as the foot treadle is depressed, and is applied with full force as the treadle ascends. These presses are fitted with a side or throat roll feed, friction dial or ratchet dial feed, or any special attachments.

Press: Ferracute Machine Co., Bridgeton, N. J. External notching press for cutting the notches in the peripheries of armature disks. This machine is designed to produce accurate work rapidly. The shaft runs continuously and is connected to the ram by a pitman and a ram clutch. The work is indexed by the direct action of a pawl upon a ratchet which is clamped to a spider, attached to the main spindle. After one revolution of the disk, the ram stops automatically at the top of its stroke, and the pawl is disengaged from its ratchet. This press is adapted for disks varying from 2 to 24 inches in diameter. When operating upon medium sized work having about 20 or more notches, the press makes about 400 strokes per minute, while for large work having comparatively few notches, it may be run at about 200 or 300 strokes per minute. The ram is capable of exerting a pressure of about seven tons. The weight of the machine is 1400 pounds.

Power Hammer: Reliance Engineering & Equipment Co., Milwaukee, Wis. Power hammer adaptable to general forging work. One of the principal features of this hammer is the spring arrangement which makes it unnecessary to adjust the stroke, except in special cases, and gives added momentum to the ram on its downward or working stroke. The arm carrying the hammer head or ram is made in two parts and is pivoted to the frame in the center. This arrangement makes it possible for the arm to adjust itself automatically for widely varying thicknesses of stock without the necessity of hand adjustment and without lessening the force of the blow. As the ram ascends, it has sufficient momentum to compress an elliptic spring, which, in turn, gives back the stored energy for the next blow; as a result the blow is many times heavier than the weight of the ram. When an adjustment of the stroke is necessary, this is made by shifting the position of the crosshead to which the connecting rod is fastened, in or out on its guide. Extending around the base of the hammer there is a semi-circular treadle or foot lever by which the hammer is started and stopped. The speed and force of the blow is also regulated by varying the foot pressure on the treadle. A brake connected with the treadle acts on the flywheel as soon as the treadle is released.

Thread Rolling Machine: The National Machinery Co., Tiffin, Ohio. Vertical thread rolling machine in which long rods can be threaded as well as bolts. The blanks are fed into the dies horizontally, enabling work of any length to be handled. The design is very rigid and occupies a minimum of floor space. As the dies have their grooves in a vertical plane, lubricant may be employed effectively. The reciprocating die-slide has a slow downward stroke and a quick return. This slide is backed by a train of hardened steel rollers actuated by racks and pinions. These rollers reduce wear to a minimum as well as the friction and power for operating. The blank to be threaded is inserted into the gap between the die against a suitable gage, the blank lying upon a rest or feed-bar. A starter actuated by a cam on the main shaft, introduces the blank to the die at the proper time, and the rest or feed-bar automatically returns to its original position to receive the next blank. The movement of the feed-bar is parallel to the faces of the dies which, with the aid given by the starter, insures the blank being introduced into the dies correctly. This machine is built in three sizes having maximum capacities for rolling threads ½ inch in diameter by 4 inches in length; 1 inch in diameter by 3 inches in length; and 2 inches in diameter by 4 inches in length. The intermediate diameters with lengths up to 6 inches can also be rolled.

* * *

MAKER OF MODEL SPRING WINDER

In the department of New Machinery and Tools for December, we illustrated and described a machine for winding springs, but failed to give the name of the manufacturer. This spring winder is the product of the Model Spring Winder Co., Bowling Green, Ohio.

* * *

Phosphor-bronze should not contain too much phosphorus, says the *Brass World*. The tensile strength is greater when it is low in phosphorus, and the castings are generally sounder. For sand castings, from 0.10 to 0.25 per cent of phosphorus may be considered as the maximum.

A MACHINE FOR MAKING BARBED WIRE

Barbed wire of the usual type consists of two No. 12 twisted strands around and between which the barbs are mounted. The recently patented machine described in the following is being introduced by Blashill & Gray, London, Canada, and is ingeniously designed for producing barbed wire for which only one No. 9 wire is used. The barbs, contrary to common practice, are first cut to the required length, afterwards formed in the machine, and finally pressed solidly onto the main wire or strand which has been flattened at intervals to

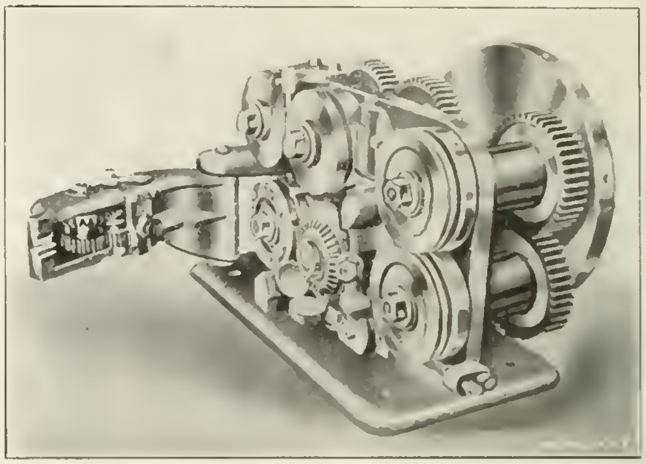


Fig. 1. Machine for Making Single-strand Barbed Wire

form seats for this purpose. The barb itself requires a minimum length of wire. It is made up of one loop only, wrapped around the main wire.

The essential part of the machine for making barbed wire of this type is shown in the half-tone illustrations Figs. 1 and 2, and in the line engravings Figs. 3 to 8, inclusive. The action of the machine is very interesting because of its simplicity and is as follows: The strand of wire passes first between rolls *A* and *B*, Fig. 2. These rolls flatten the wire slightly at the places where barbs are to be seated. From these rolls the wire passes between rolls *C* and *D*, where the barb is fed in and bent over it. The barb-wire feeding

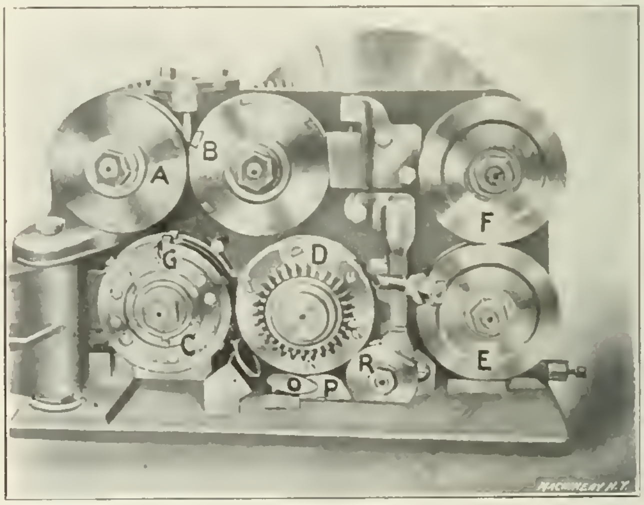
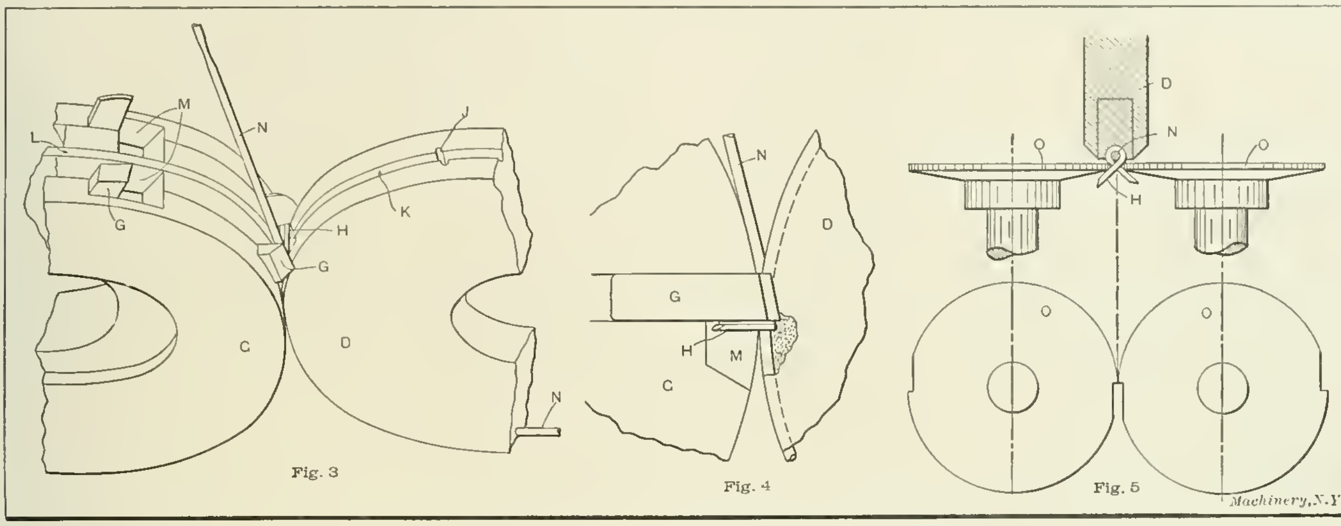


Fig. 2. Working Mechanism of the Blashill & Gray Barbed Wire Machine

mechanism is shown swung back, to give access to the rolls, in Fig. 1. Normally, when the device is in action, this arm closes in over rolls *C* and *D*, forming a guard over the gears as well. The barbs are cut off to the right length by the cutters *G* on roll *C*, shown in Figs. 2 and 3, which act against a stationary cutter on the feed roll arm. The barb *H*, Fig. 3, just cut off and still straight in form, now lies between rolls *C* and *D*, and is then forced by the strand wire into the pocket *J* of roll *D*. The strand wire itself, during this operation, is backed up by tongue *L* in roll *C*, and forced into groove *K* of roll *D*. This causes the barb to assume the form of a staple, pockets *M* in roll *C* being provided to give clearance for the ends of the bent wire.

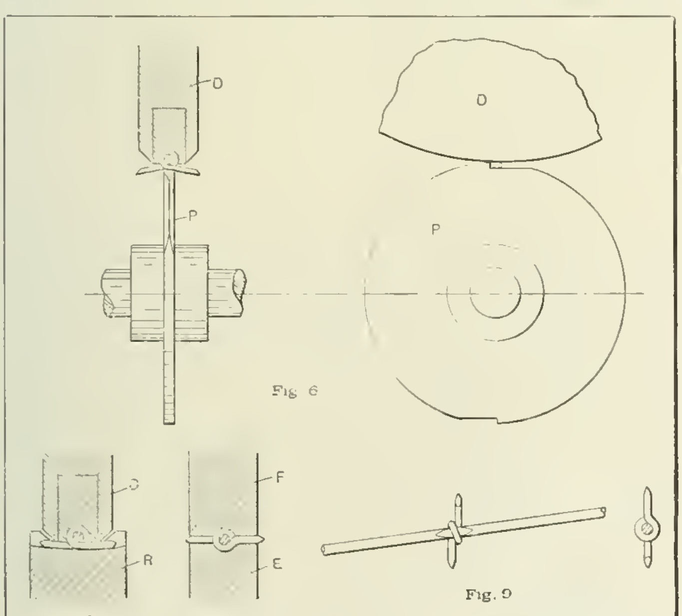
The relative positions of barb, strand wire and rolls, at the end of this operation, are shown in Fig. 4, where the outer plate or ring of roll *C* has been removed, and a portion of the roll *D* broken away to show the cutting tool and staple-shaped barb. The main strand *N* now carries the staple-shaped barbs in the pockets half-way around roll *D*, after which they pass between finishing rolls *E* and *F*. Previously, however, in their passage around roll *D*, the legs of the staple-shaped barbs are crossed by the hard steel disks *O* as shown in Fig. 5. In Fig. 6 is shown a thin hard steel disk *P* which



Figs. 3, 4 and 5. Successive Operations in Barbed Wire Manufacture

spreads the points of the barb further, while the roll *R*, acting against roll *D*, as is partly shown in section in Fig. 7, completes the wrap. Now the finishing rolls *E* and *F* press the barbs solidly on the flattened spot on the strands, as shown in Fig. 8, the whole operation being effected by a simple continuous motion, no reciprocating or oscillating parts whatever being employed. The finished barb on its wire is shown in Fig. 9.

The form of the finished barb is an important feature in this development. It will be seen that the barb is pressed until



Figs. 6 to 9. Final Operations of Manufacture and Finished Product

the points extend radially, from the center. The mechanism is very simple, and it is possible to operate it at a high rate of speed. Several advantages are gained by the method employed. It is possible to use large hard drawn No. 9 gage wire in place of two No. 12 strands, as commonly used in barbed wire manufacture. In this way the total surface to be galvanized is reduced, and the annealing is made easier. The output of the machine is also greater than that of a machine for twisting the strands, while the initial cost, maintenance and floor space are less.

MODERN GRINDING METHODS

In a paper on "Modern Grinding Methods," read before the American Society of Mechanical Engineers at the December meeting, by Mr. B. M. W. Hanson, of the Pratt & Whitney Co., Hartford, Conn., special reference was made to the large-size vertical surface grinder just completed by this company. Surface grinders have usually been made with the wheel grinding on its periphery, but in this machine the ordinary cylindrical wheel has been replaced by a cup-shaped wheel which covers the whole width of the work at once. Water for lubrication and cooling is forced through the center of the spindle, the centrifugal force throwing the water outward and compelling it to pass between the work and the wheel. The table of the machine has a stroke of 6 feet and can grind a flat piece of work 6 feet long and 25 inches wide. The cup-wheel has a diameter of 30 inches, and the whole machine is driven from a single belt by a forty-horsepower motor. As this machine has just recently been built, its capacity has not been fully tested out as yet, but it is interesting to note the results already obtained. In one of the trials, a surface of cast iron 6 feet long and 20 inches wide was reduced 0.010 inch in thickness in five minutes, leaving an excellent finish and a high degree of accuracy. In fact, when tested, no point on the surface was out of true more than 0.0005 inch.

The chips are cut by the outer edge of the wheel when it passes over the work in the same manner as chips are produced by the outer edge of an end milling cutter. The large surface of the wheel in contact with the work simply smooths the surface. It is likely that for some kinds of work having large flat surfaces this method of finishing will prove superior to any other method. It was stated that at the present time it is safe to say that grinding machines have been fully developed to the limit of the cutting capacity of grinding wheels, and that there probably will be no essential changes in grinding methods or grinding machinery until the grinding wheel itself has reached a higher development.

At the present time the difficulty met with in grinding lies in the fact that wheels supposed to be made to the same specifications vary considerably, and the feeds of the grinding machine to be used for different materials must be regulated by the operator not only to suit the material being ground, but also to suit the wheel used. In this respect he cannot always go by previous experience, but must run the machine a few minutes, in each case, to determine the proper feed.

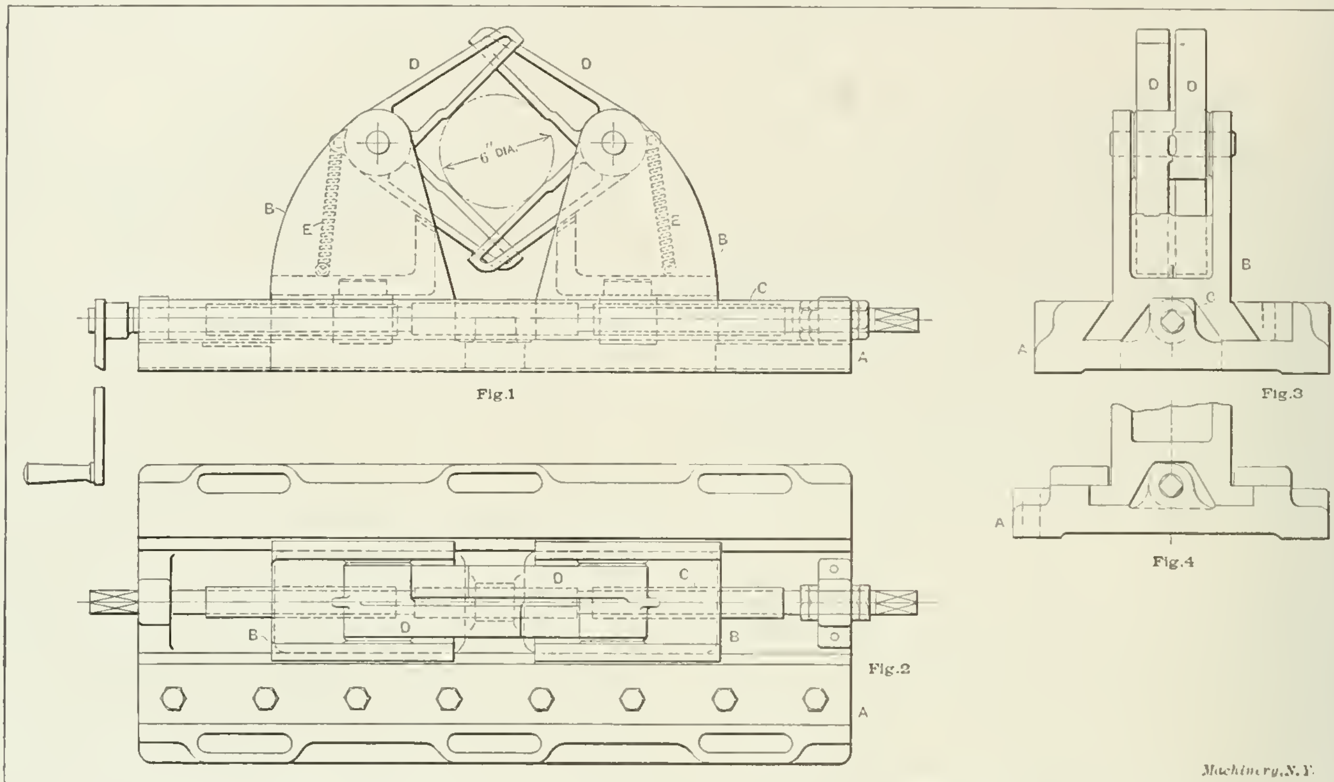
* * *

The methods followed by the leading machine tool builders in the manufacture of lathes, planers, drilling machines, etc., have been minutely described in the technical press, but comparatively nothing has been published on the repairing of machine tools. What is the best plan of rebuilding an engine lathe? a milling machine? a shaper? Some one in these United States must have the experience and ability to write and illustrate what he knows. Where is he?

BRAYSHAY'S PATENT CENTERING GRIP

By JOSEPH G. HORNER*

Messrs. Pickerings, Ltd., whose works at Stockton-on-Tees, England, are devoted to the manufacture of lifts, hoists, cranes and similar appliances, have brought out a useful device intended for holding work for boring, drilling, facing, planing, etc. It constitutes a species of large self-centering chuck, adapted for gripping hoisting barrels or drums, pipes, and similar work. When so held the object is automatically centered, so that boring or other operations may be commenced without further setting. No clamping bolts or plates are needed, which feature saves considerable time.



Figs. 1 to 3. Side, Plan and End Views of Brayshay's Patent Centering Grip. Fig. 4. Alternative Slide-ways to those shown in Fig. 3

The line-cuts Figs. 1 to 3 show the construction of the grip. There is a base A, in which slide two brackets B, caused to approach or recede from each other by a right- and left-hand screw C, provided with a square at each end for a ratchet wrench. Brass nuts are attached to the under side of the brackets to receive the screws. Fig. 4 shows alternative slide-ways to those in Fig. 3. Pivoted at the top of each bracket is a cast-steel arm D, the gripping faces of which are at an angle of 90 degrees with each other. The arms are so arranged that they can pass each other to grip work of the smallest diameter within their capacity, which is 6 inches. By drawing apart the brackets B, diameters up to 15 inches may be gripped.

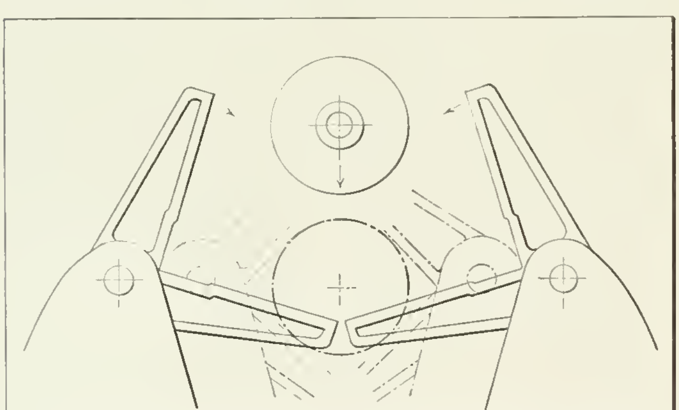


Fig. 5. Illustrating the Action of the Brayshay Patent Centering Grip

*Address: 45 Sydney Buildings, Bath, England.

The method of introducing the work forms an ingenious feature of the design; it will be seen on referring to Fig. 1 that there are strong spiral springs, E, anchored to the brackets and to the back of the arm bosses. The purpose of these is to pull the arms around so that they turn upward and thus free the work, or leave an opening for the introduction of another piece. The diagram Fig. 5, shows the brackets drawn apart and the arms turned upward to receive the drum which is being lowered down into them. As it is lowered, the arms gradually accommodate themselves to its contour, whether round, elliptical, or square, and then by turning the screw, the arms are brought into close contact with the work until it is gripped firmly and concentrically, as indicated by the dotted lines, Fig. 5. In this drawing the amount of opening is purposely exaggerated beyond that necessary to introduce the drum.

It will be understood that a pair of these grips is required to deal with work, their lateral distance apart being regulated by the nature of the work. In the half-tone, Fig. 6, two grips of slightly different pattern are seen, for work up to 2 feet 6 inches in diameter. The screws are operated by ratchet levers, and an auxiliary tie-bolt fastens the top ends of the arms. It may be mentioned that Messrs. Pickerings have supplied a large number of these grips to pipe makers.

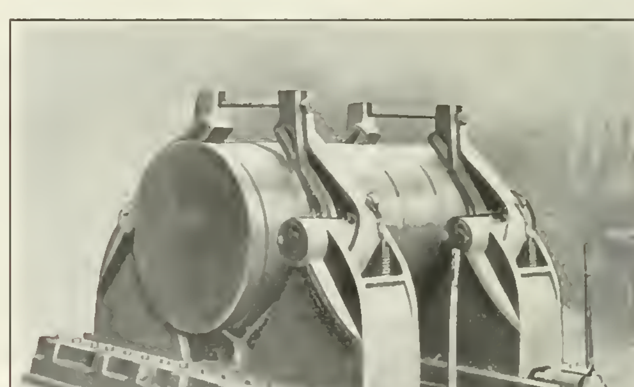


Fig. 6. Brayshay's Patent Centering Grips in Actual Use. The Grips here shown are of Slightly Different Pattern to those described

MULTIPLE PUNCH PRESS

In U. S. patent No. 977,362 (November 29, 1910), obtained by Thomas A. Banning, Jr., Chicago, Ill., there is an interesting development of the multiple punch press for punching, in conformity with a prescribed plan, by a templet previously prepared in accordance with the arrangement of holes desired in the final product.

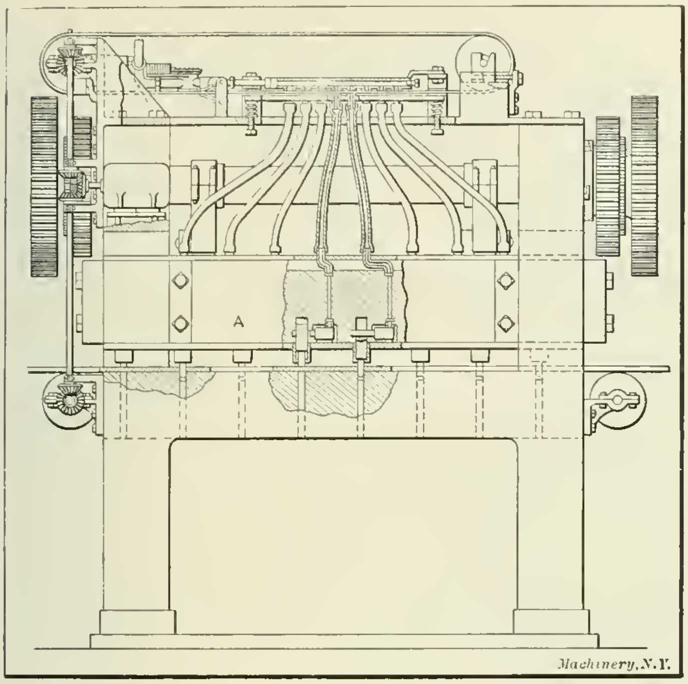


Fig. 1. Multiple Punch Press

Figs. 1 to 3 show the different features of the invention. A movable head *A* carries several rows of punches *B* which register with dies in the stationary bed below. These punches are attached to small plungers *C*. To one side of the individual plunger is a small cylinder *D* containing piston *E*, normally kept to its rear end by a spring. Air pressure from

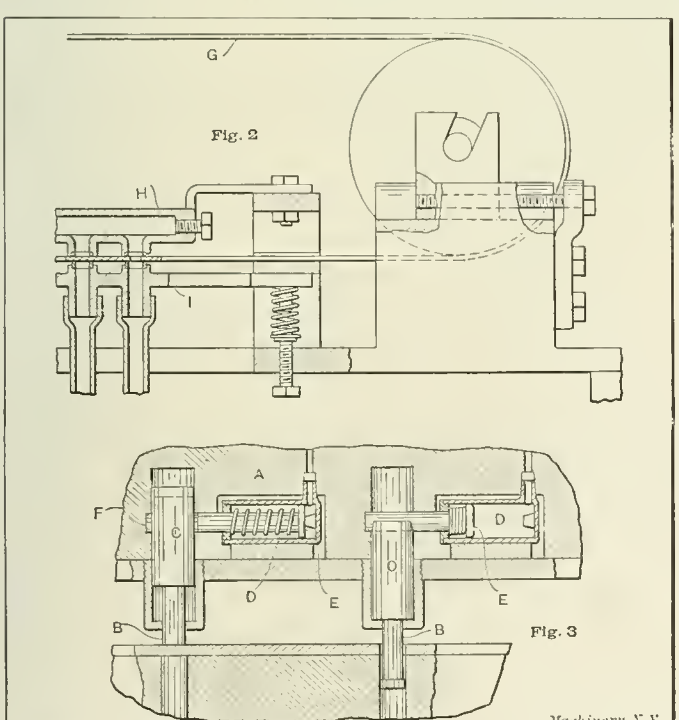


Fig. 2. Detail of Punch-controlling Templet and its Operation. Fig. 3. Punch Units showing their Dead and Operative Positions

above, controlled as hereinafter described, forces the piston forward at the proper time, its piston-rod entering recess *F*, forming a stop for the punch, the plunger for which has a formed bearing at the top to receive it. In its normal position, as shown to the left, Fig. 3, plunger *C* slides up and down and does not punch, whereas the punch to the right is in position to operate.

The control from above is shown in Fig. 2, where *G* is the previously mentioned templet passing over end drums. *H* is an air header under pressure, which pressure passes down to the punches when the templet holes register as shown by the right-hand hole. *H* is rigid, and a tight working air connection is maintained by having *I* floating on a spring as shown. Between the movable punches and this stationary part are flexible hose connections.

The various parts are controlled by electrical means, the whole being automatic, semi-automatic or manually operated, as desired. In addition, the machine is so arranged as to be made workable in units, separately, for small work, these individual units being connected from a central control for handling large parts.

* * *

LOW EFFICIENCY OF UNIVERSITIES

Morris Llewellyn Cooke, member of the American Society of Mechanical Engineers and an exponent of higher efficiency in all fields of labor, has investigated the workings of a few American universities and colleges at the instance of the Carnegie Foundation. His findings have been published in a bulletin issued by the Carnegie Foundation December 19. Mr. Cooke investigated the Universities of Harvard, Columbia, Toronto, Wisconsin and Princeton, Haverford and Williams Colleges and the Massachusetts Institute of Technology. The report indicates that great waste of effort and loose methods are prevalent in nearly all. Useless research work is being carried on at great expense and other work is being done of no practical value. Gardeners and other laborers start work at nine o'clock in the morning and the educational work is suspended for athletic events, etc. Mr. Cooke found the administration of Columbia University to be on a higher plane than any of the others investigated.

* * *

MAKING HARDENED TRY-SQUARES

A task is difficult in proportion to our inexperience. What is very difficult for a machinist may be easy for a toolmaker, and *vice versa*. So when we say the making of a knife edge straightedge probably is one of the most difficult jobs required of a toolmaker, we mean a toolmaker not having special experience in that work. If the knife-edge straightedge is secured at right angles to a hardened steel stock to make a precision try-square, the job is increasingly difficult—for the inexperienced, and most of us are in the inexperienced class. A reader has expressed his desire to see a detailed description of the process of making hardened try-squares. Is there another reader of MACHINERY experienced in making them who can clearly describe and illustrate the work? An article on this subject no doubt would interest toolmakers as well as machinists.

* * *

According to *Page's Weekly* a machine tool builders association is in course of formation in Great Britain. A meeting of the machine tool trade was held in Manchester on November 4. Among forty or fifty influential firms who have already promised membership are Alfred Herbert, Ltd., C. W. Burton, Griffiths & Co., H. W. Ward & Co., Ltd., C. Redman & Sons, Pheil & Co., Geo. Richards & Co., Ltd., Chas. Churchill & Co., Ltd., Wm. Asquith, Ltd., Pollock, Pollock & Macnab, Ltd., and J. Parkinson & Son. It was made clear at the meeting that such an association undoubtedly will meet with success, but the scope of the activity of the association was not clearly defined. It appears that one of the main objects is to form a combination for regulating shows and exhibitions of machine tools.

* * *

According to a report issued by the Society of German Machine Tool Builders, the machine tool trade improved materially during the first six months of 1910 as compared with 1909. The exports of machine tools amounted to 26,870 metric tons, which is considered good, although it is less than the exports in the first six months of 1907 and 1908, which were 27,387 metric tons and 30,256 metric tons, respectively.

PROGRESS AT OAKLEY

At Oakley, Ohio—the new and attractive industrial community near Cincinnati—the Cincinnati Planer Co.'s plant is completely installed and in operation. A descriptive article on this plant appeared in the June, 1910, number of MACHINERY. The Cincinnati Milling Machine Co. is operating both its plants at Cincinnati and Oakley; at the latter place about three hundred men are employed.

The Cincinnati Bickford Co. has just finished moving its Spring Grove Avenue and Bickford plants, which are being consolidated in the new works at Oakley. The machinery and material in the two plants totaled over 4,000,000 pounds and the work of getting all this installed and in running order is now progressing rapidly. It is expected that the Oakley works will be in running order by January 15, and the consolidation of the two plants will result in many economies of time and labor.

* * *

The Cunard Steamship Co. has invited tenders for the construction of a liner which will be slightly larger than the two new White Star liners now building. The new Cunard vessel will be 885 feet long and 95 feet wide, with 50,000 tons' displacement. The speed for which it will be designed will be 23 knots. Provision will be made for 3800 passengers, besides the crew.

* * *

PERSONALS

Leonard Munns, commercial manager of Cammell, Laird & Co., Sheffield, England, is in the United States in the interests of his firm.

John A. Logan, formerly brass-foundry foreman for the National Cash Register Co., Dayton, Ohio, has taken a similar position with the Fairview Foundry Co., Detroit, Mich.

H. C. Jones, formerly with the Warren Screw Co., Detroit, Mich., has taken a position as outside lathe demonstrator for the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

J. W. Carrel, general sales manager for Lodge & Shipley Machine Tool Co., Cincinnati, sails January 5 on the steamship *Amerika* for a four months' business trip in Europe.

Francis J. Armstrong has entered into a partnership with his father, Charles G. Armstrong, consulting engineer of New York, under the firm name of Charles G. Armstrong & Son.

R. B. Shaw has been appointed Cleveland manager for Hill, Clarke & Co. Mr. Shaw until recently was sales manager of the machinery department of the Davis Sewing Machine Co., Dayton, Ohio.

J. A. Bennett, who for the past two years has been mechanical engineer for the Lodge & Shipley Machine Tool Co., has taken the position of master mechanic for the Studebaker Bros. Mfg. Co., South Bend, Ind.

William Snyder, formerly master mechanic for the Fulton Bag & Cotton Mills, Atlanta, Ga., has taken the position of chief mechanical and electrical engineer for the Georgia Marble Co. and Blue Ridge Marble Co., Tate, Ga.

F. G. Bolles, commercial engineer of the Allis-Chalmers Co., has resigned to accept a partnership with C. A. Tupper and others in the Reliance Engineering and Equipment Co., with offices in 415-16-17 Engineering Building, Milwaukee, Wis.

Charles M. Ams, president of the Max Ams Machine Co., Mt. Vernon, N. Y., has returned from a successful three months' trip in England and the Continent where he established branch houses for the sale of his company's machines and products.

F. O. Hoagland, who for the last one and one-half year, has been chief mechanical engineer of the Remington Arms Co., Ilion, N. Y., has been appointed acting works manager of the works, and in addition will continue to supervise those departments under him as chief mechanical engineer.

C. C. Tyler, who for the last two and one-half years has been works manager of the Remington Arms Co., Ilion, N. Y., has been appointed general manager of works in charge of the general administration and operation of the Remington Arms Co. and the Union Metallic Cartridge Co., Bridgeport, Conn. His authority will extend over all employes of these works.

C. H. Norton, of the Norton Grinding Co., was recently elected president of the newly organized Worcester Publicity Association, Worcester, Mass. The objects of the association are to assist in the advancement of Worcester by studying and improving the methods of business through advertising, and to serve as a publicity bureau for all Worcester business associations.

OBITUARIES

Daniel Arthur, vice-president of the Arthur Co., New York, was killed by a railroad train November 29, aged forty-four years.

Charles Joseph de Berard died at his home in Norwood Park, Chicago, November 28, aged sixty-one years. He was associated with Robert Tarrant in the machine shop business for twenty-five years, and was a stockholder and director in the Tarrant Foundry Co.; he was also secretary and treasurer of the Felt & Tarrant Mfg. Co. of Chicago.

David Hunt, Jr., general manager of manufacturing for the Everett, Metzger, Flanders Co., Detroit, Mich., was killed in an automobile accident near Yale, Mich., November 26. The party in the car were returning from a rabbit hunt and comprised Charles Adams, general superintendent of the E. M. F. Co., Morgan Kavanaugh, the head of the drafting department, Lee M. White, chief inspector, and several other gentlemen. Mr. Adams was driving the machine, which skidded and overturned down a steep clay embankment. Recent rains had made the road slippery, and the accident appeared to have been unavoidable. Mr. Hunt was about thirty-five years old, a Harvard graduate, and began his manufacturing career as a machine operator in a shop owned by his father at Watertown, Mass., in which the first locomobile was constructed, and Mr. Hunt designed much of the machinery used in that car. Of that shop he became foreman and manager, leaving to fill a position as salesman with Manning, Maxwell & Moore, making his way in a few years to the position of Cleveland manager of that firm, which he left to become treasurer and sales manager of the Baush Machine Tool Co., of Springfield, Mass. After two years with this firm he became general sales manager of the Warner & Swasey Co., where he was for six years. The entire manufacturing of the E. M. F. Co. was in Mr. Hunt's hands, and he received reports from the works managers of each of the various plants, utilizing his knowledge to perfect manufacturing plans which he had laid out. Mr. Hunt was widely known to machinery manufacturers and users, and his sudden death was a great shock to his many warm friends all over the country.

* * *

COMING EVENTS

December 31-January 7.—International Automobile Show, Grand Central Palace, New York.

January 7-21.—Association of Licensed Automobiles' tenth annual exhibition of automobiles and automobile appliances. M. L. Downs, 7 E. 42d St., New York.

January 18-19.—Annual meeting of the American Society of Civil Engineers, 220 W. 57th St., New York. Charles W. Hunt, secretary.

January 24-26.—Annual meeting of the American Society of Heating and Ventilating Engineers, New York. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 28-February 11.—Tenth Annual National Automobile Show under the auspices of the National Association of Automobile Manufacturers, Inc., in the Coliseum and Coliseum Annex, Chicago. S. A. Miles, manager, New Southern Hotel, Chicago.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

NEW BOOKS AND PAMPHLETS

OFFICIAL CATALOGUE OF THE INTERNATIONAL CENTENNIAL RAILWAY AND TRANSPORTATION EXPOSITION OF THE ARGENTINE REPUBLIC. 270 pages, 7 x 10 inches. Price 50 cents.

This catalogue, which gives full particulars of the exposition held in Buenos Ayres from May to November, 1910, is devoted principally to the various exhibits. In all, there were some 3060 exhibits mostly from the different exporting nations, such as the United States, Great Britain, and Germany. The catalogue is divided into sections, one for each of the exhibiting countries. Under the name of the firm exhibiting, are given particulars as to place of manufacture, and the nature of the product exhibited. From the nature of the exposition, the majority of the exhibits were of machinery, adapted to railway and transportation purposes.

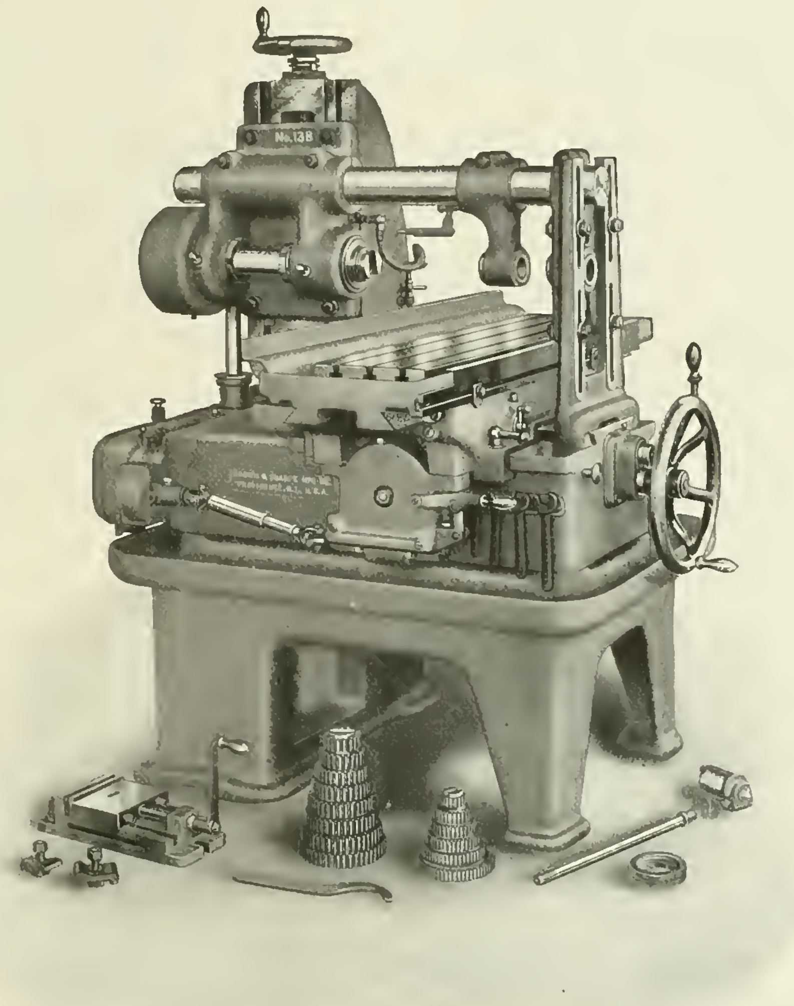
MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1911. 270 pages, 4 x 6 inches, 68 illustrations. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6d. net.

This annual pocket-book makes its appearance for 1911 in a more comprehensive and complete state than ever before, each year showing a considerable betterment. In this issue, the descriptive matter has been materially condensed, thereby affording space for a number of new tables. These include tables on current densities, permissible temperature rise, percentage losses in electrical machinery, units of illumination, current consumed by incandescent lamps, life of glow lamps, depreciation allowances, as well as other convenient tables. The accumulator notes have been rewritten and extended, and the sections on circuit-breakers, electricity in coal mines, and boosters, have been similarly treated. Besides, a new section on liquid starters or water rheostats has been introduced. That the electrical part is being made more and more the predominating feature, is emphasized by the fact that the sections on the mechanical means of transmitting power have been condensed.

UNIVERSITY OF ILLINOIS ENGINEERING EXPERIMENT STATION BULLETINS. 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

These are the bound volumes of the bulletins issued from time to time by this experimenting station. Volume IV contains bulletins 27 to 34, on: "Tests of Brick Columns and Terra Cotta Block Columns"; "A Test of Three Large Reinforced Concrete Beams"; "Fuel Tests with Illinois Coal"; "Tests of Reinforced Concrete Beams—Re-

A new machine for the rapid and economical production of duplicate parts



No. 13B Plain Milling Machine

Longitudinal Feed, 34"; Transverse Feed, 6"; Vertical Adjustment, 12"

This machine is the latest addition to our line of constant speed drive machines. It is equipped with a friction clutch driving pulley which permits of belting direct from the main line.

Three points of particular importance should be noted. First, it is readily adapted to motor drive. Second, it is rigidly constructed, the spindle is solidly supported and the bed and saddle are designed to give maximum support to the table under heavy cuts. Third, it can be operated with convenience and facility, levers and hand wheel being located where they can be easily reached.

Send for General Catalogue showing full line.

BROWN & SHARPE MFG. CO.

Providence, R. I., U. S. A.

sistance to Web Stresses;" "On the Rate of Formation of Carbon Monoxide in Gas Producers"; "Fuel Tests with House-heating Boilers"; "The Occluded Gases in Coal"; "Tests of Tungsten Lamps," and "Tests of Two Types of Tile-Roof Furnace under a Water-tube Boiler." Volume V includes bulletins 35 to 42 on a study of "Base and Bearing Plates for Columns and Beams"; "The Thermal Conductivity of Fire-clay at High Temperatures"; "Unit Coal and the Composition of Coal Ash"; "The Weathering of Coal"; "Tests of Washed Grades of Illinois Coal"; "A Study of Heat Transmission"; "Tests of Timber Beams"; and "The Effect of Keyways on the Strength of Shafts."

Shop Kinks. By Robert Grimshaw. 393 pages, 5½ x 7½ inches, 224 illustrations. Published by Norman W. Henley & Son, New York. Price $2.50.

The popularity of this handy little shop book is evidenced by the fact that it is now passing into its fifth edition. Originally it was the outcome of a suggestion offered to the author many years ago when entering a large machine shop. This suggestion was that he should keep a note-book of what he observed, and so successful did this prove that the results were embodied in a book. In the various editions through which it has passed, it has from time to time been improved so that now it presents a comprehensive list of machine shop kinks, methods, and devices for cheaply producing work, most of the ideas being from some of the largest shops in this country and in Europe, and representing a long period of contact with some of the largest machinery builders in the world. Many of the machine shop suggestions embodied, however, are from leading technical journals, some of the best of the suggestions given in these papers being included. Nearly every phase of machine shop practice is dwelt upon in a brief, breezy manner that should appeal to the average man in the shop.

Machine Shop Primer. By Fred H. Colvin and Frank A. Stanley. 148 pages, 6½ x 8¼ pages, 508 illustrations. Published by the McGraw-Hill Book Co., New York. Price $1.00, net.

This book is decidedly unique in its general make-up, and has a style peculiarly its own. There are three sectional divisions. The first part contains 508 illustrations of the various tools, machines, and devices commonly found in the machine shop arranged in alphabetical sequence. No names are given with the illustrations, merely the figure number, it being the purpose of the book to test a man's knowledge and ability to name all these machines, and, if the necessary information is not known, by turning to Section 2 of the book, all the names are listed, in the same alphabetical order as the illustrations. The third section consists of a dictionary of shop terms, wherein things from an angle plate to a wrench are defined. Where there are illustrations in the first section of the terms being defined, reference is made to that fact in the explanation, and the figure number given. While containing practically nothing new, it fulfills the intentions of the authors, who realize the fact that the first step toward a clear understanding of practical shop work, is a knowledge of the names of the machines, tools, and appliances used. The book was prepared to aid both students and instructors in this line of work, and should prove helpful to apprentices learning the trade.

Iron and Steel. By Hugh P. Liemann. 354 pages, 3 x 7 inches, 43 illustrations. Published by the McGraw-Hill Book Co., New York. Price $3.00, net.

This is a convenient, handy sized encyclopedia of iron and steel, and allied industries, gotten out in handbook style, with flexible leather cover, and printed on thin India paper, forming a reference book of less than half an inch thick. The method of treatment is unusual, the book being a combination of dictionary, encyclopedia, and handbook, possessing as well as omitting some of the features of all. To begin with, it is like a dictionary or encyclopedia, in that names and descriptions are introduced alphabetically. The definitions or descriptions of isolated terms or processes are found under the respective headings, while those employed in connection with some special subject or process, are under the latter, the location of the definition being given opposite the alphabetically arranged name, so that a compact arrangement of definitions and descriptions is made possible, and is carried out in a practical manner. Everything irrelevant to iron and steel production, and the industries closely related, is dispensed with, in order to make the book bear as closely as possible on the subject in hand, without containing matter uninteresting to the millman and metallographist for whom the book was primarily written.

Mechanical Drawing for Plumbers. By R. M. Starbuck. 111 pages, 6¼ x 9¼ inches. 150 illustrations. Published by Norman W. Henley & Son, New York. Price $1.50.

In this book is embodied a series of articles written by Mr. Starbuck for *The Plumbers' Trade Journal*, prepared by the author because of a conviction that plumbing drawing is a valuable and practical acquisition for the plumber. The following are the chapters contained: Value to Plumber of Knowledge of Drawing; Perspective Versus Mechanical Drawing in Showing Plumbing Construction; Correct and Incorrect Methods; Floor and Cellar Plans and Elevation; Use of Triangles; Drawing Plumbing Elevations and Fittings; Instructions in Drawing Plumbing Elevations; The Drawing of Plumbing Fixtures; Drawings of Fixtures and Fittings; Inking of Drawings; Shading of Drawings; Sectional Drawings; Plumbing Elevations; Elevations of Separate Parts of the Plumbing; Elevations from Architect's Plans; Drawing of Detail Plumbing Connections; Architect's Plans and Plumbing Elevations of Residence; Plans and Plumbing Elevations of Six-Flat Building; Drawing of the Various Parts of the Plumbing System; Use of Architect's Scales; Special Features in the Illustrations of Country Plumbing; Drawing of Wrought Iron Piping; Valves, Radiators, Coils, etc.; and Drawing of Piping to Illustrate Heating Systems. Much of the contained information is drawn from the author's personal experience gained in the pursuit of the plumbing business, and the thought of the personal benefit derived from a knowledge of this subject has led to his writing this book. Being well illustrated, it carries out the main desideratum of a book on drawing, by practically exemplifying what is implied by the text.

Qualitative Chemical Analysis. By J. I. D. Hinds. 265 pages, 6 x 9 inches. Published by the Chemical Publishing Co., Easton, Pa. Price $2.00.

This book is an excellent treatise on qualitative chemical analysis, and is intended to be not only educational, but to have a practical value as well. The subject is developed in such a way as to make the student familiar with the properties and reactions of all the substances with which he deals, and also to so teach him the underlying principles that he will have an intelligent understanding of the processes, and at the same time give him a rapid and accurate practical method of analysis. The subject has been approached from the standpoint of the theory of electrolytic dissociation, solubilities and law of mass action, this method being used principally wherever it was thought a better explanation was thereby afforded. This involved a discussion on ions of both polarities, the kations and anions. The classification of the former is that customarily found, while the latter is essentially the same as given in Boettger's Qualitative Analysis, arranged in a more systematic method for the anion separation and identification. Several new or uncommon methods of analysis are introduced. There are five general divisions of the book. The first on principles and methods of qualitative analysis contains an introductory chapter, followed by chapters on separators, solutions, and reactions. Basic analysis is the subject of the second part, and contains chapters entitled Silver Group, Copper-Arsenic Group, Iron Group, Zinc Group, Barium Group, and Magnesium-Alkali Group. The third section contains the corresponding Acidic Analysis, explained in chapters on Properties and Reactions of the Non-Metals, Acids and Anions, and Separation and Identification of the Acids and Anions. Parts four and five contain a single chapter apiece on Complete Analysis of an Unknown, and Reagents and Tables.

Welding. By Richard N. Hart. 181 pages, 6½ x 9½ inches. 93 illustrations. Published by McGraw-Hill Book Co., New York. Price $2.50, net.

This book has been compiled to meet the demand for a work containing most of the generally known welding data under one cover, for, while numerous tests have been performed and articles on the subject published, no attempt has thus far been made to present these data in sequence in one book. Much test and cost data are included in the work with a cautioning foreword that it be taken with the proverbial grain of salt, for, while the tests given for iron are standard and cannot be questioned, those given for the special processes are more recent and in most cases are made by interested parties. The book is divided into four parts: "Metals," "Electric Welding," "Hot-flame Welding," and "Thermit," these divisions being introduced by a brief general preface dealing with definitions, and the theories of welding. Under the metals are chapters on Iron, Platinum, Gold, Silver, Aluminum, Copper, Nickel, and Welded Products. The second part on electric welding includes chapters on such processes as La Grange-Hoho, Zerener electric blowpipe, Bernardos arc-welding, and Thomson. Part III, dealing with hot-flame welding, takes up the oxy-acetylene and oxy-hydrogen processes, dealing with the former in detail in the following chapters: Apparatus and Gases, Practice, How to Weld, Adaptability, Typical Welds and Repairs, Acetylene Welding versus Riveting, Repairing Defective Castings, How to Cut Metals, Costs, Chemistry and Thermics, and Testing. In the fourth part which deals with Thermit, chapters are given on History, Apparatus and Rail Welding, Practice, Butt welding of Pipes, Mending Defective Castings, Thermit in Foundry Practice, Typical Welds, Testing, Lafitte Welding Plate, Ferrofix Brazing Process, Brazing and Soldering, and Glossary of Terms. It forms a comprehensive work on welding in all its branches, and may be considered authoritative, several eminent metallurgists having been consulted in its preparation.

CATALOGUES AND CIRCULARS

Bristol Co., Waterbury, Conn. Bulletin No. 140 on Bristol's recording gages for all ranges of pressure and vacuum.

Winfield Electric Welding Machine Co., Warren, Ohio. Pamphlets on Winfield No. 305 electric spot welder, and Winfield No. 336 electric point welder.

Adams Co., 847 White St., Dubuque, Ia. The Farwell gear testing machine is described on leaflet No. 821. The description is brief, being limited to a single page.

Société Française de Machines-Outils, Saint-Ouen, France. Catalogue describing in detail the combined horizontal and vertical milling machines made by this firm.

Lodge & Shipley Machine Tool Co., Cincinnati, O. Catalogue No. 22 descriptive of the multiple stops for engine lathes, which can be furnished with any of the company's lathes.

Garvin Machine Co., Spring and Varick Sts., New York. Circulars No. 135 on the Garvin milling machine No. 2-A, and No. 152 on Garvin hole grinding machine No. 2.

C. F. Pease Co., 167 Adams St., Chicago, Ill. Catalogue describing full lines of blue-print machinery, blue-print room supplies, direct white-print machinery, and drafting-room furniture and supplies.

Hess-Bright Mfg. Co., Philadelphia, Pa. Sheets Nos. 62 and 63 of series 336, showing the uses of style B bearing mountings without shoulders on shaft, and ball bearing mounting and demounting tools.

Gerard Development Co., 74 Broadway, New York. Leaflet giving brief description of a series of tests recently conducted by Prof. Pryor on a 100 H.P. Herrick balanced rotary engine, with the results tabulated.

Aurora Tool Works Co., Aurora, Ind., has just issued an attractive catalogue descriptive of the full line of Aurora drills. Each of the various sizes made is illustrated, and specifications of the machines are given.

Lees-Bradner Co., Cleveland, Ohio. Pamphlet containing an illustrated description of automatic gear generators, with special reference to the No. 5 machine for hobbing spur, spiral and worm gears, and threading worms, made by the company.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Parts catalogues Nos. 6141 and 6143. No. 6141 lists parts for the Westinghouse type 306 interpole railway motor for direct-current circuits, and No. 6143 lists standard metallic brushes for alternating and direct-current circuits.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn., is distributing a table of three-place logarithms on a celluloid card, of a size suitable for the vest-pocket. The table is accompanied with a leaflet illustrating their use and showing how time can be saved in calculation of engineering problems.

General Electric Co., Schenectady, N. Y. Bulletin No. 4662-A is a new edition of the bulletin on watthour meters for switchboard service; No. 4790 deals with electric mine locomotives and their equipment in a detailed manner; and No. 4794 describes the 1200 volt lines of the Milwaukee Electric Railway & Light Co.

Buffalo Steam Pump Co., Buffalo, N. Y. Catalogue No. 230 containing 96 pages, devoted to a description of the single-stage centrifugal pump. The company's complete lines of horizontal and vertical, pulley, motor and engine-driven centrifugal pumps are here listed, the various details of construction being fully dealt with.

Modern Tool Co., Erie, Pa. Catalogue of plain, universal and internal grinding machines, Wallace die chaser grinder and universal graduating machines, self-opening screw cutting die heads, adjustable solid dies and milling tools, adjustable tap- and die-holders, friction and positive drive chucks, special lathe chuck and tapping attachments, etc.

Fairbanks, Morse & Co., Chicago, Ill. Catalogue No. TV 1427 shows the new 25 H.P. traction engine recently placed on the market by this concern. This traction engine is driven by a four-cycle gas engine capable of operating on gasoline, benzine, naphtha, or distillate,

CONTENTS FOR JANUARY

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition.

and can drive in either direction. A very neat power transmission gear is employed.

American Swiss File & Tool Co., 24 John St., New York. This descriptive price list of American Swiss files, forms a complete fine-file catalogue, illustrating and listing the various styles made by this company, which specializes on fine files exclusively. These "files of precision" are distinctly an American product, and the line being fully developed, offers a wide range for selection, for toolmakers' and die-sinkers' uses.

Ingersoll-Rand Co., New York. Form No. 3002 descriptive of class A-1 straight-line, steam-driven, single-stage air compressors, and form No. 9002 devoted to Davis calyx diamondless core drills, are typical of the publications issued by this firm. In the former, the chief mechanical constructional features are dwelt upon fully, while in the latter the drill in actual use, and the results of its use are described, as well as its construction.

Osborn Mfg. Co., Cleveland, O. Catalogue No. 131 descriptive of the full line of foundry supplies, molding machines, brushes, brooms, and hardware specialties marketed by this concern. Under the first two heads come the various kinds of Osborn molding machines, grinding machines, tumbling barrels, core ovens, barrows, ladles, and molders' tools as well as many other articles. A very large variety of brushes of all kinds for numerous purposes, are also included in the catalogue, this being one of the firm's main lines.

Joseph T. Ryerson & Son, Chicago, Ill. Two catalogues, one of which is on power presses, describing foot, bench, inclinable, power, wiring, horn, pillar, and toggle presses, special reference being made to the special, positive, instantaneous clutch, which is separately described. The other catalogue, on emery wheel machinery opens with a general talk on emery wheels with data for grade selection, and proceeds to describe and list their full line of abrasive machinery.

General Electric Co., Schenectady, N. Y. Bulletins No. 4780 illustrating and describing the Gem or metallized filament incandescent lamp; No. 4781 illustrating the G-E Magda incandescent lamp for street lighting; No. 4782 on direct current exciter panels; No. 4786 devoted to signals, auxiliary apparatus, and materials; the third edition of No. 4602-B descriptive of automatic voltage regulators for direct current generators; and Pamphlet B-3006 containing an article on luminous and flame arcs, versus open and enclosed carbon arcs for street lighting, read before the National Electric Light Association.

Carlyle Johnson Machine Co., Manchester, Conn. Catalogue E for 1911 on the Johnson friction clutches, comprising 45 pages, 4½ by 7 inches. This catalogue is larger and more comprehensive than any before issued by the company. It deals almost exclusively with the driving of machinery through friction clutches, special attention being given to the driving of machinery from line-shafting, thus eliminating cross belting, countershafting, etc. Special mention is made of clutches for cut-off coupling work for use with marine motors. The lists are complete, extending to clutch parts which are numbered to correspond with the numbers indicating the parts on sectional views.

National Machine Tool Builders' Association, Charles E. Hildreth, secretary, Worcester, Mass. Official report of the ninth annual convention held in New York, October 25 and 26, 1910. In addition to a detailed account of the business transactions, all the papers read before the meetings are given, along with the discussions that followed each delivery. The following are the papers presented: "Who should pay the Expenses of a Representative from the Factory when sent out at the request of a Dealer to help close a Deal?"; "The Use of Ball or Roller Bearings in Machine Tool Construction"; "Concrete *vs.* Wood Flooring"; "Advertising"; and "The Design and Construction of Machine Tools from the User's Standpoint." The reports of different committees previously appointed, were also received.

Eugene Dietzgen Co., Chicago, Ill. The ninth edition of its drawing materials and surveying instruments catalogue might well be termed an engineers' instrument treatise, so complete is it. It is a book, 6 by 9 inches, containing 555 pages attractively arranged. So many and varied are the lines described and catalogued, that even a partial list would be impossible. Every drafting room requisite is given, from drawing and blue-print papers to drawing instruments. In this class may be included many special topographical drafting devices. Following this is a complete array of all kinds of surveyors' instruments, chains, transits, theodolites, etc., and many other civil engineers' requirements. In addition to these few mentioned might be noted planimeters, anemometers, current meters, and other recording devices for varied uses. A good list of books on drawing and scientific subjects, is included.

TRADE NOTES

American Emery Wheel Works, Providence, R. I., was awarded a gold medal at the Brussels Exposition for its exhibit of grinding wheels and abrasive products.

Edgar Allen & Co., Chicago, Ill., announces the appointment of Schrock & Squires, 291 Pearl St., New York, as the eastern agents for their tool steels, large stocks of which will be carried by them in their warehouse, to promptly meet customers' requirements.

Peerless Automatic Machine Co., Cleveland, Ohio, manufacturer of automatic screw machines, whose plant was burned out a few months ago, is now located in its new factory at West 77th St. The shop building is 60 by 300 feet long. The company is now in position to take care of orders.

Foster Engraving Co., Newark, N. J., is having its pressure regulators made on a commercial scale in accordance with the new patent laws of Germany, Austria, Hungary, Belgium and France. Arrangements for foreign manufacture were made by Dr. Robert Grimshaw of Dresden, Germany.

Longyear & Hodge, Marquette, Mich., have been located in their new, fully-equipped factory for a short period. The whole plant has been arranged with the idea of the rapid and efficient production of their special lines which consist of diamond drills, and drill machine parts, though the plant is also equipped for doing a general machine shop business.

Max Ams Machine Co., Mt. Vernon, N. Y., has, through its president, Mr. Charles M. Ams, established branch houses in England and on the continent for the sale of its sanitary solderless sealed can and the Ams double seamers. The new Ams factory at Turin, Italy, is completed and thoroughly equipped. It is one of the largest in southern Europe.

Institute of Operating Engineers, 29 W. 39th St., New York, has issued a prospectus containing the proposed plan and scope of its work. Several branches are now in process of formation throughout the country and the work has already been adopted in the extension course at Teachers' College. The chairman of the executive committee is J. C. Jurgensen; secretary, M. W. Rice.

R. D. Nuttall Co., Pittsburg, has introduced an innovation into railway equipment parts by bringing out casehardened gears and pinions. While many of these have been in service for some time, the announcement has been deferred until experience showed that the parts would stand up under severe conditions. So satisfactory have been the results, that it has been decided to add these gears and pinions to the regular lines.

Vonnegut Hardware Co., Indianapolis, Ind., separated its machinery department from the rest of its business January 1, 1911, and is operating it under the name of the Vonnegut Machinery Co., as a branch of the Vonnegut Hardware Co. The Vonnegut Machinery Co., will be located in the building formerly occupied by the Francke Hardware Co., 43 to 45 South Meridian St. The sales organization will include Messrs. Anton Vonnegut, Charles Rassman and C. B. Williamson.

Morgan Electric Co., Alliance, Ohio, has erected a large electric sign on the smokestack of its plant. The sign spells M O R G A N, the letters being hung perpendicularly down the side of the 400-foot smokestack. The sign is readable a mile and a half away. It was built by the Dittenhafer Sign Co., Canton, Ohio, of a rust-resisting "Toncan" metal made by the Stark Rolling Mill Co., of the same place. The letters are six feet high and the width of stroke of each

LATHE CHUCK JAWS—I

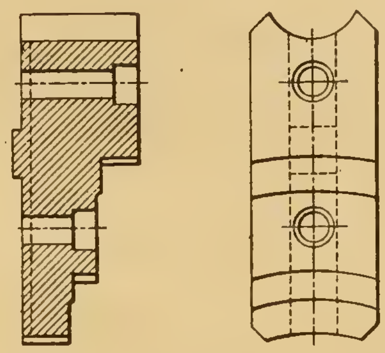


Fig. 1. Chuck jaws usually supplied with lathe chucks. The chief value of this type of jaw lies in its adaptability to a large range of work.

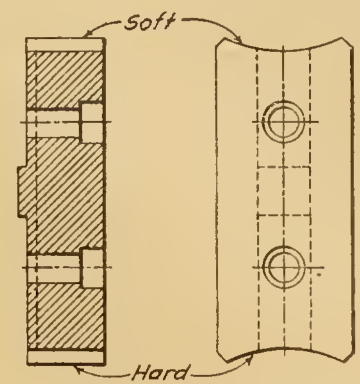


Fig. 2. For gripping plain bushings when machining in two operations: First grip rough part with hard end of jaw, then reverse jaw and grip finished part with soft end of jaw. This type of jaw is also used when it is necessary to have the work pass into the spindle.

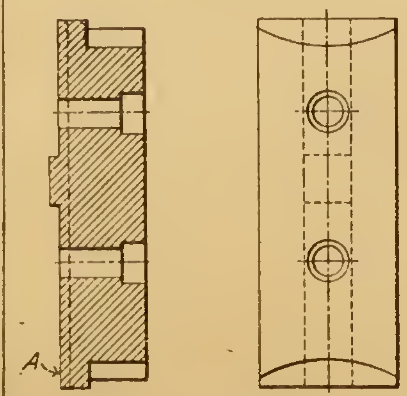


Fig. 3. For holding work which is to be faced to length. The shoulder A acts as a stop for the work. These jaws are made with either hard or soft ends.

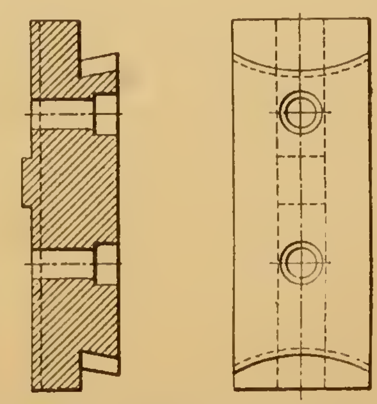


Fig. 4. For holding piston rings or similar work. The piston rings are made from long castings and are tapered on one end, which is gripped in the chuck. The jaw is made to conform to the tapered end on the casting.

LATHE CHUCK JAWS—II

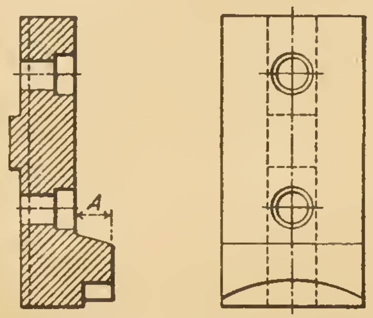


Fig. 5. For holding work where it is necessary to have the toolpost come close to the jaws. The jaws are cut back at A for clearance.

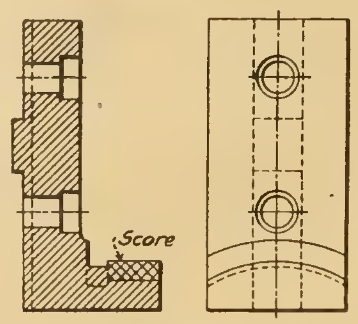


Fig. 6. For gripping under a flange. These jaws are made to conform to the shape of the work and are scored.

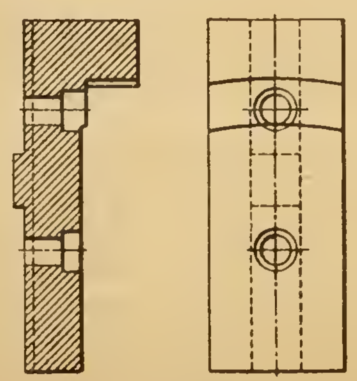


Fig. 7. "Hook" jaw for increasing the capacity of the chuck; used principally for gripping fly wheels, etc.

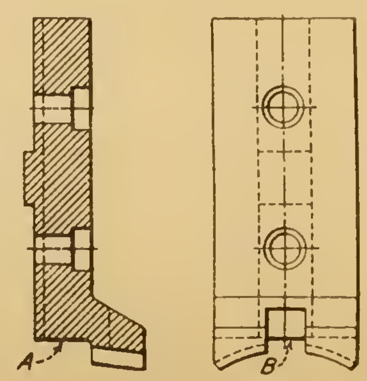


Fig. 8. For holding pulleys, etc. The jaws are cut out at A to permit back facing the hub, and are slotted at B to straddle the arms.

LATHE CHUCK JAWS—III

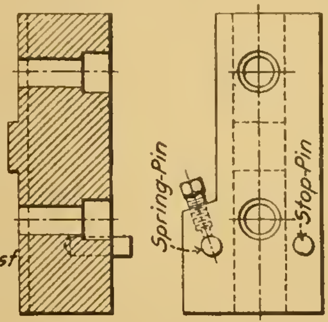


Fig. 9. For holding work of irregular shape. This type of jaw is provided with spring-pins, which are used for truing up the work. In operation place the work in the jaw against the stop-pin, then rotate chuck to true up work. Release spring-pin opposite low spot on casting, by loosening set-screw which presses on shoe. Lock spring-pin with set-screw when work is trued up.

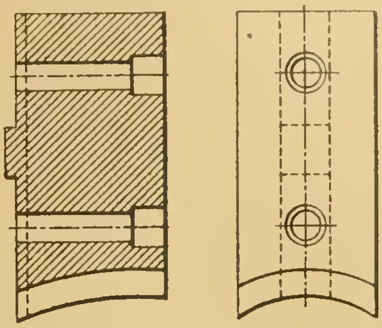


Fig. 10. A type of jaw which is usually to be avoided, but may be used if sharply scored.

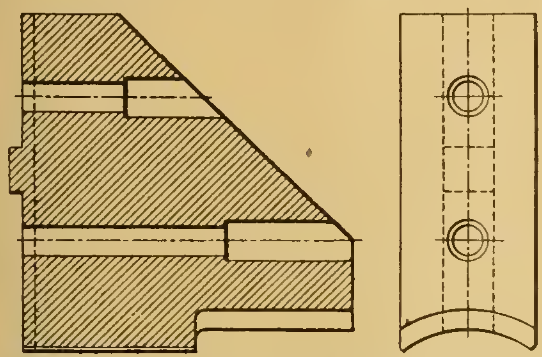


Fig. 11. For holding long finished work which has one or more diameters. Jaws are made to conform to the two diameters, thus giving a better gripping surface.

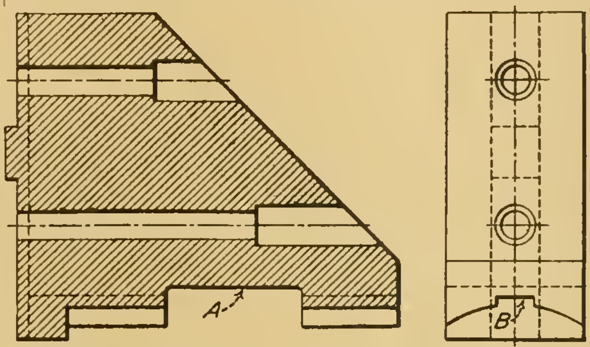


Fig. 12. For holding long rough work such as castings, etc. The jaws are cut out at A, and slotted at B, so as to give a four-point grip.

LATHE CHUCK JAWS—IV

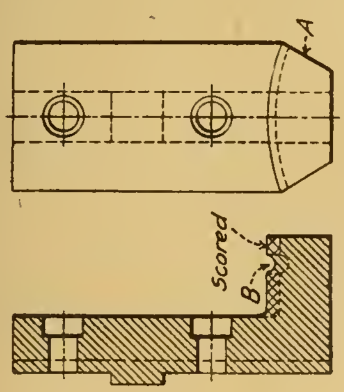


Fig. 14. For gripping between the arms, and under the rim of gears, pulleys, etc. The jaws are beveled at A to conform to the angles of the arms, and cut out at B to straddle the web.

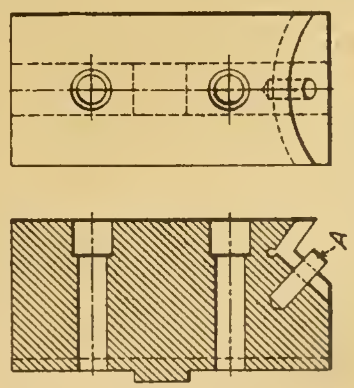


Fig. 16. For holding cast bevel gears. The jaws are made to conform to the bevel on the gear, and the pin A is used for driving, being engaged in a tooth space.

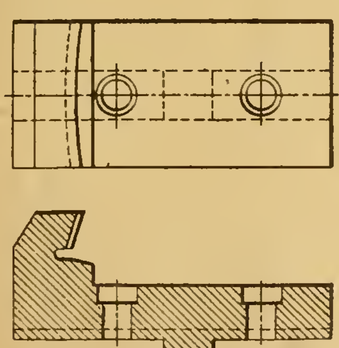


Fig. 13. For holding bevel gears, etc. The jaws are made to conform to the bevel on the gears.

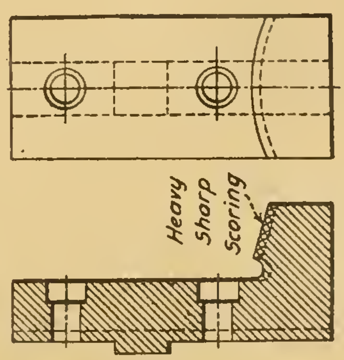


Fig. 15. For holding bevel gears, etc. which are finished in one operation. The jaws are made with a slight angle and are scored.

// MACHINERY
February, 1911

MACHINE TOOL TESTING

A METHOD OF TESTING AND INSPECTING VERTICAL BORING MILLS AT THE BULLARD MACHINE TOOL CO.'S SHOPS

By ERIK OBERG*

MECHANICS engaged in the building of machine tools are, in general, quite familiar with the methods ordinarily used for testing the alignment and truth of ways, spindles, shafts, tables, etc., as ordinarily carried out in machine tool building plants. Some of these methods have been described and illustrated in previous issues of MACHINERY. (See MACHINERY, November, 1909, "Assembling a 24-inch Engine Lathe"; December, 1909, and January, 1910, "Assembling a 48-inch Motor-Driven Planer.") Well-defined methods for a final running test, carried out systematically and with a view of detecting and eliminating all possible defects in the machine before shipping, are, however, not in vogue in machine tool building plants in general. For this reason a description of the system used for this purpose at the Bullard Machine Tool Co.'s shops at Bridgeport, Conn., will be of especial interest to all concerned with machine building in general, and especially to machine tool builders and users.

The boring mills and vertical turret lathes built by the Bullard Machine Tool Co. are all made according to the unit system of construction, that is, each of the devices of which the complete machine is made up is self-contained, being built and assembled as units, all these units being then finally assembled at one time on the frame of the machine proper. The unit system of construction admirably lends itself to the plan of testing put into use in these shops. In fact, if such a system of building the machines were not used, some of the preliminary tests now carried out would be impossible.

Briefly described, the testing system consists of first testing the running and power transmission qualities of each of the individual units that go to make up the machine, dynamometer tests being made on the most important parts, and then, when all the units are assembled and the machine is ready for shipment, it is again subjected to a final test and inspection, while running idle as well as while under load. Suitable instruments are used in the test to record definitely the conditions to be determined. Besides these tests, the machines are subjected to the regular tests for alignment, etc. and rigid inspection of both the individual parts and the assembled machine, the same as in any well conducted machine tool shop.

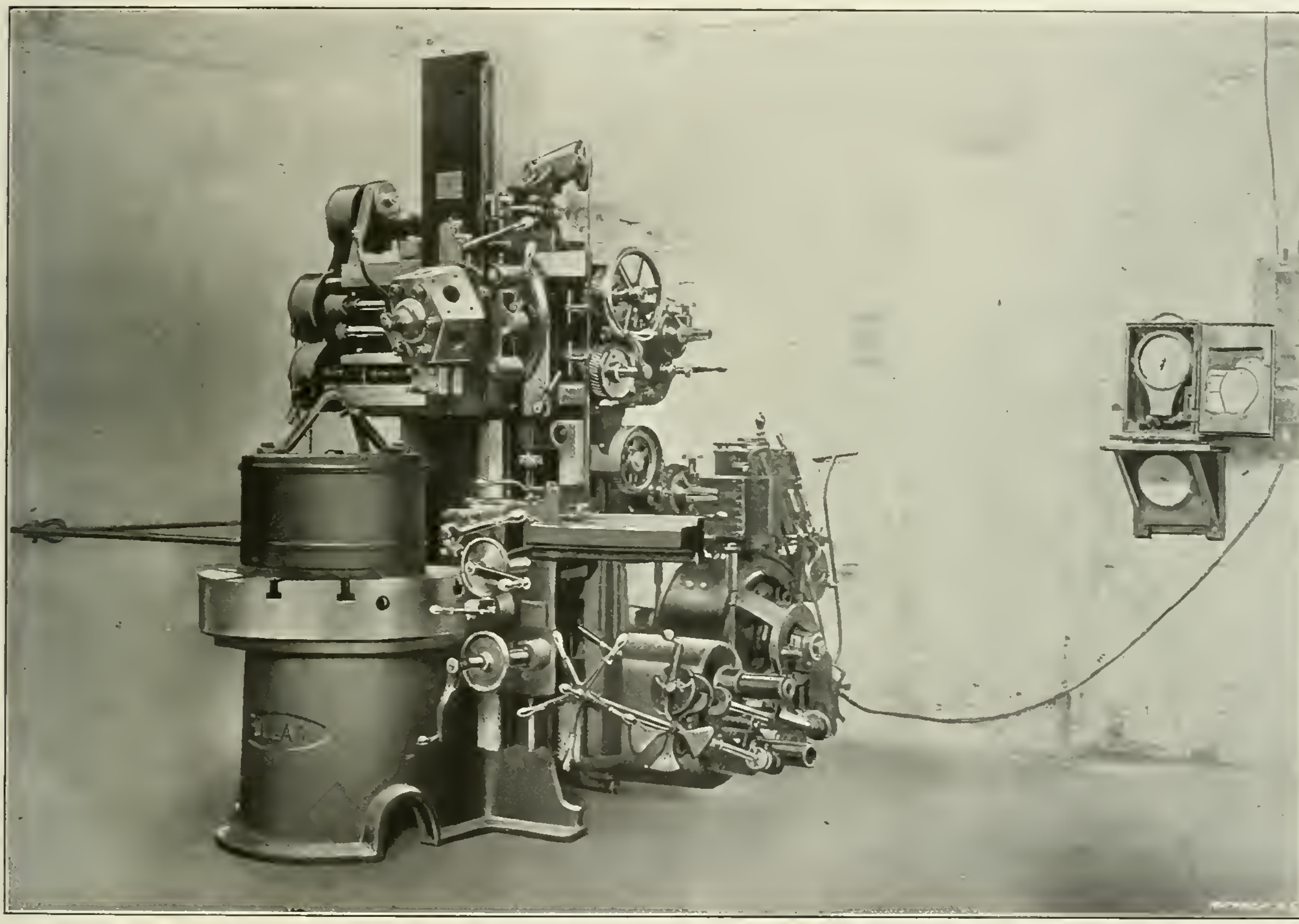


Fig. 1. Bullard 24-inch Vertical Turret Lathe under Final Test before Shipping

Testing the Driving Speed Box

In Fig. 3 is shown the arrangement for testing the running qualities of the power transmission gears in the main speed box through which the power to the machine is delivered. The speed box is mounted on a frame and support as indicated, and power is transmitted to it by means of a belt pulley on the end of the regular driving shaft. The dynamometer is then so arranged that the power delivered from the shaft which afterwards furnishes the power to the machine itself, is measured. In this way the conditions to which the speed box is subjected during the test are exactly the same as those

* Associate Editor of MACHINERY.

to which it will be subjected when assembled on the machine

There are five speed changes in the gear box and each of the sets of gears is subjected to a load test corresponding to a delivery of 15 H.P. The adjustment for measuring the power at the various speeds is very simply taken care of by means of a standard lever-arm and weight, as indicated in the illustration, the lever-arm being provided with five eye bolts at carefully pre-determined locations, to which the weight is successively attached by a hook as shown. This simple arrangement makes it possible to test the power output at the various speeds very quickly. As 15 H.P. is an output much greater than that to which the machine is ever likely to be subjected while in actual operation, any defect in the gears of whatever kind would be likely to show itself at this time. Any defects in alignment causing heating or binding, and any defects in the gears producing excessive noise, are easily detected at this time and remedied before the gear box is assembled on the machine.

Testing the Feed Gear Boxes, Power Traverse Gear, etc.

In Fig. 2 are shown a number of the minor gear boxes and mechanisms set up for testing. Some are mounted on special brackets and others directly on plates screwed to the bench. Each part is provided with an individual pulley and driven from overhead shafts. During the tests of these minor details, no actual dynamometer test is made, but each of the parts is running under a load obtained by clamps firmly secured to the ends of the shafts, these clamps being prevented from rotating by resting one end against the bench. This arrangement is seen in three instances on the illustration. The parts are permitted to run in this way for about an hour, during which time the inspector is watching their performance, looking out for any undue noises of the gears, heating of the bearings and shafts, or any other defects. All defects found at this time are remedied, and the units do not pass through this stage of the testing before they are running in a satisfactory manner.

Testing the Complete Machine

The most interesting part of the tests to which the machines are subjected, however, yet remains to be described. This test takes place when the machine is finally assembled and has passed the ordinary inspection tests on the assembling floor. Under ordinary conditions, in fact, we would say that the machine is ready to ship, and in a great many machine shops the machines *are* shipped at this stage. The experience of the Bullard Machine Tool Co., however, indicates that the final test to which they subject their machines often is a means for detecting defects which would have passed through all previous stages of inspection, and which, in fact, no other method of inspection would make it possible to detect. These are the defects which ordinarily are found first when the machine is mounted and set to work in the shops of a customer, and which cause a great deal of expense, worry and difficulty—both directly and indirectly. By subjecting the machines to this final test before shipping, nearly all these minor defects—defects which in some shops are considered as absolutely unavoidable—are in the majority of cases remedied before the machine leaves the builders' plant.

During this last test, the machine is driven by an electric motor belted to the driving pulley of the machine, a watt-meter being connected to the motor so that the load on the motor is carefully recorded. The machine set up for the final test, the motor by which it is driven, and the watt-meter are shown in Fig. 1. On the table of the machine is mounted a friction disk brake by means of which the load is applied to the machine, one set of the disks of this brake being held stationary and the other revolving with the table. The friction brake can be adjusted to whatever resistance is required.

The test proper is divided into three stages: First the machine is run idle for one hour; then load is applied during another hour's run; and finally the machine is again run idle for a third hour, except that at this time all the feed motions, traverse motions, reversing gears, etc., are set into action. During the whole of this test an inspector who is entirely independent of the shop and who has had nothing whatever to do with the machine until it passes to him for its final inspection, takes note of the behavior of all of the working parts of the machine. A most interesting feature of the test is the record made of the temperature of the bearings. Thermometers are submerged in the oil wells of all the important bearings and it has been found that this temperature test of the bearings is the only possible means for detecting slight

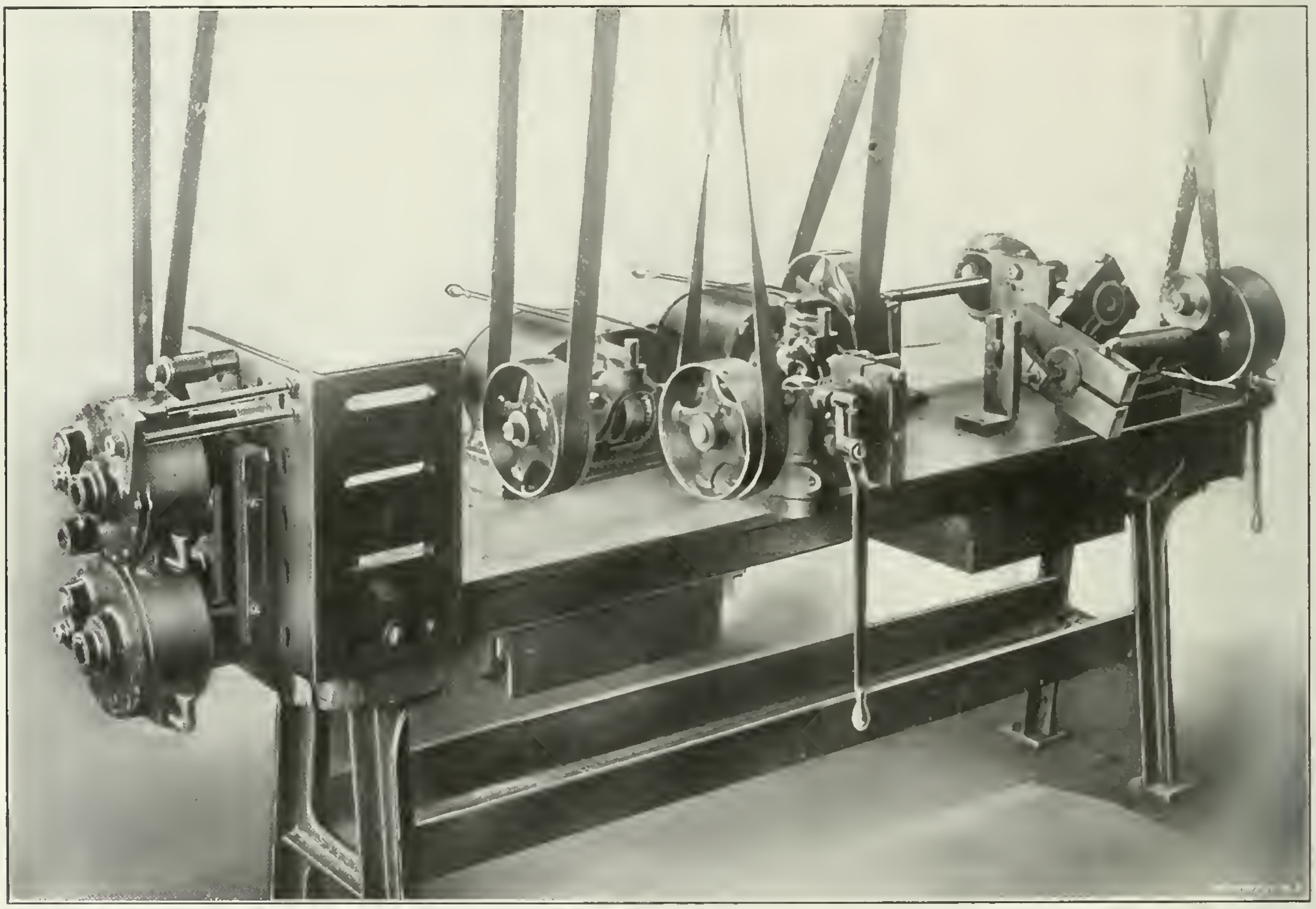


Fig. 2. Testing the Various Units—Feed-gear Boxes, Traversing Gear, etc.—before Final Assembling on the Machine

defects in the alignment of shafts, causing in some instances a very small—yet objectionable—binding action and consequent heating of the bearings. A temperature, under load, of 110 degrees F.—rapidly rising in some cases—has been found to indicate trouble, the difficulty being almost always due to misaligned bearings. Any temperature over 95 to 100 degrees is carefully watched, and the test prolonged to allow a thorough observation of the part in question.

While the inspection system in the shop proper, covering the individual parts of the machine when in process of manufacture, is as rigid as it can possibly be made, a great many

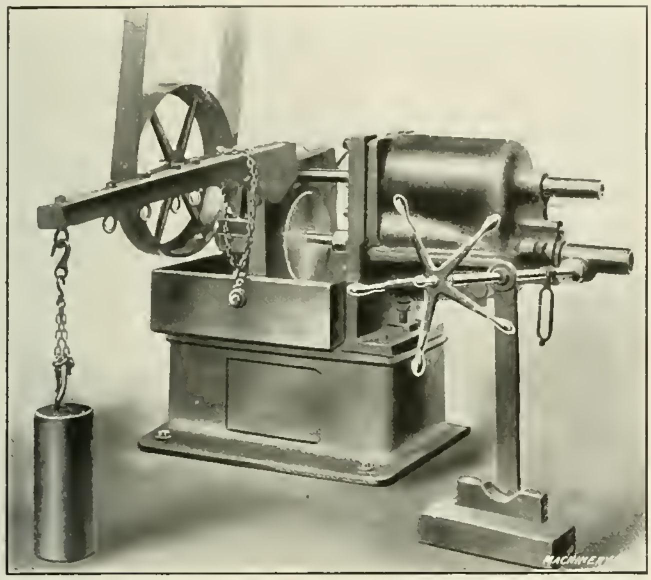


Fig. 3. Testing the Speed-box Gearing before Assembling on the Machine

minor defects in adjustments and some omissions are detected and remedied during this final inspection. The fact that the inspector is entirely removed from the shop proper and is responsible to no one but the superintendent is an important feature of this system of inspection, as, of course, the personal factor in any inspection system of this kind is a most important consideration. The inspector must actually look for defects, and have no hesitancy in putting them on record; otherwise the system would be of little value.

In Fig. 4 is shown a chart made on a Bristol's recording

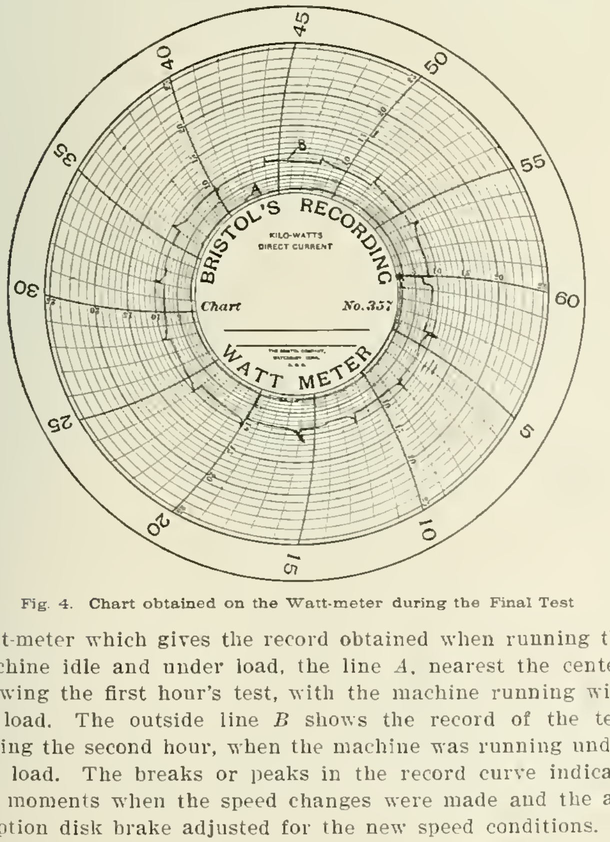


Fig. 4. Chart obtained on the Watt-meter during the Final Test

watt-meter which gives the record obtained when running the machine idle and under load, the line *A*, nearest the center, showing the first hour's test, with the machine running with no load. The outside line *B* shows the record of the test during the second hour, when the machine was running under full load. The breaks or peaks in the record curve indicate the moments when the speed changes were made and the absorption disk brake adjusted for the new speed conditions.

Ordinarily three charts are made, one for each hour's test, but in the present case the records have all been made on the same chart in order to show comprehensively how the test is made. The third hour's test covers that of the first hour, so that only one line is shown for both these tests. The report made by the inspector includes three of these charts, a temperature record for the bearings, and a list of the defects found. The inspector's report, for example, would have the appearance as shown below:

Inspector's Report of Final Test of 24-inch Vertical Turret Lathe

Bearings	Temperature, Degrees F. First Hour, Light	Second Hour, Load	Third Hour, Light
Speedbox Bearings	70	88	85
Headstock Bearings	65	68	68
Table Pinion Bearing	76	79	80
Power Traversing Bracket, Upper	68	71	72
Power Traversing Bracket, Lower	70	74	74
Feed Works, Upper	66	68	68
Feed Works, Lower	65	69	69
Driving Pulley Bracket	70	80	78

Remarks

Headstock: Oil level set too high. (Reset).
Speedbox leaked. (Return hole drilled).
Observation stops Nos. 4 and 5 bad. (Replaced).
Feed-worm bottomed in upper gear. (Stop adjusted).
Side-head turret bound on stud when filled with tools. (Hole relieved).
Instruction plate on speed box missing. (Attached).
Chuck-jaw binder bolts bottomed in T-slots. (Shortened).
Two securing-screws loose in table gear. (Replaced).
(Signed) Olsen—Inspector.

The items under the head of "Remarks" which are in parentheses, indicates what means have been taken to remedy the defect. At the time when the machine has passed out of the inspector's hands, there is little likelihood that any defect of a serious nature will ever be detected after the machine has been installed in the shop of a customer.

The Bullard Machine Tool Co. believes that this system of protecting both itself and the customer against the annoyances of small imperfections is unique. The system shows an appreciation on the part of the company of the importance of guarding against the unfavorable influence caused by small and comparatively unimportant details being overlooked. These, in the long run, have a most important effect on the reputation of a firm as regards the care with which the machinery is built and the final inspection carried out.

* * *

COPPER-CLAD STEEL

As a result of a number of attempts to produce steel with a copper coating which could be of any desired thickness and in which the two metals could be so securely welded together as to be amenable to any of the usual methods of metal working without destroying the integrity of the weld, a method of thus treating steel has been developed according to the *Journal of Industrial Engineering and Chemistry.* In this process the steel is rolled into short round billets which are sandblasted and pickled to remove the scale. The billet is brought to red heat in a pre-heater, and then immersed in a copper bath which is in a supermolten condition, and forms an alloy film on the billet. The billet is then centered in a tube mold and commercially pure molten copper poured in around it. This forms a uniform shell which is allowed to harden. The copper clad billet thus formed is removed from the mold and after a washing heat, is rolled to the size desired, the proportional areas of the copper and steel remaining practically constant for all sizes. The tensile strength of this copper clad steel is equal to, if not greater than the steel which has been thus treated.

* * *

The composition of babbitt metals as specified by the Bureau of Steam Engineering of the United States Navy, should be 88.8 per cent banca tin, 7.5 per cent antimony, and 3.7 per cent copper. The metals should be well fluxed with resin and borax in mixing.

PUNCHES AND DIES FOR MAKING A SPRING CLIP

By DAYTON

The following article describes an interesting set of punches and dies for making a spring clip which is attached to a leather typewriter carrying case. These punches and dies were designed in a shop where the writer was formerly em-

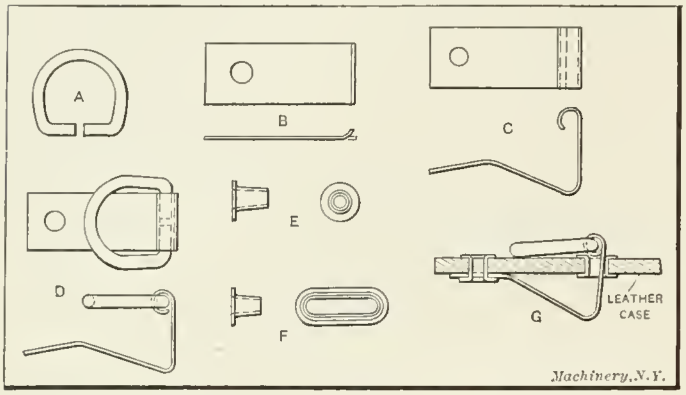


Fig. 1. View showing the Various Operations on a Spring Clip used on a Leather Carrying Case for a Typewriter

ployed, and were used for performing the various operations on the pieces shown in Fig. 1. It may be mentioned that these tools have been in continual use for over two years, and notwithstanding the fact that they were somewhat in the nature of an experiment they have proved to be all that was expected of them.

The various operations on this spring clip are illustrated in Fig. 1. The piece *A* is a ring made from soft-steel wire, which is cut off and bent in one operation. At *B* is shown the flat spring after the first operation, where it is pierced, cut off and slightly bent. The curling and bending operation on this spring is shown at *C*. Here the spring is bent and a three-quarter curl given to it. At *D* is shown the spring and ring assembled. *E* and *F* are the hollow rivets or eyelets, which are used. *E* is used for fastening the spring clip to the leather carrying case, and *F* is used as a guide, through which the spring operates. At *G* is shown the spring clip complete, and attached to the case. Here the spring clip is fastened to the carrying case by the hollow rivet *E*, and the hollow rivet *F* is riveted over the case and acts as a guide.

The first operation on this spring clip, is the making of the ring *A*, Fig. 1, and the dies for doing this operation are shown in Fig. 2. In this die the wire is fed in, cut off and bent at one stroke of the press. In operation, the wire is fed through the bushing *A* and up against the stop *B*. The hole in the bushing *A* is tapered, and the stock passes freely through it, except at the extreme inner end where it is made the same size as the stock. After the stock is inserted in the bushing *A* the press is tripped, and as the punch *C* descends, the shoulder *D* rests on the stripper-plate *E*. On the further downward movement of the ram, the punch *C* ascends into the space *F* against the tension of the spring *G*. This spring *G* returns the punch to its normal position on the return stroke. Ths cam *H* is set to act just after the punch *C* is in position on the stripper and moves the blade *I* which is fastened to the slide *J*. This plate or former *I* also cuts off the stock, performing this operation at the point *K* where the bushing *A* is hardened so that it acts as a shear. As the ram of the press descends still further, this former *I* is forced in and bends the stock around the lower end of the punch C_1.

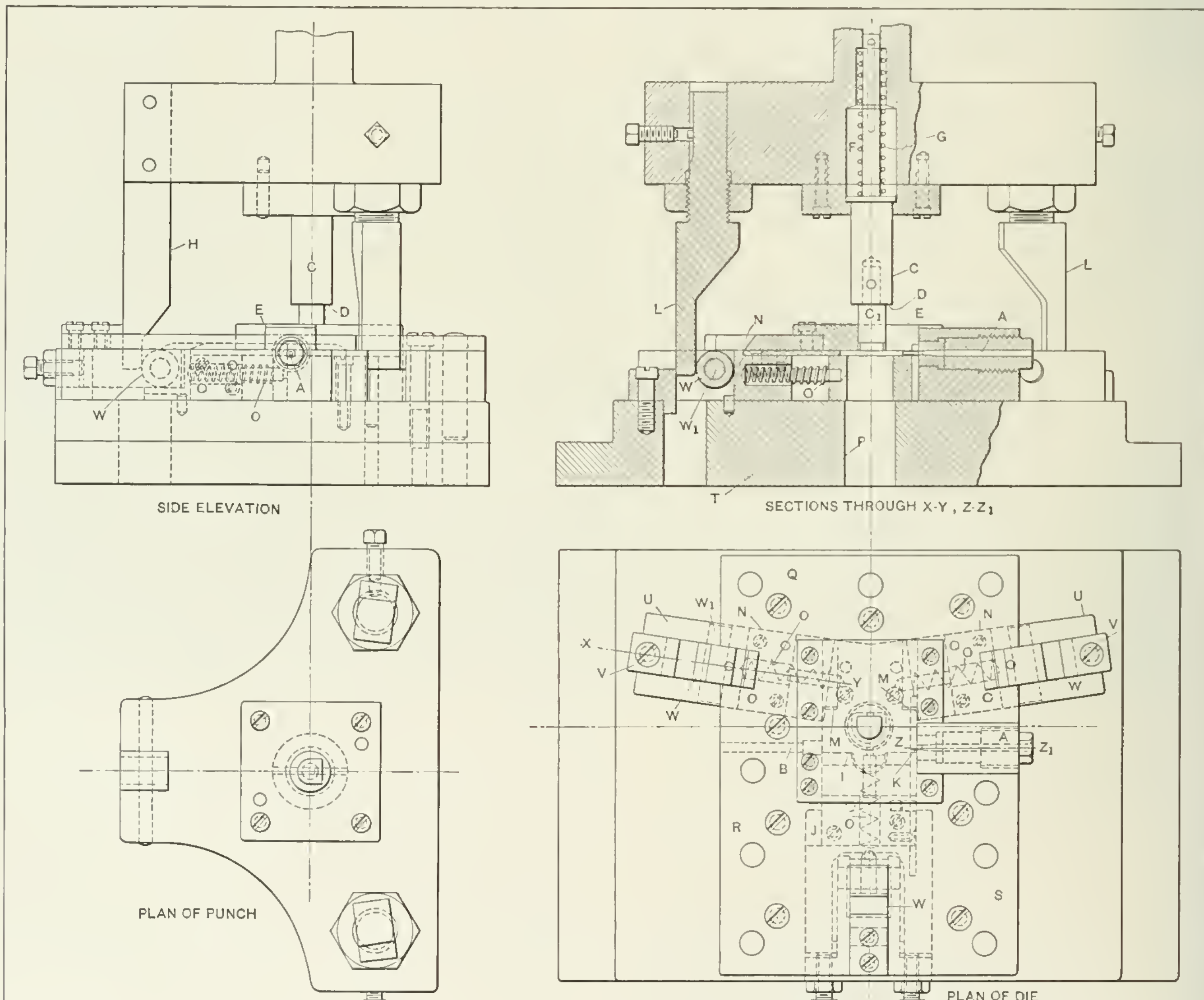


Fig. 2. Punch and Die for Cutting off and Forming the Ring

The former *I* is actuated by the cam *H*, which presses

against the roll W attached to the slide J. The slide J now remains stationary because of the straight portion of the cam H, and on the further descent of the ram the cams L come into operation on the slides N which are attached to each side of the die. These slides work in unison and carry formers M which bend the stock around the punch C_1. The slides N work in the holders U, and have rollers W attached to them. All the rollers W are pivoted on studs W_1. This completes the forming of the ring, and on the upward stroke

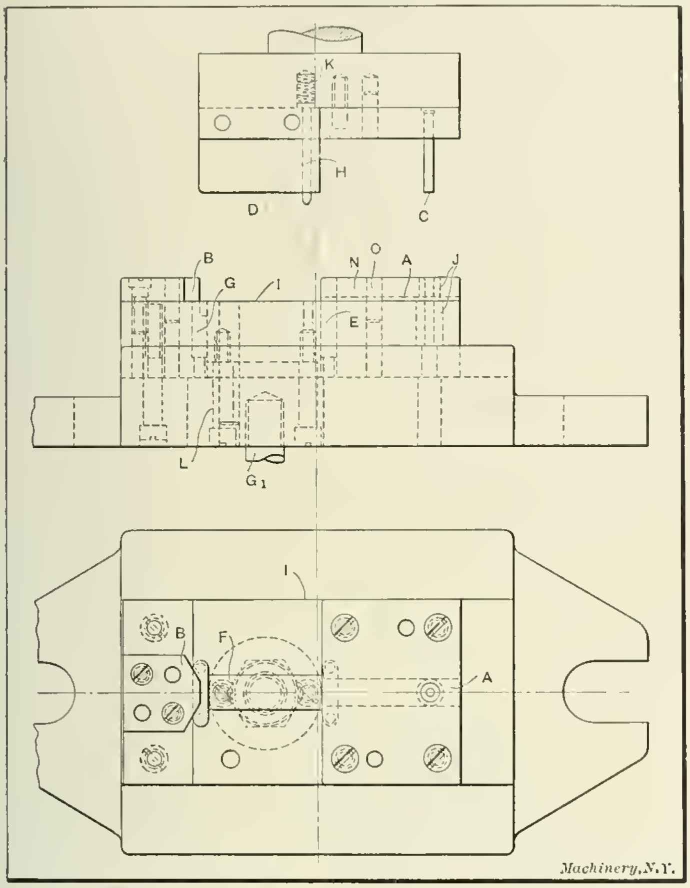


Fig. 3. Punch and Die for Cutting off and giving the First Bend to the Spring

of the press, cams L and H release the forming members which are returned to their normal positions by means of the various helical springs O. When the punch C rises, the completed ring is stripped by the stripper E and falls through the hole P cut in the base, into a basket. The feeding of this die is continuous, and as the trip can be held down until the stock is exhausted, the production is very rapid.

The guide-blocks Q, R and S are fastened to the base T and serve to guide the slides J and N in their travel. The slides N consist of the slotted pieces U, which slide between guides Q, R and S, and are also guided by blocks V. A keyway is cut in the punch C, in which a pin operates to prevent it from turning against the action of the forming slides.

The next step in making this spring clip is the cutting off and the forming of the first bend in the spring B, Fig. 1. The punch and die used for this operation are shown in Fig. 3. The stock is fed through the channel A against the stop B, and is pierced by the punch C. The punch D cuts the strip off, and also gives it a slight curl. The blade E and former G are set in the die, the blade E acting as a shear for cutting off the stock, and the blade G acting as the lower former. The blade E is carried down into the die on the pad F until the end of the stroke is reached, when the blank is curled on the former G.

As the hole is not blanked in the first step it is necessary that the pilot H should retreat. Provision is made for this by drilling a hole in the punch-holder, and making a shoulder on the punch. A spring K is set in the holder, behind the pilot H, which allows the latter to ascend when it strikes a strip without a hole, and forces it out when a hole has been blanked in the strip. This pilot H locates the blank in the correct position in the nest by engaging with the pierced hole, thus preventing the blank from slipping in the curling operation.

It will be noticed that the die proper is made up of several separate pieces, which are fitted to the main block I, the latter being made from tool steel. The piercing punch C works in a hardened bushing J. The blade E and former G are separate pieces and are hardened and ground. This permits them to be easily removed in case they break or other repairs are necessary. The pad F descends far enough for the curling operation to be completed when the punch D bears against it. A stiff spring, not shown, is fastened by the stud G_1 underneath the press, which actuates the pad F. The other details of this punch and die can be clearly understood from the illustration.

The spring is now ready for the second operation, that is, the complete forming and making of the three-quarter curl. This operation is done in the sub-press die shown in Fig. 4. The base A and plunger B of this sub-press are made from cast iron and are lined up with each other by the guide-pins C, as shown. These guide-pins are placed at the rear of the die, so as to facilitate its operation. The spring which is now in the form shown at B, Fig. 1, is placed in the nest in the carrier F, located at the front of the die. The carrier is then shoved into position by hand, and the spring located by the gage-plates D and E. After the spring is in this position the carrier F is returned to the front of the die by the spring G.

In operation, the punch H descends and forms the spring on the die I. The action of the punch H forces the work up in a perpendicular position between the face L of the pad O and face K of the punch. As the punch continues in its downward movement, the work passes up between the faces K and J on the punch, and is curled around in the circular former in punch N. The plate K_1 prevents the curl of the spring being

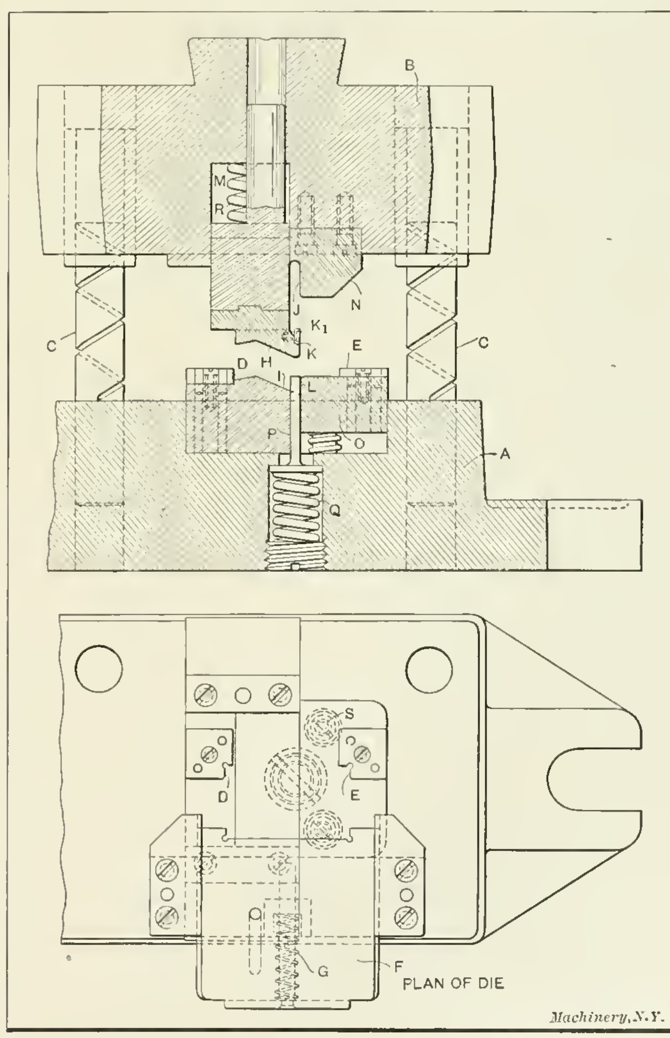


Fig. 4. Sub-press Die for Completing the Spring

completely closed. While the spring is being formed the punch H ascends into the space M, and after the bending operation is completed, the punch is returned to its former position by means of the spring R. In making the three-quarter curl the punch N forces pad O and plunger P down into the die,

these latter being returned by helical springs S and Q respectively, as shown. This plunger P acts as an ejector and forces the spring out of the die when the punch ascends.

The next operation on the spring clip is the closing of the

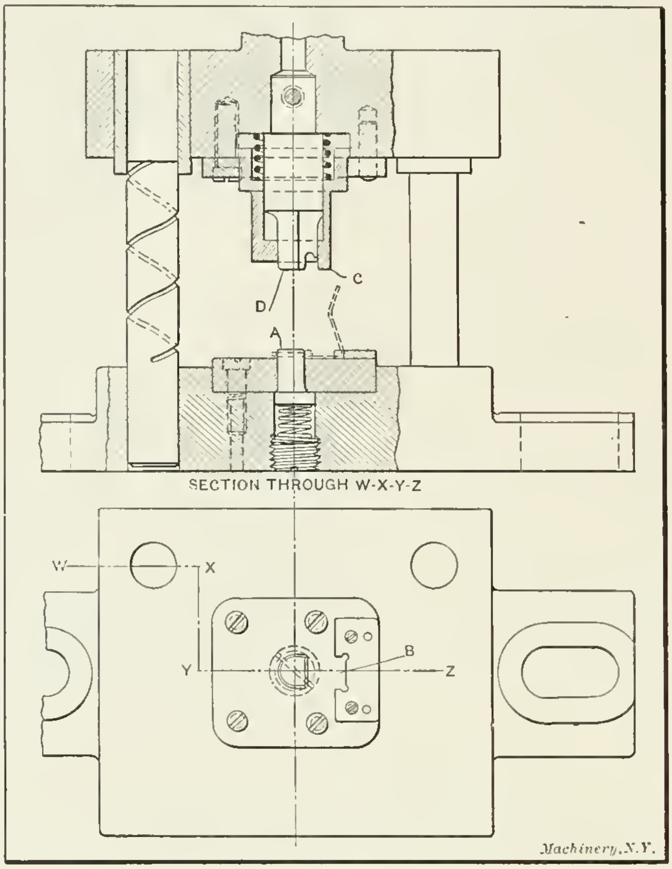


Fig. 5 Sub-press Die for Fastening the Spring to the Ring

spring over the ring. This operation is completed in the subpress die shown in Fig. 5. In operation the spring is hooked

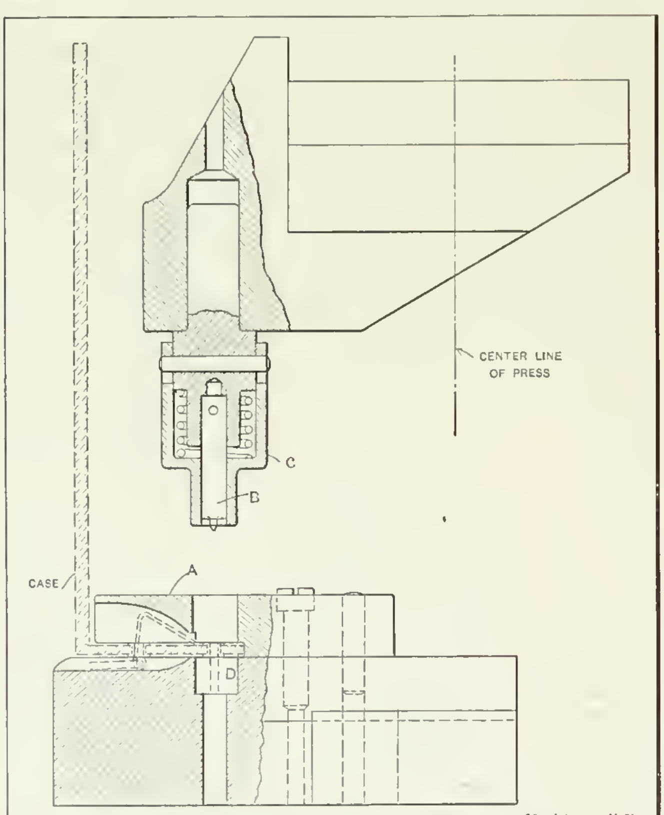


Fig 6. Punch and Die for Fastening the Spring to the Leather Case

over the ring, and the ring then placed on the plunger A, with the spring in the gage B. When the ram descends, the pad C holds the spring and ring down on the base of the die, and the punch D completes the bending of the spring around the ring. The punch D also forces the plunger A down into the die, and as the ram of the press ascends, the punch D lifts the ring from the die. As the ram ascends still further, the pad C descends, stripping the blank from the punch. This completes the making of the spring clip. It is now necessary to fasten it to the leather carrying case.

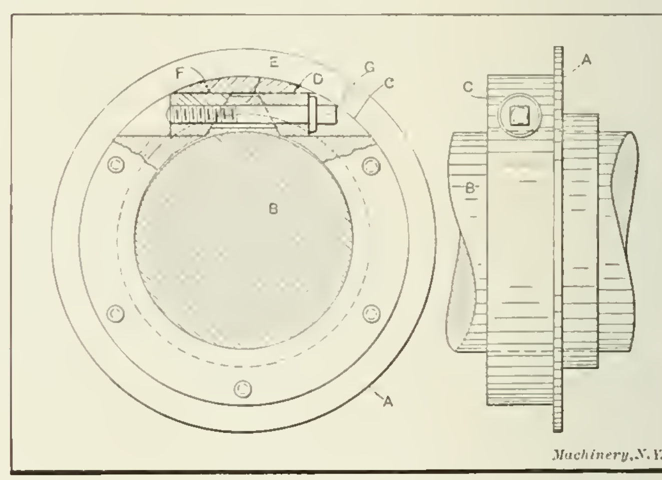
Before fastening the spring to the leather carrying case, the eyelet F (Fig. 1) is riveted in the case, but as the die for this operation is very simple it will not be necessary to show it. After the eyelet F has been riveted in the case, the spring can then be assembled. This is accomplished in the punch and die shown in Fig. 6. As can be seen from the illustration, this die is offset from the center of the press, so as to clear the ram.

In operation the spring is put through the eyelet F; then the eyelet E is inserted, and the case and spring placed in the die as shown. The stripper A is cut away to clear the spring. On the downward stroke of the press, the punch B bends the eyelet over the spring, thus fastening it to the case. The spring is held down on the case by the stripper C. A hardened steel block D is located in the die-block, on which the eyelet E rests. This block D has a hole in it which clears the teat on the riveting punch B. This completes the operations on the spring clip as shown at G in Fig. 1; a section only of the case is shown, as this is sufficient to illustrate the method of fastening.

* * *

FRICTIONAL LOCKING DEVICE

A frictional locking device, applicable to a large range of uses, but specifically applied in the patent to fastening the hand-adjusted reversible cutter-carrying bar of a paper board scoring machine, and also for fastening the cutters to their shafts in a paper or paper board slitting machine, is de-



Frictional Locking Device

scribed in U. S. Patent 974,156 (November 1, 1910) obtained by John G. Jones of Rochester, N. Y., assignor to M. D. Knowlton Co., also of Rochester.

The accompanying figure explains the mechanism, showing a paper-cutting knife A locked to the shaft B. The circular hole C contains three sleeves D, E and F, the latter one being threaded to receive the stud G which passes through the center of the sleeves D and E. The bore of E is larger than the bolt in order to allow lateral play, so that when G is tightened the sleeves D and F draw up on the sleeve E (the three sleeves having their inner ends tapered to bear upon each other) thereby tightening the sleeve E down on the shaft B. The lower side of E is gouged out to fit a small arc of the shaft. The figure clearly shows the details.

* * *

A power transmission plant is being erected at Lauchhammer, Germany, designed to generate current for transmission at a pressure of 110,000 volts, which is stated to be the highest voltage used for power transmission in Europe. The current transmitted is three-phase; the generator pressure is 5500 volts, which is transformed up to the transmission voltage by four transformers, each of 6800 kilowatt capacity.

DIE-CASTING*—2

GENERAL PRINCIPLES OF DIE MAKING AND EXAMPLES

By A. C. VON DREELE†

The making of casting dies calls for ingenuity and skill of the highest order on the part of the die-maker. There is probably no class of die-making in which the work produced is more faithful to the dies, both in showing up the little details in the making that reflect credit on the dies, and in exposing the defects and shortcomings in the workmanship, if there be any. The castings from casting-dies or molds as they are sometimes called, may be produced in dimensions down to ten-thousandths for accuracy if necessary, and once the dies are made the castings will not vary in the slightest degree, if the working conditions are kept uniform.

In spite of the close work required in making casting-dies, the work is very fascinating. Perhaps it is on account of this accuracy; possibly it is on account of the fact that they are made from machine steel; but most likely it is because there are no hardening troubles to be contended with. Another factor that makes the work interesting is the ingenuity required in the work, for almost every die-maker, if he is worthy of the name, likes to figure out and plan for the best way of building a die for a difficult job.

General Principles of Casting-die Making

Casting-dies, or molds, have little in common with sand molds. It is true that the dies for die-casting are composed of two parts corresponding to the cope and nowel of the sand mold, but they are so different in every other way that no benefit would result from a comparison.

Generally speaking, casting-dies are made of machine steel; the parts which are exceptions are the heavy bases and frames, which are made of cast iron, and the dowel pins and small cores, usually made of tool steel. Except in rare instances, there are no hardened parts about a casting-die; this is the case because the melting points of some of the alloys that are die-cast are high enough to draw the temper from any hardened parts of the dies.

The ideal die is simple in construction, with as few parts as practicable; the castings should be easily ejected and should come from the dies as nearly free from fins as possible. To meet these requirements in the best way is the proposition that confronts the ingenuity of the die-maker. As the die is primarily in two parts, there must be a parting line on the casting. This line is always placed at the point that will permit the casting to be ejected from the dies in the easiest manner possible, bearing in mind the effect the joint will have on the appearance of the finished casting; this is a point far less important than with sand casting, for, if the dies are properly made this seam will be barely perceptible. When it is practical to do so, it is wise to have the parting line come on an edge of the die-casting. Draft is unnecessary on the straight "up-and-down" places, but of course it is impossible to draw any parts that are undercut. Means must be provided for ejecting the casting from the dies after completion and it is usually done by means of ejector pins, though frequently it is better to have the bottom of the die or some other section movable and do the ejecting on the same principle that is used on drawing dies of the compound type. On close work, shrinkage plays an important part, and the amount of shrinkage varies from 0.002 to 0.007 of an inch per inch. Aluminum shrinks the greatest amount, Parsons white brass shrinks considerably, while tin shrinks but little. Thus, it may be easily seen that to figure the shrinkage allowance for an alloy that contains three or four metals with different shrinkages, requires judgment. To prevent the air from "pocketing," air vents are necessary at frequent intervals around the die-cavity. These vents are made by milling a flat shallow cut from the die-cavity across the face of the die to the outside edges of the block. From 1/4 inch to 1/2 inch is the usual width and from 0.003 to 0.005 of an inch, the customary depth, varying with the size and shape of the die in question.

The dies or molds for die-casting are of various styles, as are also punch-press dies, and it would be difficult to lay down specific rules for their classification. There are the plain dies, without complications of any kind; slide dies with one or more slides; dies for bearings, both of the "half-round" and of the "whole-round" types; dies for gated work; and many other less important classes. Then there are dies that have features that belong to more than one of these types, so that it is easily seen that to decide upon the style of die that would be best for a given piece of work requires a good deal of experience. Some of the most important of these types can best be shown by illustrating dies made in the various styles, showing, step by step, how the dies are made and assembled. To commence with, consider the making of a casting-die of the very simplest form.

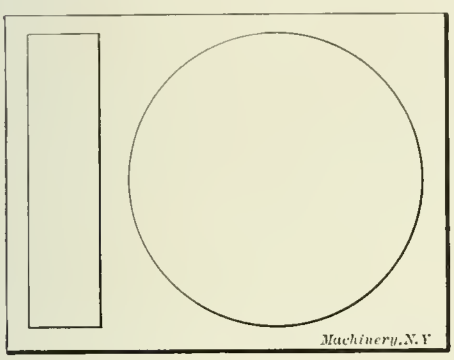


Fig. 8. Disk cast in Simple Casting-die

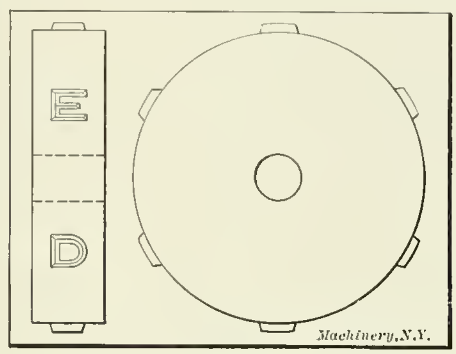


Fig. 9. Printing Wheel cast in a Slide Die

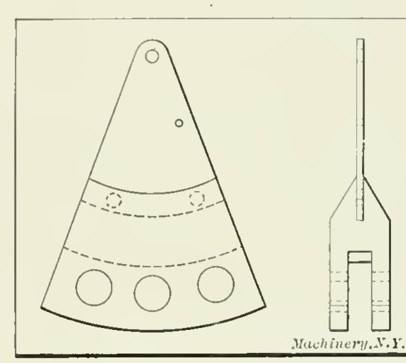


Fig. 10. Die-cast Weight with Inserted Sheet-steel Punching

Making a Plain Casting-die

In Fig. 8 is shown a plain flat disk made by die casting. In actual practice, a die would not be made for such a simple piece, unless there were some features about it that would prevent it being made on a screw machine or with press tools. It might have a cam groove cut in one of its flat sides, the sides might be covered with scroll work, there might be gear teeth around its circumference, or a hundred and one other conditions to make die-casting a desirable method of manufacturing. All these complications are omitted for the sake of simplifying this initial description of a casting-die.

Fig. 11 shows the die for this piece in plan and sectional elevation. *A* is a square cast-iron frame, made from a single casting. This frame or box, as it is generally called, is planed on the top and bottom only. Next, the two die-halves *B* and *C* are shaped up from machine steel. In this casting die, and in the majority of others, these die blocks are square. The lower half of the die *B* is held to the cast-iron frame by fillister head screws, set in counterbored holes, thus sinking the screw-heads under the surface of the block. The upper half of the die *C* is located upon *B* by dowel pins driven into *B* which have a sliding fit in the reamed holes in *C*. This being done, the die-half *B* is fixed to the faceplate of the lathe and the recess bored for the die-cavity. This operation is a simple one in this case, for it is merely a straight hole one-half inch deep and three inches in diameter. Of course this recess must be carefully finished with a tool that has been stoned up

* The second and concluding article of this series, the first of which appeared in the January issue.

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to a sharp edge, using lard oil. Emery cloth should be used as little as possible. It is unnecessary to give this hole draft, but it must be free from ridges or other marks that would prevent the casting being pushed out. If the faces of the dies are spotted with a small piece of boxwood or rawhide held in the drill press and kept charged with flour emery, the die-casting will reproduce this "birds'-eye" finish and the appearance will well repay the few minutes additional time that it will take. The spotting should be done with dry emery (without oil) to get the brightest finish. The upper die-half *C*, is simply ground on its working face. The outside corners and edges of the faces of both die-halves should be well rounded off so as to insure the absence of slight dents or rough places that might prevent the dies from fitting perfectly.

The ejecting mechanism must next be considered. Lever *D*, pivoted from bracket *E*, has a steel pin *F* that engages in the elongated hole in bracket *G*, so that an upward pull of the lever *D* raises bracket *G*, which is attached to ejector-pin plate *H*. This plate is a loose fit over the guide screws *I* that are attached to the lower die-half *B*. The ejector pins *J*, four in number, in this die, are riveted into the ejector-pin plate, and they work through holes drilled and reamed through the lower die-half. The ends of these pins must be finished off so as to lie perfectly flush with the inside of the

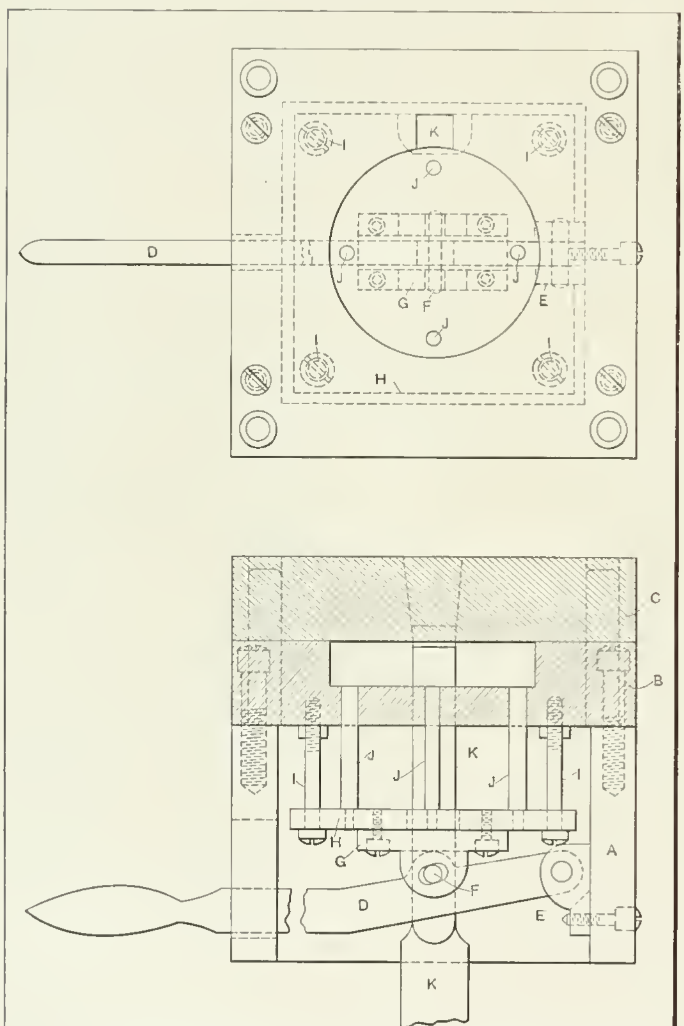

Fig. 11. Simple Casting-die for Casting Block shown in Fig. 8

die when ready for operation and, of course, they must be a sliding fit in the holes in the die.

An important feature of a casting-die is the sprue cutter, shown in this die at *K*. If the disk for which this die was made, had had a hole or central opening of any kind, the sprue cutter would best be operated at that point; but, as this disk is plain, the sprue cutter must be placed at the edge. At the outside of the die-cavity, as shown in Fig. 11, the opening for the sprue cutter is laid out, drilled and filed to shape. It is obvious that the side of the sprue cutter adjacent to the die must fit the outline of the die perfectly, so that there will be no break in the appearance of the casting. The opening for it is extended through the upper die-half, and from a point ¼ of an inch from the inside face of the die this hole is flared out nearly as large as the opening through the die-plate of the machine. Of course the aperture in the upper die-half must be no larger than the opening through the die-plate; otherwise the sprue could not be pushed out. The sprue cutter itself is a long rod, whose section is of the same shape and size as the openings just made, and it is connected to the sprue cutting mechanism of the machine. Of course it is unnecessary to shape the entire length of the sprue cutter to size; after the working end is milled to shape for a distance of six or eight inches, the rest of the rod may be left round The sprue cutter is finished first, after which both the openings in the die are fitted to it; and while the fit should be metal tight, it must be perfectly free to slide.

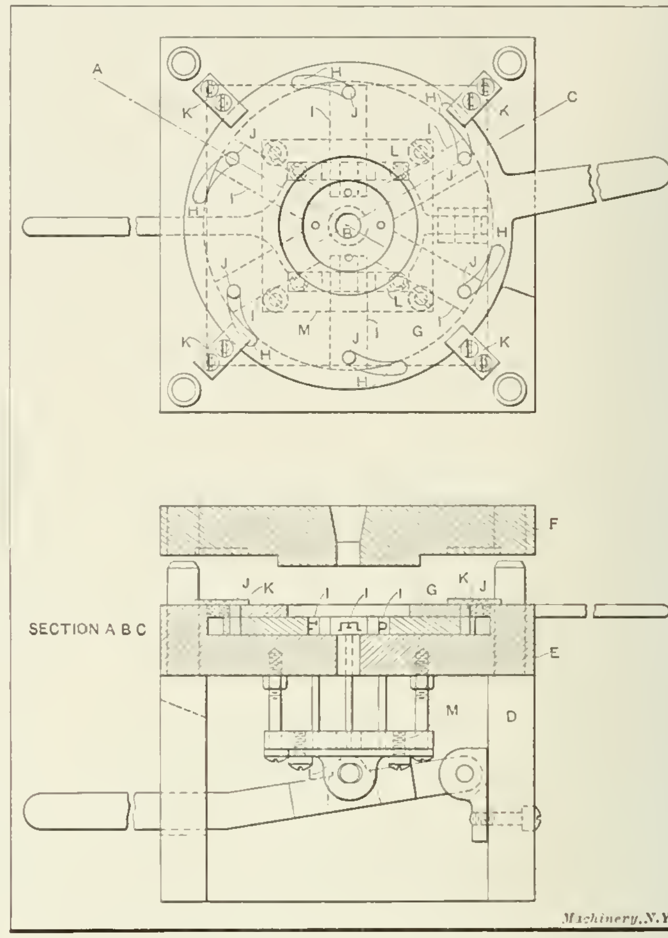

Fig 12. Slide Die for Casting the Printing Wheel shown in Fig. 9

The dies are mounted on the die-plates of the casting machine by means of straps, much the same as holsters are held on punch press beds. The position of the die on the die-plate must be such that the opening for the sprue cutter will line up with the nozzle at the outlet of the cylinder. At the time of casting, the position of the sprue cutter is as shown in the illustration of this die, Fig. 11. In this position there is room for the metal to enter the die-cavity, and yet there is but a small amount of metal to be cut off and pushed back after the die has been filled with metal.

With slight modifications, the above style of die may be used for die-casting any piece that will draw or pull out of a two-part die. If holes must be cast through the piece, it is only necessary to add core pins to the lower die *B*, a point that will be more fully described later. It is unnecessary to add that both halves of the die may be utilized in making the cavity for the die, should they be needed. Also, it is often easier to machine out the recess larger than is needed, and set in pieces in which parts of the outline of the die-casting have been formed. Gear teeth are put in the die in this way; a broach is cut similar to the gear desired, then hardened and driven through a piece of steel plate which is afterward fitted to its place in the die.

Slide Dies

The die illustrated in Fig. 12 is one of the most successful of the various types of casting-dies, and if properly made is an interesting piece of die work. The principal use of this particular style of die, called a slide die, is to cast parts like the one shown in Fig. 9, which is a disk similar to the one which the last die described was to cast, except that it has raised letters at the edge and a hole in the center. It is obvious that the die last described, (Fig. 11) would not do for disks or other pieces having projections or depressions around their edges, as, for instance, printing or counting wheels with raised or sunken characters, or grooved pulleys. Briefly, this style of die is similar to the simple casting-die, except that slides are provided, to the required number, which form the edge of the casting. A die for a plain grooved pulley would

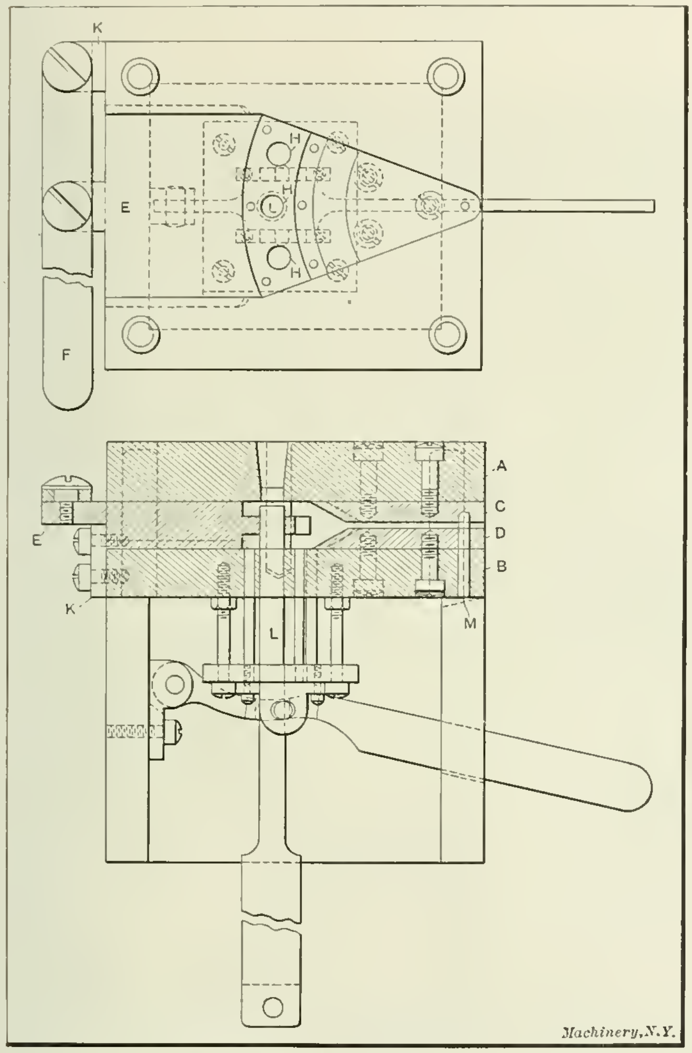

Fig. 13. Casting-die for Making Castings with Inserted Pieces like that shown in Fig. 10

require but two slides, while a die for a printing wheel with forty letters around its edge would necessitate forty slides, one for each of the letters. The die about to be described, shown in Fig. 12, was made to cast a wheel with six raised letters as shown in Fig. 9.

Referring to Fig. 12, *D* is the cast-iron box or frame, *E*, the lower die, and *F* the upper die. In making the lower die-half, the stock is first shaped to size and doweled to the blank for the upper die-half, and the holes for attaching to the frame are drilled. For the sake of clearness, these holes and screws are omitted from the illustration as are also the vents, since they have been fully explained. The lower die is next strapped to a faceplate, trued up, and bored out nearly to the diameter of the body of the piece to be cast, exclusive of the raised letters. The depth of this recess is equal to the thickness of the printing wheel plus 3/16 inch to allow for the cam ring *G* that is used to reciprocate the slides of the die. The cam ring is made large enough to cover the die-cavity as well as the slides that surround it, with an allowance of an inch or two for the cam slots *H*. The six slides *I* are made long enough to have good bearing surfaces. With the size of the cam ring determined, the die is next bored out to receive this cam ring and the last inch of the recess is carried down to the depth of the die cavity so as to make an ending space for the slots that the slides are to work in. The die is now

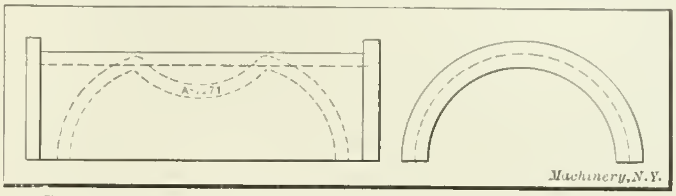

Fig. 14. Die-cast Half-round Bearing, showing the Cast Oil Grooves

taken from the faceplate and the slots for the slides laid out.

These slots may be milled or shaped but milling is to be preferred. The next step is the making and fitting of the slides, which are of machine steel, having a good sliding fit in the slots. The six slides are fitted in position and left with the ends projecting into the die proper. The slots *H* are next profiled in the cam ring *G*, and the pins *J* that work in them are made and driven into the holes in the slides. With the slides and cam ring in place, the cam ring is rotated to bring all the slides to their inner position where they are held temporarily by means of the cam ring and temporary screws. The die-half with the slides thus clamped in the inner or closed position, is set up on the lathe faceplate and the die-cavity indicated up and bored out to the finish size, which

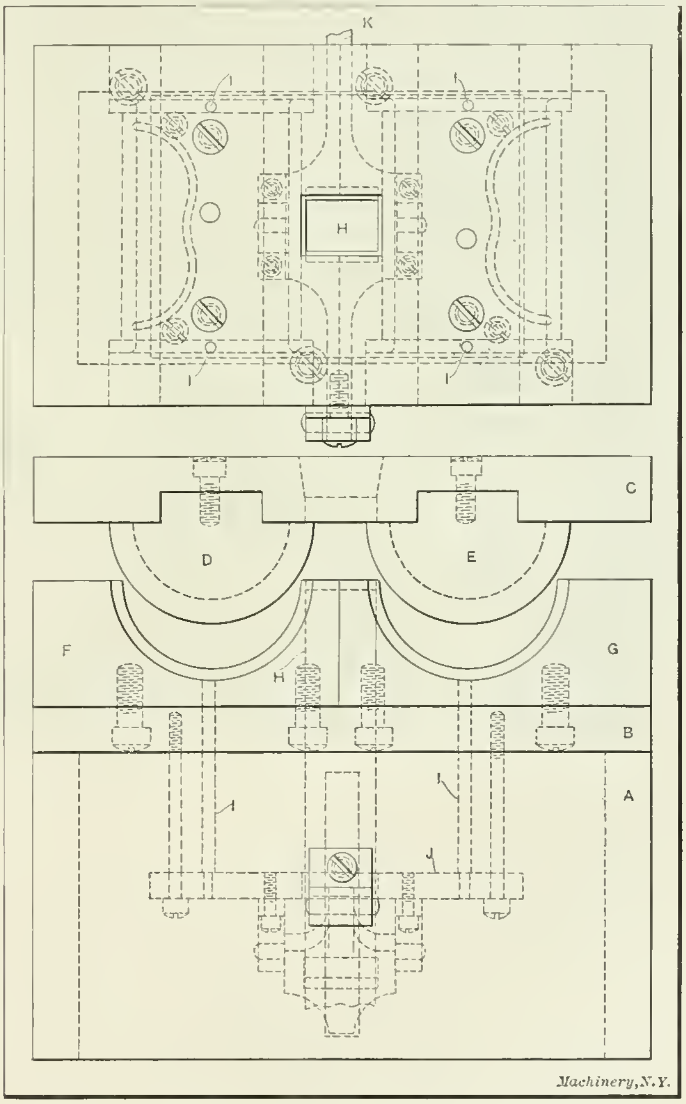

Fig. 15. Casting-die for the Half-round Bearing shown in Fig. 14

operation also finishes the ends of the slides to the proper radius. The die may now be taken down and the slides removed to engrave the letters upon their concave ends. The engraving can be done in the best manner on a Gorton engraving machine, but if such a machine is not available they may be cut in by hand. Stamping should never be resorted

to for putting in the letters, because the stock displacement would be so great that it would be impossible to refinish the surface to its original condition. Before fitting the cam ring, an opening must be milled in the die to allow the handle to be rotated the short distance necessary. After the cam ring has been fitted, it is held in by the four small straps *K*, attached by screws to the lower die-half at the corners.

The sprue cutter, which is not shown, is operated through the hole in the center of the piece and is, of course, round in this die. Its action is the same as was the one previously described, and the ejecting device is similar, with the exception that the brackets *L* that are attached to the ejector-pin plate *M*, are widely separated so as to make room for the sprue cutter that works through a hole in the plate *M*.

Die for Casting with Inserted Pieces

For making die-castings that are to have pieces of another metal inserted, it is necessary to have a die with provisions for receiving the metal blank and holding it firmly in position while the metal is being cast around it, and of course the piece must be held in such a manner that it can be easily withdrawn from the die with the finished casting.

The die illustrated in Fig. 13 is for a part that is used as a swinging weight, shown in Fig. 10. The upper part of the piece is made from a sheet steel punching, so as to lighten this part of the piece as well as to give increased strength, especially at the hole at the pivoted end of the work. The cast portion of the piece is slotted lengthwise, as the illustration shows; and three holes pass through the casting, piercing the sides of the slot. In addition to showing the method of making dies for inserted pieces, this die shows the principles of simple coring.

In making this die, two machine-steel blanks are planed up for the upper and lower halves of the die, *A* and *B*, the lower die being made nearly twice as thick as the upper die because it is in this part that the most of the die-cavity will be made. In this lower half of the die the stock is milled out the same shape as the outline of the plan view of the casting, being carried down to the exact depth of the thickness of the casting. From the wide end of this recess the stock is milled or shaped out in a parallel slot to the outside of the die-block. At the bottom of the side of this wide slot are T-slots to guide the slide *E* that is to work in this opening. The slide is milled and fitted to the T-slots and opening in the die, but is left considerably longer than the finish size. Next, the slide is mounted on the faceplate of a lathe and turned out on the end with the proper radius and a tongue to form the slot that is to be in the curved end of the casting. At the outer end of the slide is left a lug that is drilled and tapped for the operating lever *F* that reciprocates the slide, using the stud in bracket *K* as a fulcrum.

Two pieces of machine steel are next shaped and finished up to form the chamfered part of the casting and to locate the inserted steel punching in the die. The combined thickness of these pieces *C* and *D* is equal to the thickness of the casting, less the thickness of the inserted piece. It is now an easy matter to seat section *D* in the bottom of the milled part of the lower die-half, and to locate section *C* in its proper position on the upper half. A pilot pin *M* is fitted in *D* to hold the steel punching in position by means of the hole that is in the extreme upper end of the punching. The pilot pin extends through this hole into a corresponding hole in section *C*. At the lower end of the steel part that is inserted, there are two holes whose object it is to secure the punching to the die-casting, for the molten metal runs through these holes, practically riveting the die-casting to the inserted piece.

Provision has now been made for holding the sheet-metal part that is to be inserted, and the cavity has been completed for the casting, including the tongue at the end; it now remains to describe the manner of forming the holes that pierce the casting through the slotted portion. In the lower die-half the positions of the three holes *H* are laid out, drilled and reamed. Then, with the two die-halves together and the slide clamped at its inner position, the holes are transferred through

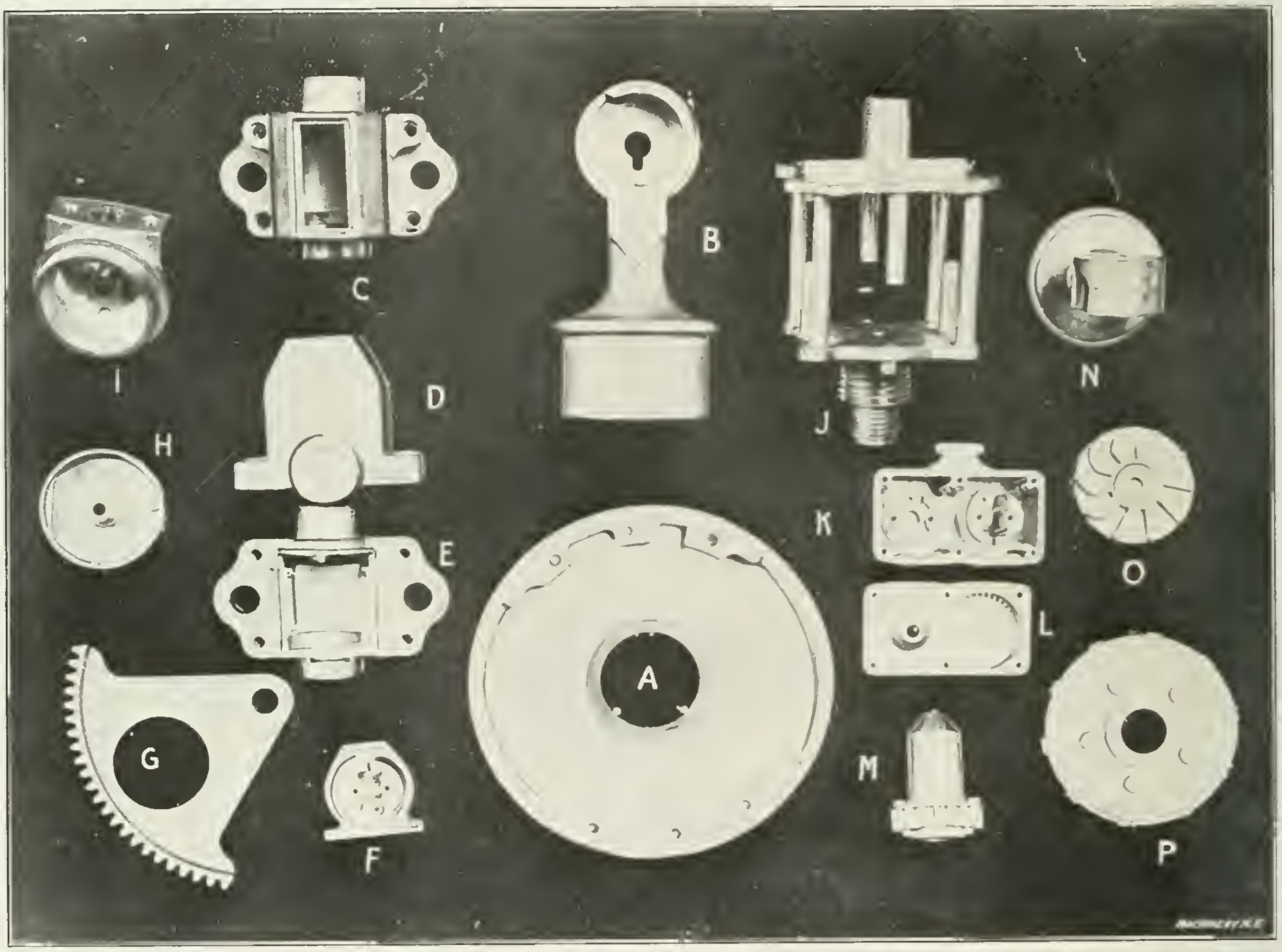

Fig 16. Examples of Die-cast Parts for Telephones, etc.

the slide and the upper die. This being done, it is an easy matter to make core pins and drive them into the upper die at the two end holes, the center hole being taken care of by the sprue cutter L that will be described later. The core pins should be a nice sliding fit through the slide and in the holes in the lower die, into which they should extend from a quarter to a half an inch. In addition to coring the holes, these pins act as a lock to hold the slide E in its proper position at the time of casting.

The sprue cutter L is most conveniently operated in the center hole, thus doing away with the core pin that would otherwise be reqnired. The sprue cutter needs little description in this die, for as in the slide die, it is merely a plain round rod that fits closely in the holes through the dies and slide. The ejector mechanism is the same in this die as in the dies already described; therefore further description is unnecessary.

The operation of this die is very simple. The sheet-steel piece is laid in the recess in the open die, being located by the pin M. Slide E is thrown in by means of lever F, and the dies are closed. At the time of casting, the sprue cutter is in the position shown in the sketch, being nearly through the die-cavity. As before explained, this position admits the molten metal to pass into the die cavity but still leaves very little sprue to be cut off after the die-casting is completed. It should be stated that the steel piece that is inserted must be perfectly flat and free from burrs that would prevent the die-halves from coming together properly.

Bearing Dies

Bearing dies are one of the most important of the various classes of casting-dies. The bearings produced by die-casting are so far superior to those made by other casting methods and machining that their use is now very extensive. Dies are made for "half-round" and "whole round" bearings. There is little out of the ordinary about a whole-round die, but the half-round die involves many interesting methods of die-making and for that reason is here described.

Fig. 15 shows a casting-die for half-round bearings. Half-round bearing dies are usually made to cast two bearings at a time, for the reason that it is just as easy to cast two pieces of such a shape as it is to cast one, and, in addition, the die is balanced in a better manner. As with other dies, the first step is to machine up the frame A and the two die-halves B and C. The pieces D and E that are to form the insides of the bearings are then turned up and one side of each shaped and keyed to fit the slots that have previously been milled in die-half C. These parts are held in place by dowels and screws. One of the bearings produced by this die is shown in Fig. 14, and it will be noticed that there is an oil groove within that covers the length of the bearing. To produce this groove in the die-castings, a shell must be turned up and bored out whose inside diameter is that of the inside of the bearing, and whose thickness equals the depth of the oil groove. This being done, the oil grooves are laid out upon the shell and cut out by drilling and filing. After rounding the outside corners, these little strips are pinned to the cores D and E in their proper places and that part of the work is done.

Another little kink in this connection is worthy of noting, especially as it was originated by the writer and has never been shown before. So many different styles and sizes of

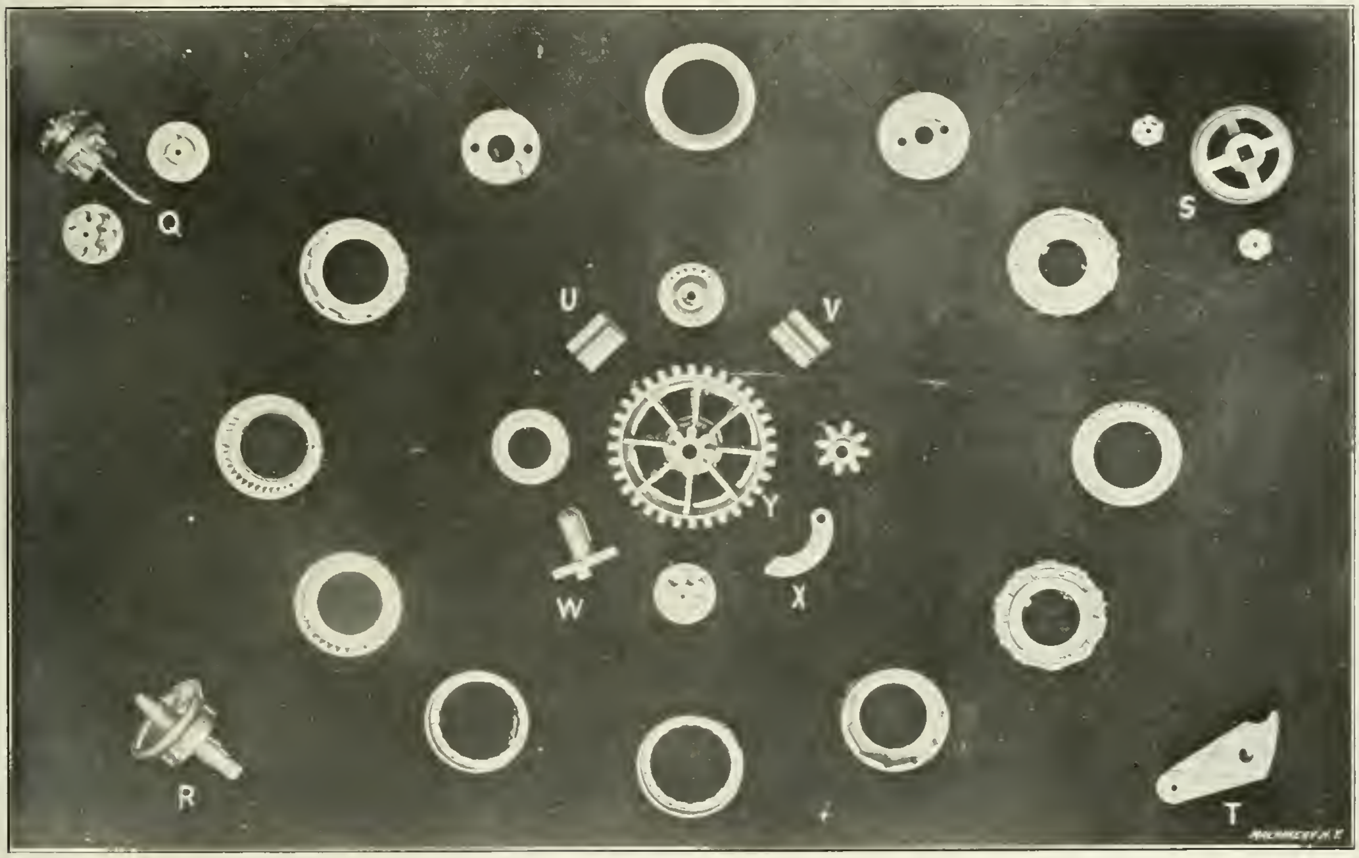

Fig. 17. Small Die-cast Parts of Cyclometers, Watches, etc.

bearings are made by a concern doing much die-casting that it is essential that the die-cast bearings should bear some distinguishing number to identify them. As this number is of no consequence to the user it is well to have the number in an inconspicuous place, but it must be where it will not be effaced by scraping, etc. Bearing in mind that it is much easier to produce raised lettering by die-casting than to produce sunken lettering, it will be readily seen that the oil groove affords a good place in which to put the bearing number. This is easily done by stamping the figures upon the narrow strip that forms the oil groove. In this place on the bearing it may be easily found if needed and of course there is no danger of its being taken out by machining.

The lower die consists of two blocks F and G, each of which contains an impression of a bearing. The best way to get these parts out is to lay out the ends of each of the blocks with the proper radius, taking care to have the center come a little below the surface of the face of the block. Then the blocks should be shaped out to get the bulk of the stock out, before setting up in the lathe. After the lathe work is done on each piece, which of course is usually done separately, the faces of the two blocks are faced down just to the exact center of the impression. It will be noticed that two blocks are used for

the lower part of the die. The reason is to facilitate the locating of the female parts of the die in proper relation to the male parts. After properly locating, they may be doweled and screwed to baseplate *B*.

The sprue cutter *H*, better shown in the plan view, is square in shape and connects with the die-cavities in a thin narrow opening on either side of the sprue cutter. The ejector pins, *I*, two to each die, are at the ends of the bearings. The ejector-pin plate *J* is necessarily large, and is operated by lever *K*.

The illustrations Figs. 16 and 17 are photographs of die-castings made by the Veeder Mfg. Co., of Hartford, Conn., who make hundreds of thousands of die-castings annually for use in the cyclometers and odometers that they manufacture as well as large quantities of die-castings for other firms who are not equipped to do their own work. The casting machines of the Veeder company are all automatic and they are able, after the dies are completed, to turn out the die-cast product very rapidly.

Referring to Fig. 16, *A* is a telephone transmitter that is used in connection with *B* and *N*, as parts of a telephone desk set. These parts are die-cast complete as they appear in the photograph, ready for assembling, and the fine surface finish that they possess is very noticeable. It is obvious that very little buffing would be required before plating such pieces. At *C* is a cyclometer case consisting of two die-castings, a base and a cover. These are shown separated at *D* and *E*. These specimens splendidly illustrate the possibilities in making good fits by casting, for cover *D* is cast a nice sliding fit over the vertical part that extends from the base. So accurately fitted are they, that it requires a careful, straight pull to separate them. At *F* is an odometer part, consisting of a case and barrel, cast integral; *G* is a segment used in a cash register, showing gear teeth made by die-casting; *H* is a register wheel with sunken figures, used in a voting machine; while *I* is an angle bracket used in electrical work. *J* shows a specimen of die casting in the form of a frame for a water-meter movement that involves some interesting features. The frame consists of but two castings; the lower half has the four corner posts and two others, midway of the ends, cast integral, while the upper half has the two posts at the sides cast in a similar manner. The corner posts are cast at the ends to fit corresponding holes in the top plate. The ends of these posts are slightly hollowed so that the ends may be easily spun over after assembling. Naturally, these holes and the posts that enter them must correspond perfectly. The threaded portion at the bottom also tends to make the job interesting, for the two threaded sections are of different diameters and pitches. The parts are cast of a somewhat softer alloy than usual, on account of the spinning that must be done in assembling.

All of the Veeder castings shown represent good die work, but the die-castings at *K* and *L*, a double cyclometer case and cover, are specimens of the highest class of casting-die making. The case is an oblong box, $\frac{3}{4}$-inch wide by $1\frac{1}{2}$-inch long and $\frac{5}{8}$-inch deep, and within are two bearing studs which have holes, lugs, pins and slots cast in the one operation. The cover, which is cast with a seat that fits the case perfectly, is hollowed out to make room for an internal gear on the one side, while on the other side is raised a bearing for part of the mechanism. *O* is a voting machine register wheel; *M* shows a water-meter gear; and *P* illustrates a printing wheel for a fare register.

Fig. 17 shows some of the smaller class of Veeder die-castings. At *Q*, and on either side of *S*, appear illustrations of small pinions for the Veeder "set-back" cyclometer. *R* is a part used in odometers; *S* is a handle for a combination lock; and *T* and *X* are watch parts. The face of the part *T*, is covered with imitation engraved work and the effect is very pleasing. *U* and *V* represent an interesting use for die-castings as made into rifle sights, and on this work the dimensions are held very close. The two sights shown differ only by a few thousandths. *W* represents a part for a cash register and the combined gear and pinion at *Y* is used in water-meter work.

The other illustrations in Fig. 17 are parts of cyclometers in the form of register wheels, gears, sleeves, etc., and show some excellent work, especially in various forms of gears, both internal and external. These illustrations convey some idea of the extent that die-casting has played in revolutionizing the cyclometer manufacturing industry, and present indications show that it bids fair to do as much for other branches of manufacturing.

In casting machines where the plunger is operated by compressed air, the gages are held at a pressure anywhere from 80 to 120 pounds per square inch. As can be readily seen it does not require as much pressure on soft alloys, as it does on the hard ones. However, it is a fair statement to say that the average would be somewhat over 100 pounds per square inch.

* * *

BOLLINCKX BABBITTED BEARINGS

The two views Figs. 1 and 2 show a method of securing babbitt in bearings, developed and patented by H. Bollinckx, Brussels, Belgium. The common manner of securing the babbitt, is by means of dovetailed grooves into which the metal runs while hot. This method has certain disadvantages, largely due to its higher cost occasioned by the necessary core boxes for casting, etc., and also to the difficulty of obtaining

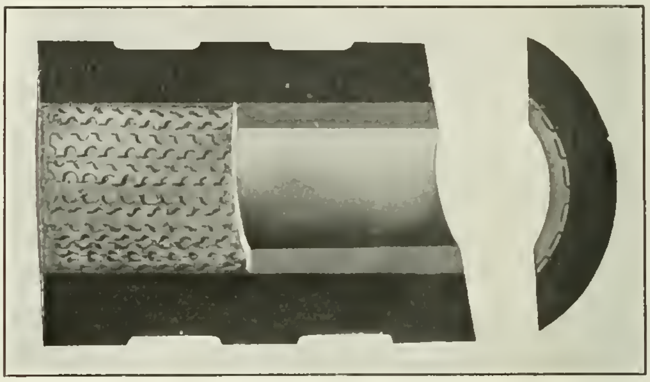

Fig. 1. Bearing babbitted by the Bollinckx Method, with Part cut away to show Construction

a perfect shape, for frequently, the shrinkage separates the metal from these dovetailed grooves. It was with the idea of overcoming these disadvantages that the bearing described was invented. By reference to both Figs. 1 and 2 it will be seen that the babbitt is held in position by perforated strips of

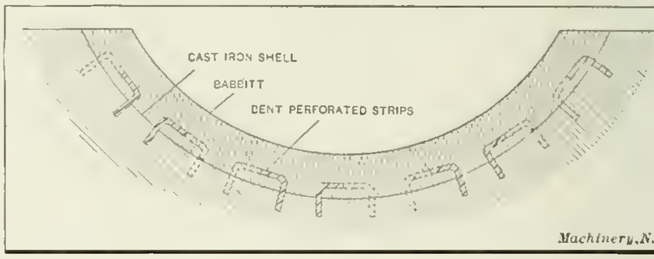

Fig. 2. Cross-sectional View of a Bollinckx Babbitted Bearing, showing Construction

metal bent longitudinally in the form of a "U." The edges of the "U" are cast into the iron bearing, thus forming an integral part of the casting. The babbitt metal is then poured into position and running under these perforated strips is securely held in a manner similar to the reinforcing strips in concrete work. These strips or liners being tinned, allows the babbitt to amalgamate with them, thereby forming a perfect union. They also tend toward the rapid cooling of the babbitt during the casting process, which avoids the usual setting, giving the metal greater homogeneity.

* * *

An unusual case of the possibility of the human body to withstand the effects of a high voltage is mentioned in the *Industritidningen Norden*. The master mechanic in a textile mill in Norrköping, Sweden, came in contact with the high-tension conductor to the mill, carrying a pressure of 3000 volts. The current was conducted through his body to the ground, and while he lost consciousness, he afterwards recovered. The visible effects were comparatively small, the hair only being singed.

EXTERNAL CUTTING TOOLS—2

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

In the previous article on external cutting tools, various methods of applying turning tools, and also methods of holding and adjusting them were illustrated and described. In this article, which is a continuation of the series on external work, the following subjects will be treated in detail: Application of box-tool supports to the work, and methods of holding and adjusting them; cutting angles for box-tool cutters, and adjusting the tangential cutter for turning different diameters.

Applications of Box-tool Supports to the Work

The type of support to use and the method of applying it are governed largely by the following conditions:

1. Shape of the stock, whether round or otherwise;
2. Character of the cut, whether taper or otherwise;
3. Nature of the material, whether soft or hard;
4. Number of different diameters to be turned;
5. Length of the work being turned;
6. Clearance allowable between the face of the circular form tool and box-tool.

These various points should be taken into consideration before designing a box-tool.

At *A* in Fig. 4 is shown a box-tool support which is commonly used in roughing box-tools. This support envelopes the work and precedes the turning tool. Its use is mainly for turning down cylindrical work in which the finished diameter is to be concentric with the part which is not finished, that is, which has not had a cut taken from it. Where the work being turned projects more than five times its diameter from the chuck, and is of large diameter, it is not advisable to use a bushing support, unless the stock is reduced by the circular cut-off tool, as was described in the previous article.

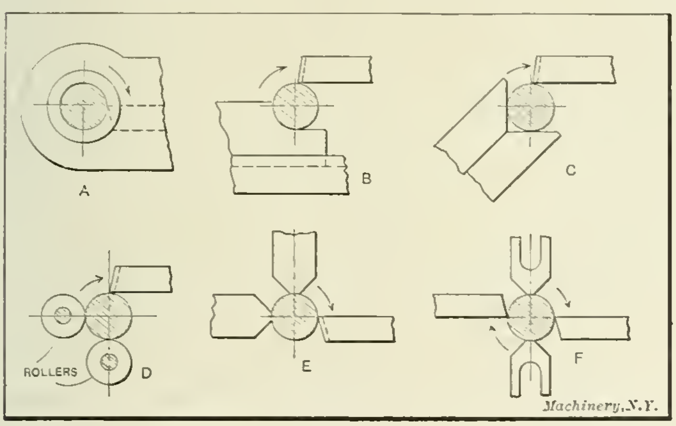

Fig. 4. Method of Applying Box-tool Supports to the Work

At *B* is shown a support which is recommended by some authorities for finishing box-tools. As a rule this support should be used sparingly, and in fact, the writer would suggest that it be entirely dispensed with, particularly where the work has not been previously turned. There are a few objections to this support, especially when it is made solid with the holder, among which the following might be given: As this support does not envelope the work, a bar which is larger in diameter than the hole in the support can be turned; therefore, the support throws the bar to one side, so that it is not in line with the chuck, thus producing work which is not straight, but is slightly tapered. At times this is objectionable, and can be avoided if an adjustable support is used. It is also sometimes suggested to drill this support in the machine in which it is to be used, and after hardening to lap it in the machine also. This seems a roundabout way to make a support for a box-tool, when it is a very simple matter to have the box-tool support adjustable.

The support shown at *C* has not the objectionable features that were mentioned regarding that shown at *B*. This support is commonly called a V-support, and has a two-point bearing on the work. As shown in the illustration, the thrust from the tool is against both supports. As a rule, this support should not precede the cutting tool, for the reason that if the work is not cylindrical in shape, the irregularities of the bar will be reproduced on the work that is turned, so in using a V-support it is always best to have the cutting tool precede the support an amount varying from 0.010 to 0.015 inch. This V-support can be used for brass, steel and similar materials, and gives satisfactory results when it does not precede the turning tool.

In turning cast iron, aluminum or materials of a similar character, difficulty is sometimes encountered in producing a finished surface on the work. This is usually due to fine chips or dust getting in between the supports and the work, thus causing an abrasive action which roughens up the work. It is therefore advisable when turning aluminum, cast iron or materials of a similar character, to use roller supports. One method of applying the roller supports is shown at *D*. These rollers should be hardened and ground, and it is usually preferable to lap them also, so that they are made very smooth. It is obvious that this support rotates with the work, and hence has not the objectionable features mentioned in connection with the V-support. This support is also used when turning machine steel, and is made to bear rather hard against the work, which gives it a burnished appearance.

Another support which is sometimes used for cast iron is shown at *E*. This gives a two-point bearing, and allows the tool to be set radially to the work. This support, however, is not as efficient as the roller support and therefore is of limited use, especially for materials such as cast iron, aluminum, etc.

At *F* is shown a method of supporting the work when applying two turning tools to it. This is used principally for roughing down steel work. The supports, as shown, are set at right-angles to the tools, and one tool acts as a support for the other in a horizontal direction. This manner of turning steel work is used largely when it is necessary to rough down the work from a large to a small diameter in the least possible time.

As a rule, supports for box-tools should be made from high-carbon steel, although where a box-tool is used on work which has a low periphery velocity, supports made from ordinary carbon steel can be used. But, as this is not often the case, especially on the automatic screw machine, supports made from ordinary carbon steel are seldom used. Supports made from Styrian steel are used extensively for box-tools, owing to the fact that this steel can be given an extremely smooth finish, which is one of the chief requisites of a box-tool support.

Holding and Adjusting Box-tool Supports

There are various methods used for holding and adjusting box tool supports, some of which are shown in Fig. 5. At *A* is shown a common method of holding a bushing support. This is driven into the body of the holder and is held with a cone-pointed screw *a*, which is located in a spot drilled in the bushing. The bushing as shown is straight, but it is sometimes advisable to make the bushing with a shoulder on it, so that if a large piece of stock is encountered, it will not force the bushing back against the cutting tool. Of course, this is an extreme case, and where the stock varies to such an extent, the bushing support should not be used. At *B* is shown a method of holding a support similar to that shown at *B* in Fig. 4. The adjustment in this case, however, is only longitudinal along the body of the holder, there being no provision for variations in diameter. *C* shows one method of holding a V-support. A rectangular hole is cut in the body of the holder in which the supports fit. When in position the supports are held by the set-screw *b*. This method of holding a V-support is commonly used for both roughing and finishing box-tools, where one cutting tool is applied to the work, and sometimes where two cutting tools are used, which are so close together that it is only necessary to support the work on one diameter.

At *D* is shown a method of holding a V-support, where it is necessary to apply more than one support to the work, as in the case when turning down more than one diameter at a time. This support is held in a movable block *c*, which is

* Associate Editor of MACHINERY.

adjusted along the body of the holder. This block *c* is held to the holder by the cap-screw *d*. A slot is cut in the body of the holder, in which this cap-screw is adjusted, and a groove is also cut in the holder to fit a projection formed on the base of the holder *c*. The supports in this case are held in the holder by means of a set-screw, as was shown at *C*.

These last two methods are principally for box-tools used for turning brass or a similar class of materials, in which the cutter is set radially to the work. At *E* is shown a common method of applying the V-support to a box tool used for cutting steel and work of a similar character. This method of applying a support is used when the cutting tool is set tangentially with the work. The support is held in a rectangular hole cut in the body of the box-tool, by a set-screw, as shown.

The methods shown at *C*, *D* and *E* are limited in their scope, to a certain extent, owing to the fact that they cannot be used in conjunction with a circular form tool, when it is necessary to have the tool work closer to the forming tool than the thickness of the web *e*. For this class of work the method of holding a support shown at *F* is commonly used. This support is beveled as shown, and set in a correspondingly beveled slot cut in the front end of the box-tool body. As it would be impossible to bind these supports by having a screw pressing on top of them, it is necessary to split the body of the holder, and have screws pass through the two parts, as shown, binding them together. A clearance hole for the body of the screw is drilled in the upper part, while the lower part is tapped out to fit the screw. As this method depends on the elasticity of the material, it is usually best to drill a hole varying from 1/4 to 3/8 inch at the rear end of the slot, to facilitate the drawing of the two parts of the body together, which is necessary to bind the supports in a rigid manner. There is one objection to this method of holding a support, *viz.*, the difficulty of applying the turning tool (in some cases) due to the fact that it comes very close to the face of the box-tool, which is objectionable in hardening.

As was previously mentioned, difficulty is sometimes encountered in turning cast iron, aluminum and materials of a similar character, owing to fine chips or dust getting in between the box-tool supports and the work. It was also mentioned that roller supports were found to be advisable for this class of work. At *G* is shown a method of applying roller supports. These roller supports are held to two movable members, *f* and *g*, which, in turn, are fastened to the body of the holder by the clamping screw *h*. These members, *f* and *g*, are cut out so that they fit into each other and form a sort of "mortised" joint. As the clamping screw *h* would not be sufficient to hold these roller-support holders against the pressure of the cut, they are held in the correct position by large-headed screws *i*, which are screwed into the body of the holder.

At *H* is shown another method of applying roller supports. In this case the supports are held on two sliding holders, *j* and *k*, which slide in grooves cut in the box-tool body. They are adjusted in and out to the required diameter, and held by the clamping screws, as shown. This method of holding the supports is more rigid than that described in connection with *G*, and should in most cases be used in preference. Naturally there are various conditions which govern the method of applying these supports.

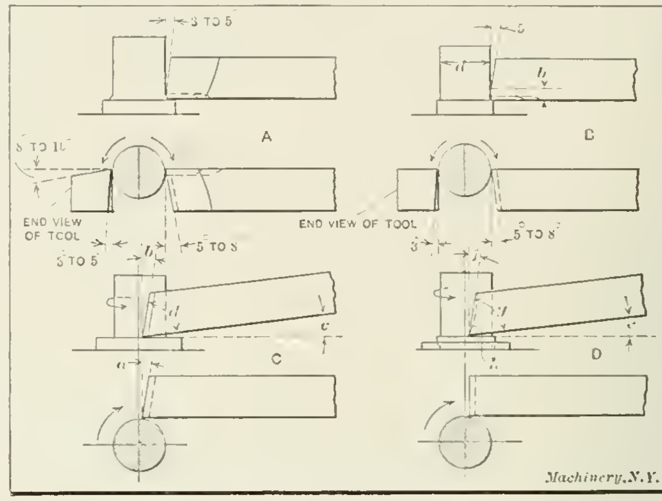

Fig. 6. Cutting Angles for Box-tool Cutters

There are numerous other methods of holding roller supports, but as they are of a somewhat similar character to those already shown, they will not be dealt with here. The methods of holding supports illustrated in Fig. 5, are those generally used in standard box-tools, and do not include those used for special conditions. Special applications of box-tool supports will be dealt with in subsequent articles.

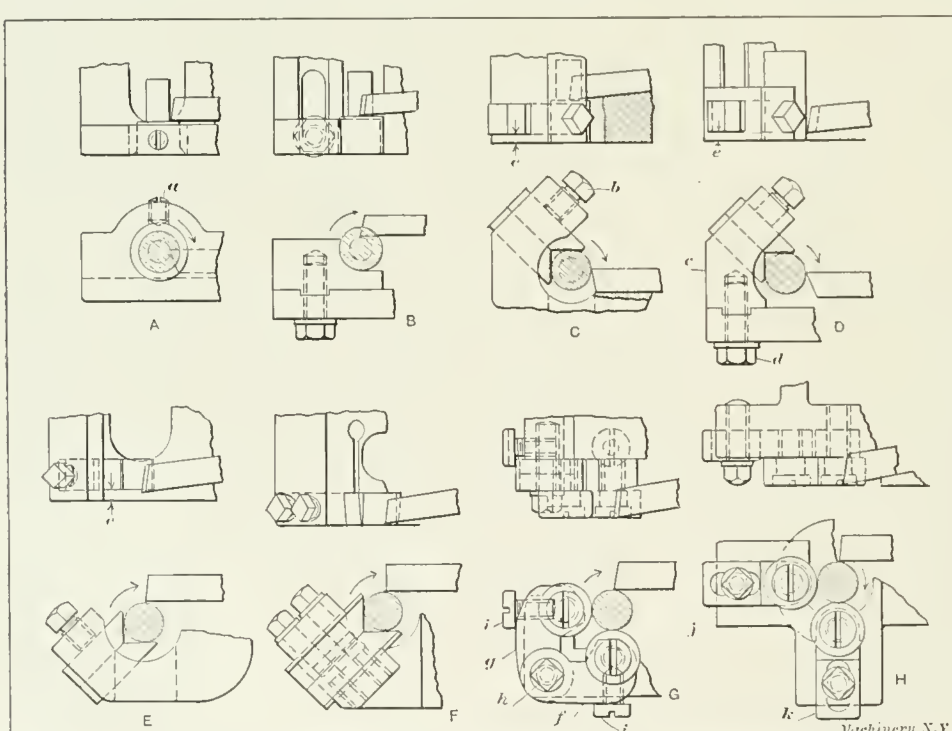

Fig. 5. Methods of Holding and Adjusting Box-tool Supports

Cutting Angles for Box-tool Cutters

It is not sufficient to hold a box-tool cutter rigidly, and support the work well, to obtain good results, but it is also necessary to have sufficient clearance, and the correct cutting angle on the tool. That is, the tool must have sufficient clearance and rake, so as to remove the superfluous material with the least possible resistance and power. The manner in which the tool is applied to the work, and the material on which it operates, govern the cutting angle on the tool. Generally, in automatic work, for cutting brass, the box-tool cutter is set radially to the center, as shown at *A* in Fig. 6. For taking a roughing cut on brass with the turning tool set radially to the work, the tool should be ground to the shape shown at *A*.

When taking a finishing cut on brass work, the tool is ground to the shape shown at *B*. Here a portion of the cutting surface, equal to the distance *b* is made parallel, so as to produce a smooth finish on the work. For usual conditions b equals $\frac{d}{5}$, where d equals the smallest diameter of the work being turned. It will be noticed in both these cases that the

tool is not set at an angle with the face of the work, but is set parallel with it. While this method of setting the tool can be used for brass work, it is not advisable for steel work, as it does not give as satisfactory results as the tangent cutter. A turning tool set tangentially with the work is shown at *C*. The angles on the tool for cutting the materials as specified are as follows:

Cutting Angles for Machine Steel	Cutting Angles for Tool Steel
$a = 10$ degrees,	$a = 8$ degrees,
$b = 10$ degrees,	$b = 8$ degrees,
$c = 8$ to 10 degrees,	$c = 8$ to 10 degrees,
$d = 70$ to 72 degrees.	$d = 72$ to 74 degrees.

The method of grinding the tool shown at *C* is commonly used for roughing cuts, and will not produce an absolutely square shoulder on the work. For finishing cuts the tool is ground as shown at *D*, which produces a square shoulder on the work. The cutting angles for the materials specified are as follows:

Cutting Angles for Machine Steel	Cutting Angles for Tool Steel
$e =$ from 10 to 12 degrees,	$e =$ from 8 to 10 degrees,
$f =$ from 15 to 18 degrees,	$f =$ from 8 to 10 degrees,
$g =$ from 60 to 65 degrees.	$g =$ from 70 to 74 degrees.

While the cutting face on the tool shown at *D* is straight, it is usually advisable, especially when cutting machine steel and Norway iron, to give more lip to the tool, as is clearly shown by the dotted line *h*. This produces a curling chip and is conducive to better and more efficient cutting. It is generally advisable to make the turning tools for roughing box-tools, from high-speed steel, especially for cutting machine steel, Norway iron, etc., because on automatic screw machine work better results are obtained by using a high peripheral velocity and a fine feed. For this reason the steel should be as hard as possible to withstand the high speed used. For brass work, a turning tool made from Styrian steel gives very good results, and is especially recommended where a high finish is desired. Turning tools made from Styrian steel are also used to a large extent for producing a smooth finish on steel work; nevertheless, it is preferable, in most cases, to use tools made from high-carbon steel.

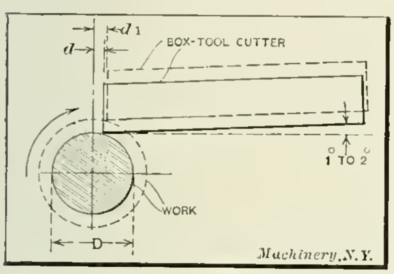

Fig. 7. Adjusting a Tangent Cutter for Turning Different Diameters

Adjusting the Tangent Cutter for Turning Different Diameters

The use of the so-called "tangent" cutter has been found to be the most satisfactory method of applying a box-tool cutter for cutting machine steel, Norway iron, etc., although this method of applying the cutter is also sometimes used for cutting brass. In Fig. 7 is shown the manner of setting a tangent cutter. The face of the cutter should be set at a distance *d* back of the center. This gives the tool more clearance on the periphery of the work, and is conducive to a cleaner and better cutting action. The distance *d* should be equal to about $\frac{D}{8}$ for tool steel, and $\frac{D}{10}$ for Norway iron and machine steel, where *D* equals the smallest diameter of the work being turned. The tangent cutter is adjusted in a vertical direction, and also back an amount equal to d_1, as shown by the dotted lines in the illustration. It is also sometimes advisable, especially when cutting machine steel to set the tool up from the horizontal at an angle of from 1 to 2 degrees, which increases the clearance between the tool and the periphery of the work. This is accomplished by means of adjusting screws, as was clearly illustrated in Fig. 3 of the previous installment of this article.

Sections of Steel Used for Box-tool Cutters

Box-tool cutters should not be made of too weak a cross-section, especially for roughing, although a rigid tool is also required for finishing. The conditions under which a box-tool cutter is used govern to a large extent the cross-section of the tool. For special conditions, the tool is sometimes made of rectangular section, but for standard box-tools, it is made from square stock. The square sections recommended for box-tool cutters are as follows:

Largest Diameter of Work in Inches	Square Section of Tool in Inches	Largest Diameter of Work in Inches	Square Section of Tool in Inches
$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{4}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{1}{4}$	1	$\frac{7}{16}$
$\frac{1}{2}$	$\frac{5}{16}$	...	..

Where box-tools are to be used exclusively for taking light finishing cuts, the sections given above can be slightly decreased.

* * *

A MONUMENTAL EDITORIAL TASK

Some interesting facts relating to the bringing out of a large encyclopedia—the Encyclopedia Britannica—were given at a dinner to the contributors to the eleventh edition of the work. It was stated that the eleventh edition will contain fifty million words, or be equal to five hundred average sized books, each of one hundred thousand words, or of nearly three hundred average book pages. All the articles have been read by the editorial staff on an average of ten times and have all been set in type in fifteen months. The great work which consists of thirty volumes is largely printed on India paper (generally known as Bible paper), and two thousand tons of this paper are required. As the normal annual output of the world of this paper is only two hundred tons, paper mills in all the chief European countries are at work producing the required amount. In the course of his address, the editor, Mr. Chisholm, stated that in dealing with industrial subjects, it has been found difficult to obtain writers who had practical knowledge, and who could also put their ideas on paper. The practical man, he said, is a great critic, and is always ready to state that matters are wrong, but it is seldom that he can explain why they are wrong, and how they can be corrected. In general, the articles of practical men had to be rewritten. Again he said that it was easy to get articles from professors, but in the past these had been distrusted, although it is true that at the present time there is a type of professor who can not only write, but who also knows his subject thoroughly from the practical point of view.

* * *

WOOD REINFORCEMENT FOR CONCRETE

Some interesting tests have been undertaken by a committee of the Institute of Civil Engineers (Great Britain) on the possibilities of reinforcing concrete with wood. At first sight it would not seem that wood could efficiently replace iron for reinforcing concrete, but there are many purposes where wood reinforcement would be satisfactory. Just as concrete with iron reinforcement tends to replace steel construction for buildings, bridges, etc., so concrete with wood reinforcement, or, as it is called, ligno-concrete, may replace ordinary bulk wood construction in many instances, as for example, in piles, posts, beams, foot-bridges, etc. It has been found that properly seasoned wood will keep intact when imbedded in concrete, and that the strength of the ligno-concrete reaches what is considered a satisfactory figure. The experiments are considered only as an entering wedge for deciding whether the matter is worthy of being investigated more fully, and the results so far obtained seem to justify more extensive research with various types of wood and concrete. The more extensive experiments have been commenced, and will be made at the East London College, England.

* * *

An effective method of fighting forest fires has been adopted by the Chicago & Northwestern Railway on its Ashland division. The equipment, as described in the *Railway Age Gazette*, consists of three tank cars and a steam pump. The tank cars have a capacity of 24,000 gallons, and are standing ready to be hurried to any point on the division, an engine constantly standing fired up in the roundhouse. This engine also supplies steam for operating the pump. A suction hose forms part of the equipment, so that water can be taken from any river, pond or tank along the road.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
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Associate Editors

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FEBRUARY, 1911

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SCIENTIFIC TESTING OF MACHINE TOOLS

The time to correct errors of manufacture is before the product is taken out of the factory. Obviously it costs much less to align a shaft and its bearings properly where the tools, appliances and men trained to the work are at hand, than to do it a thousand miles from the shop. It also costs less in reputation, and that is the important consideration.

But it is by no means easy to build heavy machine tools, even with jigs and fixtures provided for all the parts, so that everything will run satisfactorily from the start; nor is it possible to discover all the defects by making ordinary shop running tests. An inspection system feasible and satisfactory for light machinery will not disclose some defects of heavy tools that are likely to crop out in service. For one thing the molecular changes that take place in certain castings during their progress through the shop are not always the same. A shaft may, as a result of these imperceptible changes, be thrown slightly out of alignment; and an ordinary test might not expose the defect, which in a few weeks' use would result in a ruined bearing and a scored journal. There is, however, an infallible and simple means of discovering such defective bearing conditions when making a running test under known load, and that is the thermometer. The work done in overcoming frictional resistance is inevitably converted into heat, and the temperature rise of a bearing running under a known load for a certain period, is nearly directly proportional to the foot-pounds of work absorbed in the bearing.

Determining the temperature index and using it as evidence of the condition of all important working parts, is the basis of the admirable testing system described in another part of this number. Every important working part is subjected to a known load for a definite time, and the temperature rise is registered by thermometers and recorded by an attendant. The system of constructing speed boxes, feed mechanisms, etc., as independent units, is well suited to making such tests. The units are run independently under load and then assembled in a complete machine and run under load. During this test the temperature rise of all important parts determines the condition of these parts when working in the assembled machine.

The important and valuable feature of this system of machinery testing is that it practically eliminates the personal equation. Nothing is left to judgment or guess work. In short, it is a scientific method of securing exact knowledge of obscure conditions.

* * *

STUDY OF NEW TOOL DESCRIPTIONS

An important aspect of the new machinery descriptions published in MACHINERY, worth considering by interested manufacturers, is the study that is being made of them by students in technical schools and other institutions giving advanced instruction in machine shop practice. Although it is impracticable to keep a school shop equipped with all the very latest and best machinery on the market, the mechanical laboratory or machine shop of the up-to-date engineering school is quite a different place from that found ten years ago. Manufacturing is being conducted in the best school shops with manufacturing tools, and the students are instructed not only in the theory of machine work but also in its practice as found in the leading manufacturing plants.

To supplement knowledge of machine tool characteristics gained in the shop, systematic study is made of the new machinery descriptions published in the technical journals each month. The salient features of improved machine tool design are so clearly described in these columns that the students in practical touch with manufacturing conditions in the school shop have no difficulty in grasping the meaning and practical value of the improvements described.

The important point is that young engineers are being trained to study the characteristics of machine tools and to look to the technical journals for reliable information on the latest improvements. Hence the importance of conveying to them, as well as to the general mechanical public, clear and definite descriptions of the construction and use of the machines which they probably will have in their charge in a few years. The hearty cooperation of our manufacturers has enabled MACHINERY to do good work in this field, and our aim is to constantly improve the service.

* * *

NEW MATERIALS AND METHODS

An engineer responsible for ways and means of manufacturing a product in metal, may become so narrowed by his practice as to overlook the possibility of handling a new proposition using non-metallic materials in an entirely different way than would be best for metal. Take the case of building up a product from a material that is easily and economically punched from sheet stock with cheap dies. The practice of punching and piling is assumed to be quite correct for the material with which the manufacture was begun. Should the material be changed to a woven fabric, however, the process of punching and piling may not be the best one adapted for the manufacture of the product.

The production engineer in this situation should carefully canvass the field of manufacture, using this, to him, new material as a basis for its product, and discover if other methods of forming and assembling the desired shapes have not been developed and practically perfected. He may find that, instead of using many expensive punches and dies, for example, the economical manufacture of the product using the woven fabric should revert to simple manual methods making use of primitive tools. For instance, garment cutters cut complicated patterns with great rapidity through many thicknesses of cloth simultaneously, using a special knife of razor-like keenness. A later development is an electrically-operated cutter guided by hand which cuts rapidly through many thicknesses of cloth, but the cutting is still essentially a simple manual operation.

It was manifestly out of the question to construct dies for the great variety of shapes required in the manufacture of ready-made clothing, and the problem of cheap production was solved long ago by employing a highly skilled man who knew how to work rapidly and to maintain his tools in the required condition for efficient operation.

THE SMALL MANUFACTURER

In these days of gigantic organizations of capital and labor, the small manufacturer often feels that he is greatly handicapped in the struggle for business; but whether he really is or not depends largely on himself. In the manufacturing end of a properly conducted, moderate-sized business the advantage lies with the small manufacturer. In the selling end the advantage undoubtedly lies with the large business. In either one, results depend more on the management of the business than on its size. The small business affords opportunities for personal oversight and economies which are impracticable in the large business; the latter affords opportunities for organization and extension which are impossible in the smaller one.

In the machine tool field there is usually a market for the very good and for the very cheap machine—one sold on its reputation, the other on its price. It is the mediocre product—neither one thing nor the other—that is hardest to sell. A choice between these two extremes should be made without hesitation; if for no other reason than because any manufacturer can turn out a poor machine, while only one can produce the best.

The best product in any field is always sure of a market. Users demand it and dealers compete for the representation—and then the selling problem is solved. There are many small makers of machine tools who turn out a product near enough the best to sell all they can make in good times; and as they started with no selling organization, the reason for success must be found in their product.

The moral is plain.

* * *

SOME DESIRABLE CHARACTERISTICS OF AN APPRENTICE

A maker of machine tool accessories, located in one of the outlying districts of Greater New York, is so situated that he is obliged to train all the mechanics constituting his working force. The experience gained in training raw material drawn from the working classes is interesting and valuable, observation showing that the boy who has the making of a careful and thoroughgoing mechanic quickly displays the characteristics necessary for a good workman. The manufacturer referred to watches his boys and notes carefully whether or not they display any inclination to acquire the tools needed by a machinist in working at his trade. The boy who is content to go on day after day using tools borrowed from the tool-room or from his shop mates is put down as being N. G. It is considered that he has no real interest in what he is doing, but is simply working at that trade because it happened to offer an opening.

On the other hand, the apprentice who early provides himself with calipers, squares, micrometers and other small tools commonly found in a mechanics's tool-box, displays one of the characteristics that are necessary for success. Naturally it does not follow because a man or boy has a fine box of machinist's tools that he is or will be a good workman, but it indicates an interest in his work that is encouraging, and the chances are that, given early opportunities, such a workman will turn out well.

* * *

THE ADVANTAGE OF MEMORIZING SIMPLE FORMULAS

Under "Letters on Practical Subjects" in this number of MACHINERY, a contribution appears relating to a shop calculation for determining the diameter of a bored hole that is afterwards to be threaded. This simple calculation, and the method by which a machinist in the shop was able to quickly determine, without the aid of tables, the necessary amount to leave for any required pitch of thread, illustrates forcefully the usefulness of carrying a few simple formulas and constants in the memory. Many tables of formidable size are based upon, and calculated from, a formula of the very simplest kind, containing a constant which can be easily memorized. A great deal of time is frequently wasted in searching for a specific table giving the constant to be used in a particular shop calculation; and the memorizing of a few formulas and constants would save considerable time in many instances. Besides, it is a satisfaction to be able to go ahead without continually referring to handbooks and tables for the simple formulas and constants in almost daily use.

It is also extremely useful to the mechanical man, whether he be an engineer or machinist, to know how the formulas which he uses in his calculations are derived. If he does know, he is able to deduce a formula which may have been forgotten, and which he cannot find in a handbook at the time he needs it. It is said of Lord Kelvin that he seldom remembered the formulas he used in engineering calculations, but derived them each time, going through the mental processes of each calculation from the beginning. This, of course, would be a waste of time in the engineering office or the shop, but it is of importance for the successful mechanic to know how to arrive at a formula which he uses frequently in his work, if an occasion arises when the memory fails or leaves him in doubt. The handbooks are not always within reach, and while they are extremely useful, it is a good practice to train oneself not to depend entirely upon them for the simplest kind of information.

The substance of what has been said may be stated as follows: Memorize as many formulas and constants as can be conveniently carried in the head, and master their derivation whenever possible.

* * *

RESTRAINED COLUMN FORMULAS

That the stresses in the wall of a tube exposed to external fluid pressure are of the same character as those in a column having the ends fixed in direction, is the conclusion drawn by Professor Reid T. Stewart, in a paper on, "Stresses in Tubes," delivered before the January meeting of the American Society of Mechanical Engineers.

Using the experimental results for the collapsing pressures of commercial steel tubing from 3 to 12 inches in diameter which he had previously obtained, equivalent column formulas were derived upon the assumption that the circumferential stress in a tubular annulus subjected to external fluid pressure is theoertically the same as in a straight column with fixed ends whose length is one half the mean cicumference of the tubular annulus.

The results of the investigation were that

$$S = 42{,}640 - 127.4\,\frac{l}{r}$$

for values of $\frac{l}{r}$ less than 221, and

$$S = 25{,}105{,}000 \times \frac{1}{\left(0.1838\,\frac{l}{r} + 1\right)^2}$$

for values of $\frac{l}{r}$ greater than 221. This latter formula may be represented with sufficient accuracy for all practical purposes as follows:

$$S = 708{,}000{,}000\left(\frac{r}{l}\right)^2$$

In these formulas: S denotes the axial load on equivalent column, l, the length of equivalent columns, *i. e.*, half the mean circumference; and r, the radius of gyration of the column cross-section. The fraction $\frac{l}{r}$ is the slenderness factor.

* * *

An interesting and apparently rational explanation of the thunder accompanying lightning is given in *Nature* by Herr H. L. Braun. According to this explanation the electricity discharged between two clouds or between a cloud and some object on the earth decomposes the small particles of water in the atmosphere into its constituents. The hydrogen and oxygen thus produced are mixed mechanically and form an explosive mixture which is immediately ignited by the heat of the flash, and when exploding produces the characteristic rattling report of thunder.

SHELL TURNING OPERATION IN THE HARTNESS FLAT TURRET LATHE

By FRANKLIN D. JONES*

At the Edison Works in Orange, N. J., a great many "mold shells" similar to the one illustrated in Fig. 1 are employed. These shells must be accurately finished to a slight taper, both inside and out, threaded and plain recesses are required at the ends, and, in addition, one or two minor operations are necessary, so that their manufacture on an efficient basis is an interesting example of turret lathe practice. This work is done in the Hartness flat turret lathe, built by the Jones & Lamson Machine Co., of Springfield, Vt.

The shells are turned from cold-drawn seamless steel tubing, having a carbon content of 0.20 per cent, and they are finished at the rate of one in nine minutes. The tubing comes to the machine in 12-foot lengths, and the tube being operated upon, is, of course, fed forward through the hollow spindle as each successive shell is severed. In finishing this shell, five different operations are required. During the first operation the shell is rough bored and turned by one passage of the box-

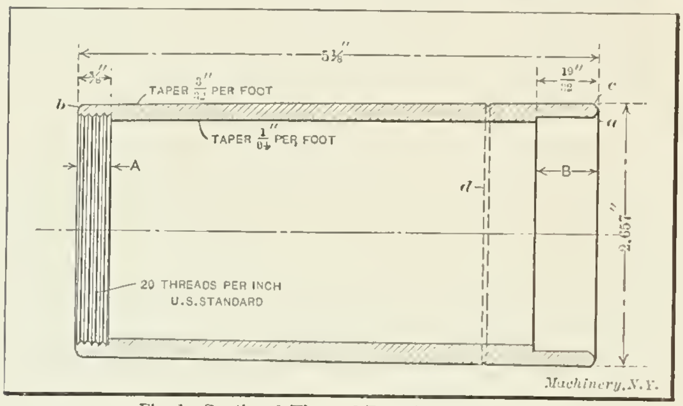

Fig 1. Sectional View of Tapering Mold Shell

tool, Fig. 2, and the recess A, Fig. 1, at the outer end, is finished to size by a second cutter located in the boring-bar close to the turret. The turret is then indexed to the second station which brings the threading attachment G into position, as shown in Fig. 3. After the thread is finished, the recess B, Fig. 1, is turned by a flat cutter K, Fig. 4. The inner and outer surfaces are then finished to size by a box-tool mounted on the fourth station of the turret and shown in position in Fig. 5. The final operation, Fig. 6, is performed by three tools

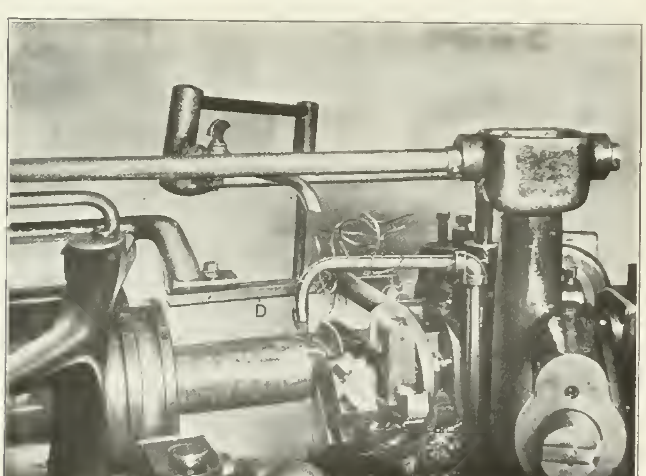

Fig. 2. First Operation on the Mold Shell Rough Turning and Boring

on the turret cross-slide, and consists in rounding the corners at b and c, Fig. 1, and severing the finished shell.

One of the interesting features connected with the machining of this shell, is the finishing of the inner and outer tapering surfaces. The taper on the outside is 3/32 inch per foot, while the bore has a taper of only 1/64 inch per foot, and these surfaces are finished simultaneously, with practically no special equipment. The box-tool employed is of a standard type, with the exception of an inserted boring-bar, and the taper on the outside is obtained by the regular attachment which consists of a templet D (Fig. 2) of the required taper, that causes the turning tool to recede at a uniform rate as it traverses. To secure the internal taper, the headstock of the machine is swiveled slightly on its transverse ways by the use of tapering gibs. By this simple method, the double taper is finished

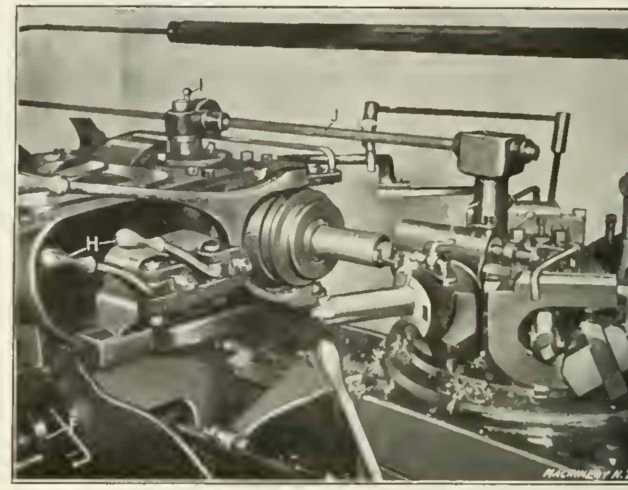

Fig. 3. Second Operation Cutting Internal Thread

to the required accuracy without special tools or equipment.

As those familiar with this machine know, the longitudinal movements of the turret as well as the transverse movements of the headstock are controlled by positive stops. The headstock has ten stops which are mounted in a revolving holder and are brought into position, as required, by manipulating a lever at the front. The stops for length, or those controlling the turret travel, are divided into two general groups, known as "A" and "B." Each of these groups has six stops so that

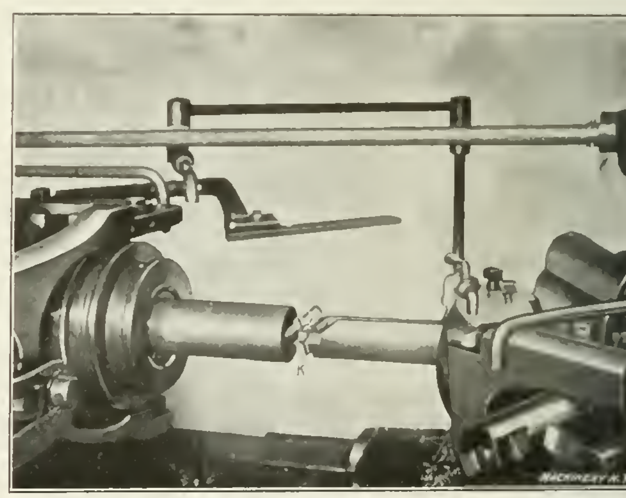

Fig 4. Third Operation—Turning Recess at Rear End. Tool is shown withdrawn

there are two stops for each of the six positions or stations of the turret, and, in addition, five extra stops are available for any one tool, by the engagement of a pin at the rear of the turret. The change from the "A" to the "B" stops is made by adjusting lever L, Fig. 5, which also has a neutral position.

After the box-tool for the roughing cut, shown at work in Fig. 2, has reached the end of its travel, further movement is arrested by a stop of the "A" group. The outside turning tool is then withdrawn by operating lever E and the turret is run back and indexed to the second station, thus bringing the threading attachment into position. The surface speed of 130 feet per minute which is used for turning is reduced to about 30 feet per minute for threading by manipulating levers H, Fig. 3. After the turret is located by another stop of the "A" group, the threading attachment is made operative by depressing a small plunger I, which connects a vertical driving shaft from the spindle with the splined transmission shaft J. A reciprocating movement is then imparted to the thread chaser t which advances on the cutting stroke and then automatically

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retreats to clear the thread on the return. This movement is repeated until the thread is cut to the proper depth, as determined by one of the stops for the headstock. While the thread is being cut, the carriage is locked to the bed by the lever *N*, Fig. 5. It was found necessary to perform the threading operation before taking the outside finishing cut, owing to a slight distortion of the shell wall, caused by the threading operation. After the thread is finished, the turret is turned to the third station as shown in Fig. 4, and tool *K* for the inner recess *B*, Fig. 1, is brought into position and fed to the proper depth, as determined by another cross stop. The turret is also locked in position for this operation. The finishing cuts for the bore and the outside are next taken by a box-tool which is shown near the end of its cut in Fig. 5. This box-tool is similar to the one used for roughing, but it is equipped with differently shaped cutters to obtain the required finish. The outside turning tool has a straight cutting edge set tangent to the cylindrical surface and at an angle, while the boring tool has a cutting edge of large radius. An end view of this box-tool is shown in Fig. 6. A reduced feed is employed for the finishing cut, which is obtained by turning the feed variator *F*, Fig. 3, and the speed is increased to 130 feet per minute, which is the same as that used for roughing.

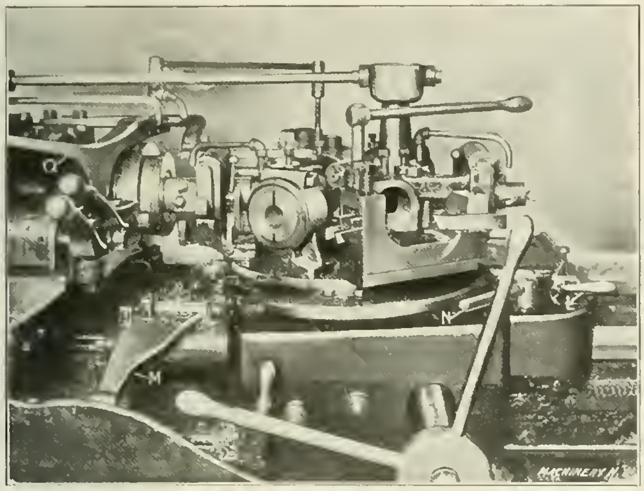


Fig. 5. Fourth Operation—Finishing the Bore and Outside

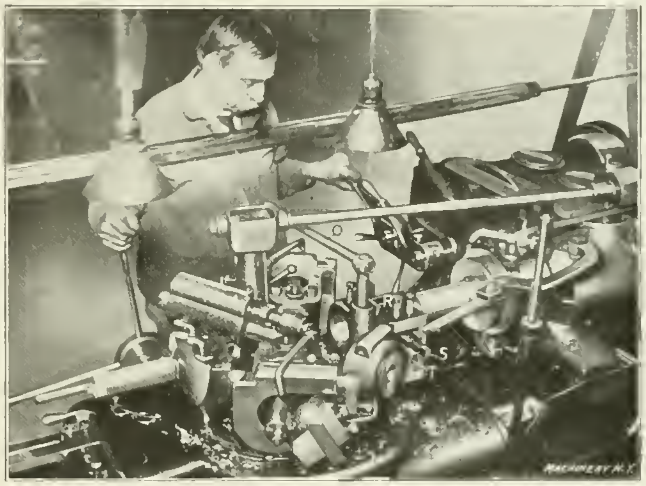


Fig. 6. Fifth Operation—Rounding Ends, Scoring Large End, and Cutting Off

During the next and final operation, the turret, after being indexed to the position shown in Fig. 6, is first located by a stop of the "A" group so that the cutting-off tool *R* in front can be used for rounding the corner *b*, Fig. 1. The stop lever *L* is then shifted and the turret is moved to a second stop of the "B" group. The corner *c* is then rounded and the shell is scored at *d* by two inverted tools *S* and *T* at the rear, after which the finished work is severed by the cut-off tool at the front. The cross movement of these three tools is controlled by positive stops on the cross-slide, and the latter is moved to and fro by hand lever *O*. After the shell is cut off, the stop *M*, mounted on the turret, Fig. 5, is swung into position, and the tube is automatically fed forward to the swinging stop by the roll feed, as soon as the chuck is released by operating lever *Q*. This completes the cycle of operations. A copious supply of lubricant is, of course, furnished to the tools during these operations, and the two boring-tool shanks are hollow so that lubricant can be forced through them and be made to play directly upon the cutters.

The gages for testing the accuracy of the finished shell are illustrated in Fig. 7. At *A* the over all length gage is shown in place on a finished shell, while at *B* and *C*, respectively, are the "go" and "not go" gages for the recesses at the ends of the shell. These recess gages also check the depth of the counterbored part. At *D* is the thread gage, and at *E* the internal and external taper gages—the one being an ordinary plug gage and the other the straightedge type of external taper gage. Both these gages have limit marks and are used for testing both diameter and taper. When a shell is being tested in the external gage, it is located in a central position laterally, by two contact pins in the rear, and the taper must be sufficiently true to prevent daylight being seen between the work and the straightedge.

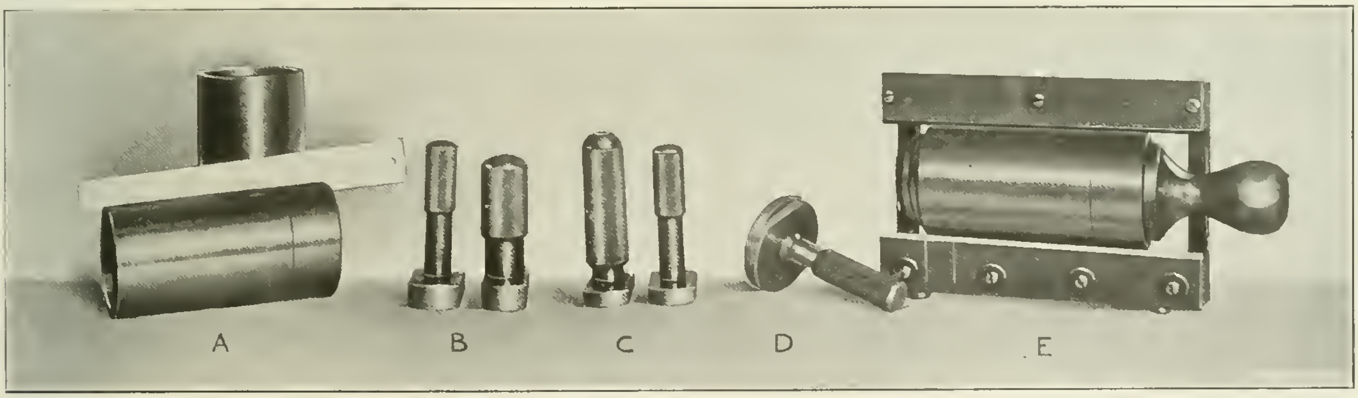


Fig. 7. Gages used for Testing Accuracy of Finished Shell

* * *

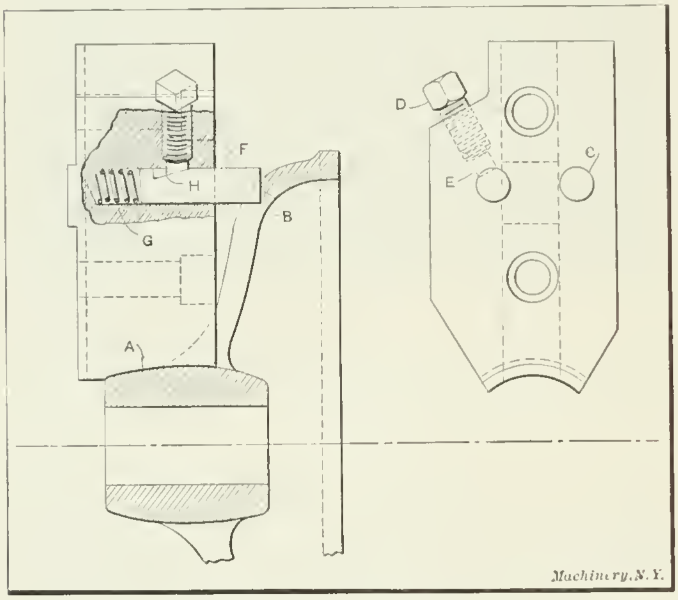
At a public lecture in Manchester, England, on November 18, Mr. Joseph Clarkson gave a demonstration with a flying-machine model 8 feet in diameter, provided with a new form of propeller of his own invention. This invention is intended to solve the problem of vertical and slow flying. As described in *Engineering*, various weights were attached to the frame of the model, and the propeller, which was driven by an electric motor, was made to revolve. As soon as it attained the required speed, the model rose gently vertically from the floor until it reached a stop which had been provided for preventing its rising too high in the room. After having remained in this position for a short time the speed of the motor was slightly reduced, and the model descended slowly until it came to rest almost silently, on the floor. In another test it was shown hovering in the air, neither rising nor falling. The energy used for lifting 12½ pounds vertically and maintaining it in the was 0.4 horsepower, the revolutions per minute being only 53. The inventor calls his device the "aerocar." A full-sized model would have four propellers, two on each side of the car. When the aerocar has risen sufficiently, some of the power may be used for forward or reverse movements.

LATHE CHUCK JAWS*

By FRANK H. MAYOH†

When we take up the question of rapid production, we meet with the necessity of having an effective method of holding the work while operating upon it. The method to be used is always governed by the shape of the work, the material from which it is made and other requirements. The main requirements are that a very rigid method of holding should be adopted, so that the work will not slip or slide while it is being operated on. This generally necessitates the scoring of the face of the chuck jaws, which enables them to get a better grip on the work. As a rule, for rough material such as iron castings, etc., it is advisable to harden the faces of the chuck jaws and also have them scored; but when holding work which has a finished surface it is preferable to leave the jaws soft. Having the jaws soft also has the advantage of enabling them to be trued up when they become sprung or bruised.

The writer's aim in the accompanying data sheets has been to present a number of different chuck jaws which are used



Holding a Handwheel with Chuck Jaw shown in Fig. 9 of Data Sheet Supplement

for ordinary work. Of course, with slight modifications, jaws of the description given could be used for special conditions. The type of chuck jaw shown in Fig. 1 is that which is usually supplied with standard lathe chucks. This type of jaw is generally made so that it can be inverted, thus making it adaptable for both external and internal work. This evidently increases the value of these jaws in making them adaptable for a wide range of work.

Fig. 2 is a type of chuck jaw which is sometimes used when it is necessary to have the work pass into the spindle. These jaws are usually made with a hard and soft end, so that they can be used for both rough and finished work. Fig. 3 shows a type of jaw which is somewhat similar to Fig. 2, but differs in that it has a shoulder *A* which acts as a stop for the work. The principal advantage of this type of jaw, is that it can be used for facing the work to length, as well as for numerous other operations.

Fig. 4 shows a type of jaw which is principally used for holding bevel gears, piston rings, etc. The rings are made from long castings which have a tapered portion on one end which is gripped in the chuck. This necessitates that the shape of the jaw should conform to the tapered portion on the end of the casting.

It is sometimes found necessary to take a cut up close to the chuck which necessitates the toolpost being in close proximity to it. For this class of work the chuck jaw is cut away as shown at *A* in Fig. 5, so that the jaws will clear the toolpost. Fig. 6 shows a jaw somewhat similar to Fig. 5, but its use is principally for gripping under the flange of pulleys, or work of similar character, and it has its gripping portion scored to prevent the work from slipping. This type of jaw is usually hardened on its gripping portion. Another advantage of this jaw is that it facilitates the complete machining of a piece of work—for example, a pulley, as both edges of the rim may be turned, the hubs faced and the hole bored all in one chucking.

A type of jaw which enables us to grip a piece of the full capacity of the chuck is shown in Fig. 7. This jaw is used for gripping a large variety of work such as flywheels, etc. In order to get as much of the work as possible into the chuck, or furnish a more substantial drive, as would be sometimes necessary in turning a pulley, the chuck jaw is made as shown in Fig. 8. Here the jaw is slotted at *B* so that it straddles the arm; the jaw is also cut out at *A* so that a back facing tool may be used, thus enabling the facing of both faces of the hub in one chucking.

In Fig. 9 is shown a chuck jaw which is a little out of the ordinary. The main feature of this jaw is its adaptability to holding rough castings such as handwheels. The accompanying illustration shows this type of jaw (Fig. 9) applied to holding a handwheel. In operation, the hub *A* of the handwheel is gripped in the jaw, as shown, and the web is placed against the stop-pin *C*. The lathe is then rotated and the casting trued up. If it is found that the casting runs out much, it is trued up in the following manner: The spring-pin *F*, which is opposite the low spot is released by loosening the set-screw *D*, and forced out by spring *G*, after the casting has been knocked out. The set-screw *D* presses upon a shoe *E*, which is tapered to correspond to the tapered portion *H* on the spring-pin, so that the pressure of the cut will not force the pin back to its former position.

The type of jaw shown in Fig. 10 is for special cases which are not met with very frequently. Usually this type of jaw is used for gripping a curved hub, but when used for this class of work, the jaw should be sharply scored, in order to prevent the work from being forced out of the jaws when screwing them down. As a rule this type of jaw should be avoided. When gripping a long piece of work having one or more different diameters, we frequently find that it would not be sufficient to have the jaws just grip on one diameter. For this class of work the jaws shown in Fig. 11 are used, which obviates the trouble mentioned.

One class of work which is very difficult to hold is long rough castings, and if the ordinary type of jaw is used for this work it is usually a difficult job to get the casting to run true near the jaws and also at the outer end. For this kind of work the type of jaw shown in Fig. 12 is recommended. The jaws are cut away at *A* and slotted at *B*, which gives a four-point bearing. This holds the work very effectively, and enables it to be trued up with less trouble.

Fig. 13 shows the type of jaw which is commonly used for holding bevel gears of large diameter. The gripping part of this jaw is made to conform to the bevel on the gear. A suitable jaw for holding spur gears which are made with arms is shown in Fig. 14. This jaw is beveled at *A*, so as to fit in between the arms, and is also grooved at *B* to straddle the web. Holding a spur gear in this type of jaw, enables it to be finished in one operation, as the rim can be faced and turned, the hole bored and both sides of the hub faced.

Fig. 15 is used for holding gears or other work finished in one operation, and which is beveled on the inside of the rim, as is usually the case with most gears. The angle on the jaw is made very slight and a groove is cut as shown. This jaw should also be sharply scored and hardened.

When machining cast gears it is sometimes found a difficult proposition to prevent the gear from turning against the cut until the scale is removed. For this class of work, when convenient, a driving pin *A*, as shown in the jaw in Fig. 16, is sometimes used. This pin fits in a tooth space, avoiding the necessity of screwing the jaws down excessively tight on the work to prevent it from slipping.

No attempt has been made in this article to describe the means of attaching the jaws to the chuck. The universal

* With Data Sheet Supplement.
† Address: 1 Dix Ave., Pawtucket, R. I.

method at present is to form a tongue on the jaw which fits into a corresponding groove cut in the members that are operated by the adjusting screws. Making the jaws in this manner insures their interchangeability, so that different jaws can be used for holding various classes of work.

* * *

COMMON DEFECTS IN METAL ALLOYS*

The knowledge of the properties of non-ferrous metals and alloys has not developed as fast as that of iron and steel. Several causes have contributed to produce this condition. The number of industrial metals and alloys is so large, and their characteristic properties so diversified, that conclusions arrived at from a study of one group would be of little or no value when applied to another.

Many difficulties are met with when using alloys in practice. Some of these are inherent, but some could be avoided by careful treatment. It frequently happens that a perfectly satisfactory alloy fails because of being subjected to entirely unreasonable heat treatment or to mechanical stresses, in the course of being fitted for use. Such treatment is applied in ignorance of the effect likely to be produced, but considering the care that is taken in handling steel, it is remarkable that non-ferrous alloys are often treated as if they were mere inert material, which might be ill-treated without suffering any injury. For instance, while no user of metals would quench steel from high temperature or submit it to prolonged annealing without reference to the purpose for which it was to be used, it is not an uncommon experience to find bronzes made for special purposes treated in such a way.

There are eight distinct classes of defects commonly found in alloys used in machine building. These defects may be classified as: 1. Sponginess; 2. Brittleness; 3. Defects due to inequalities of composition; 4. Excessively coarse structure, due to casting at too high a temperature; 5. Defects due to wrong thermal treatment; 6. Defects due to molecular change other than that produced by mechanical stress; 7. Shrinkage cracks; and 8. Defects due to mechanical deformation.

1. *Sponginess.*—This is caused by gases dissolved in the molten metal or alloy, which are released at the moment of solidification. This defect is aggravated by over-heating the metal, and may be remedied by re-melting it and pouring it at the proper temperature.

2. *Brittleness.*—This may be caused by oxides or dross due to lack of care in pouring, or to over-heating, which causes burning, as in the case of the zinc alloys. The oxides of different metals vary as to their ability to separate themselves from the liquid and rise to the surface, and various deoxidizers are used to facilitate their removal in the form of slag. A second source of brittleness is the presence of thin layers of non-homogeneous alloys between the crystals. The microscope is of great assistance in studying cases of this kind.

3. *Defects due to inequalities of composition.*—These defects are due either to improper mixing of the ingredients, to separation by gravity during solidification, or to segregation in the mold. When the ingredients are not uniformly mixed, the usual cause is the difference in specific gravity of the ingredients. Aluminum, for example, tends to float, and lead to sink. Certain metals, particularly aluminum, also possess the property of becoming enclosed in a film of oxide as soon as in the molten state, while others have an action similar to that of oil and water and must be stirred to an emulsion and then carefully cooled to prevent separation. With alloys of tin and antimony, or mixtures containing them, a difficulty is met with in that crystals of tin and antimony form and float upward. This tendency is overcome by rapid chilling. Impurities in general, such as lead and bismuth in bronzes will accumulate at the center of the parts and cause unsound castings.

4. *Excessively coarse structure due to casting at too high a temperature.*—As the strength of an alloy depends upon the degree of adhesion between neighboring crystals, as well as upon their size, and as these qualities in turn depend on the casting temperature and the degree of chilling, this becomes a complex question that requires much further investigation. A few alloys containing copper and zinc, and especially those rich in zinc, have an extraordinary tendency to form large crystals having little mutual adhesion.

5. *Defects due to wrong thermal treatment.*—These defects are due to a number of causes, as for instance, to quenching from too high a temperature; heating at too high a temperature or too long during annealing; burning, as in the case of copper and zinc alloys; and unequal thermal treatment of different parts of the same casting and forging. The principal effect of wrong thermal treatment is the production of coarse structure in alloys in general, and a hard, brittle metal in most bronzes. Unequal treatment also produces differences in the structure in different parts of the alloys.

6. *Defects due to molecular changes other than those produced by mechanical stresses.*—Some metals undergo changes at definite temperatures which involve a complete alteration of their properties. The most striking instance is that of tin, which may pass spontaneously into a gray powdery substance devoid of mechanical strength, at a low temperature. Many alloys have been known to disintegrate spontaneously from no known cause. Some of the alloys of aluminum with other metals fall to powder after a time, while an alloy of 80 per cent of aluminum and 20 per cent of tin breaks up into coarse crystals. It may be that these phenomena are due to impurities in the constituents. This is indicated by the behavior of alloys of copper and manganese which have been described as disintegrating spontaneously. When prepared from pure metals, however, these alloys are permanent, and the disintegration is entirely due to the presence of non-metallic impurities.

7. *Shrinkage cracks.*—These may be due to a poor arrangement of the mold, to wrong casting temperature and to the great brittleness of the alloy at a temperature just below that of solidification. The latter condition is the cause of the great tendency of aluminum-zinc castings to crack during cooling.

8. *Defects due to molecular changes produced by mechanical deformation.*—These defects show themselves as brittleness in cold worked metals; "season-cracks" in brass and other alloys which become visible some time after rolling; and "fire-cracks," which differ from the foregoing only in that they appear during the annealing process alone. It is said that fire-cracks never appear in pure metals, but always in alloys. German silver is particularly liable to this defect. "Chilling-cracks" are produced when metals are suddenly quenched. Cracking is also due to hot working, as most alloys show an increased brittleness at some particular temperature. Many bronzes have only a small range of temperature within which they may be safely worked. This subject has as yet been but imperfectly investigated.

In addition to the defects mentioned, there are some defects which arise in the course of the use of alloys, and which do not fall under any one of the above heads. These defects are due to corrosion and erosion. The question of corrosion of alloys is now being investigated by a committee of the Institute of Metals (Great Britain), because as yet but little data has been collected on this subject. The conditions which affect the liability of alloys to mechanical erosion also demand further study. An interesting case of erosion is that of high-speed propellers acted upon by eddy currents in the water. In some cases the propeller blades are eroded to a depth of as much as 1½ inch in the middle of a blade, while the remainder of the blade is perfect. It appears that different bronzes behave very differently in regard to this action. A definite relation between the microscopic structure and the liability to erosion yet remains to be established.

* Paper read by Dr. C. H. Desch, before the Glasgow meeting of the Institute of Metals, September, 1910.

* * *

A "non-stop run" of sixteen days and nights was made during the Texas State Fair at Dallas, last October, with a $600 Maxwell runabout. The car covered, during sixteen days, 3162 miles, much of the driving being done through crowded streets.

STOCK-KEEPING

By S. M. HOVIS

In all manufacturing establishments the place in which the most money can be lost or saved is undoubtedly the stock room; for here in one department, we find all the parts comprised in the product, the smaller tools used in its making, and in some cases expensive printed and advertising matter. Yet, in nine cases out of ten, this department is placed in some poorly-lighted, ill-ventilated, obscure part of the building in charge of a man who has probably secured the position in consequence of a good memory or his inability to become a mechanic, and who is very frequently incompetent or worse, probably due to his being very much underpaid. As assistants, there are usually with him a few boys or old men who cannot be usefully employed in other departments.

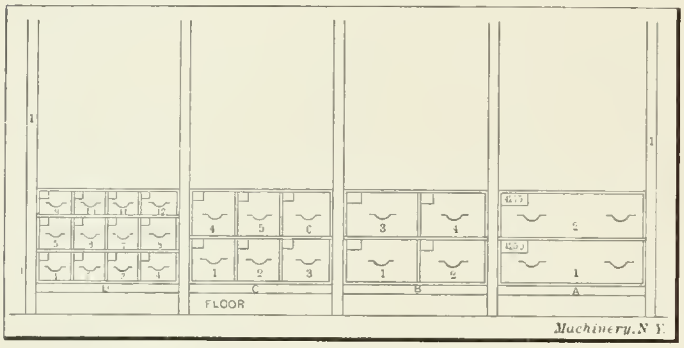


Fig. 1. Elevation of the Arrangement for Keeping Parts, used by a Company Manufacturing Small Machines

The system of stock-keeping submitted in this article has been tried in various plants and proved to be very successful, not only from a production, but also from a pay-roll standpoint. It must be understood, however, that the success of any system depends largely on the cooperation of the office and accounting departments with the stock-keeper, and any error or misunderstanding between them should be investigated and settled at once; for frequently, even in the best managed plants, the office is obliged to call on the stock-keeper for information, and his prompt attention facilitates matters.

In a properly systematized plant all the parts entering into the final product should be kept in the stock room and drawn out as desired on orders signed by the proper authority, usually the foreman of the department concerned. This stock may be divided into three classes: finished stock, rough stock and supply stock. Under the classification "finished stock" are included all the parts which are manufacured in the plant. The rough stock includes all purchased materials such as steel, iron, rough castings, etc. Supply stock constitutes such materials as paint, waste, oil, small tools, etc., and at times includes such things as advertising matter, letter-heads, envelopes and office supplies. The first-mentioned of these supplies are frequently included under the "rough-stock" head, but experience shows that by keeping these supplies under a separate heading, better accounting results may be secured. These divisions, of course, may be varied to suit the requirements of the accounting department, but in most cases these three divisions will be found to be sufficient.

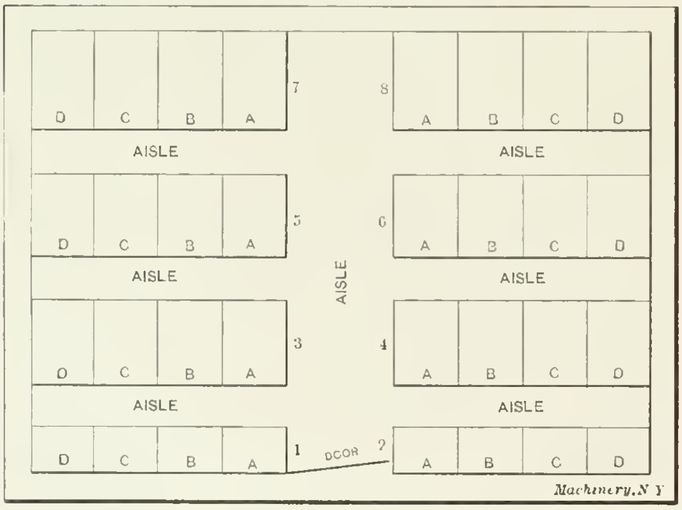


Fig. 2. Plan of the Arrangement for Keeping Parts shown in Fig. 1

It cannot be too forcibly stated that every article in a stock room should be known by a number in addition to its name, and wherever possible that number should appear on the requisition for material. In good manufacturing systems the use of names for parts may be entirely eliminated, numbers being used exclusively, the result being better and quicker service in the filling of orders. The use of letters in designating material, except where absolutely necessary, is to be avoided, although in some cases a letter is placed before or after a number to show the kind or quality of the material. As for example 211A might mean casting; 642B forging; and so on, although a system of numbering may be devised that is equally effective. For instance in a case where the product is a machine consisting of a number of minor assemblies, all numbers ending in 0 would designate an assembled part; 01 a screw; 03 casting, and so on. By such an arrangement a parts-list may be made up and mastered after a little study.

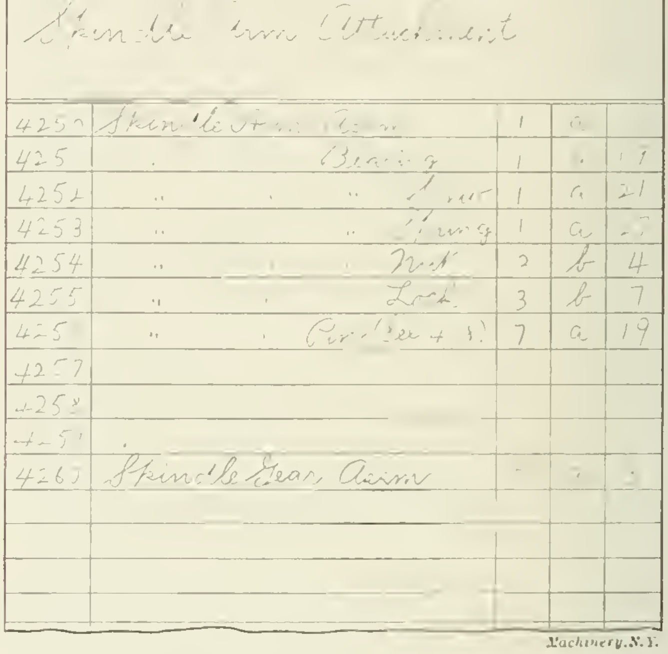


Fig. 3. Portion of a Parts List

The center of the building seems to be the preferred position for the stock room, but the ideal location is at the end of the building, as near the office as possible, for in the former case a considerable drawback arises should it ever become necessary to enlarge this department, as other departments would be more or less inconvenienced. Furthermore, firmer and better structure for holding material may be built at the end of the building.

No drawers or shelving for parts that are in constant use should be more than seven feet above the floor, the space above this being utilized for such parts as are only occasionally called for. In so arranging the parts that they may be readily located, an indexing system has been devised which with slight variations may be suited to any special business. Fig 1 shows the front view of an arrangement used by a plant manufacturing a number of small machines. This room which is about forty feet square is divided through the center by an aisle four feet wide and is sub-divided into sections, tiers, and compartments. The term *section* is applied to the construction on either side of the aisle, that on the right being designated by even numbers and that on the left by odd. These sections are divided into *tiers* which represent spaces between the uprights and are alphabetically lettered to avoid the confusion of numbers. The *compartments* are the drawers or shelving for hold-

ing parts. Figs. 1 and 2 give a general idea of the application of this plan.

Sheet iron or heavy tin is the most practical and durable construction material for drawers, especially for those holding parts which are oiled. These, with a small card-holder and handle, may be obtained at low price, and being easily washed and lighter than wood, facilitate handling. In addition they should be made interchangeable, the tiers being fitted with strips to hold interchangeable boards upon which the drawers can rest. In drawers that are the same width as the tiers

STORES ORDER — ORDER NO. 1437

DELIVER TO 110 DEPT. H DATE 7/2/10 LOT NO. 2

QUAN	DESCRIPTION	NO.	COST PER UNIT	COST TOTAL
100	Parts to Assemble	4250		

FILLED BY	CHECKED BY	O.K. STOREKEEPER	FOREMAN
616	712	Smith	Brown

Machinery, N. Y.

Fig. 4. Stock Requisition Slip

(see Fig. 1, 1A1 and 1A2), these strips may be fastened to the sides and will be found to work very satisfactorily if proper dimensions are used.

The arrangement for taking care of the stock having thus been attended to, the application may next be noted. Fig. 3 shows a section of a page of a parts-list in common use. A requisition calls for part 4250 which is shown in parts-list as being located in section 1, tier A, drawer 1 (1A1.) The stock clerk knows that 1 being odd, is located to the left of the main aisle; A being the first letter of the alphabet, is the first tier of section 1; and drawer 1 will be at the bottom of a tier. One company, in mind at present, has its product divided into sections, parts for which are drawn out, assembled and then

Spindle Arm Assm. 4250

PART	QUAN	NAME	SEC	TIER	COMP
4251	1	Spindle Arm Bearing	1	a	19
4252	2	" " " Screw	1	a	21
4253	2	" " " Spring	1	a	27
4254	1	" " " Pivot	3	b	4
4255	1	" " " Lock	3	b	7
4256	2	" " " Pin (4118)	7	a	19
4257	1	" Gear Assm	5	a	3

Machinery, N. Y.

Fig. 5. Stock-keeper's Location Card

returned to the stock room and again drawn out combined with other assemblies, completing the finished product. Fig. 4 shows the form of stock requisition slip which is given to the stock clerk, who turns to the card or sheet shown in Fig. 5, looking up the corresponding number, which readily locates the article desired. This order after being filled is checked and forwarded to the office where, after being priced, it is filed against the original order. It is not within the range of this article to discuss systems of accounting, but it may be stated that the best results will be obtained where the least time is lost between filling the order and sending it to the accounting department.

In handling steel bars of all shapes iron pipe may be used in the building structure, and the divisions marked with tin tags.

The stock card, Fig. 6, gives a record of the in-coming and out-going material; and the stock clerk after making deduction, should see that the amount in stock is above the low mark which is indicated in the upper right-hand corner. As soon as filled these tickets should be forwarded and old cards filed numerically per part number; but, this work should be done by the stock-keeper and not by his clerks. In every case where the ticket is to be forwarded or parts to be ordered, the ticket should be placed on the stock-keeper's desk where a glance at it will at once convey to him a knowledge of the way things stand in regard to this particular article. Every card should be gone over carefully before forwarding on account of arithmetical errors which are always likely to occur; and, if the stock system is used in connection with the so-called perpetual stock record system, this is imperative as any difference between card and ledger will cause delay in checking for the inventory.

The most important consideration in the organization of a stock department is the selection of stock-keeper who must be a good man even if it be necessary to pay him the highest salary on the roll. This man who has charge of what should be the most valuable department in the plant, should be above

NO. 4250 — LOCATION 1-a1 — LOW MARK 50

Spindle Arm Assm

IN DATE	IN QUAN	OUT DATE	OUT QUAN	ON HAND
6/2	50			50
		[illegible]	14	36
		"	3	33
[illegible]	100			133

FRONT

EXAMINED AND FORD 6/2/19	ORDERED 6/2/19
QUAN 100	ORDER NO. 1437
RUSHED 6/8	ORDER COMP [illegible]
OTHER USES	

BACK

Machinery, N. Y.

Fig. 6. Stock Card Recording Stock in the Stock Room

the ordinary employe as regards both ability and character, and one who is indifferent or incapable should not be retained. Furthermore he should have sufficient capability to assume full control of his department. By this it is not to be understood that the stock-keeper is to be allowed to adopt his own methods regardless of the prevailing policy of the management, but that he should be strong enough to fill his position without being constantly called upon to explain errors and accidents, for a man of this type would never be able to manage a department.

* * *

LOSS OF POWER IN GAS ENGINES DUE TO ELEVATION ABOVE SEA LEVEL

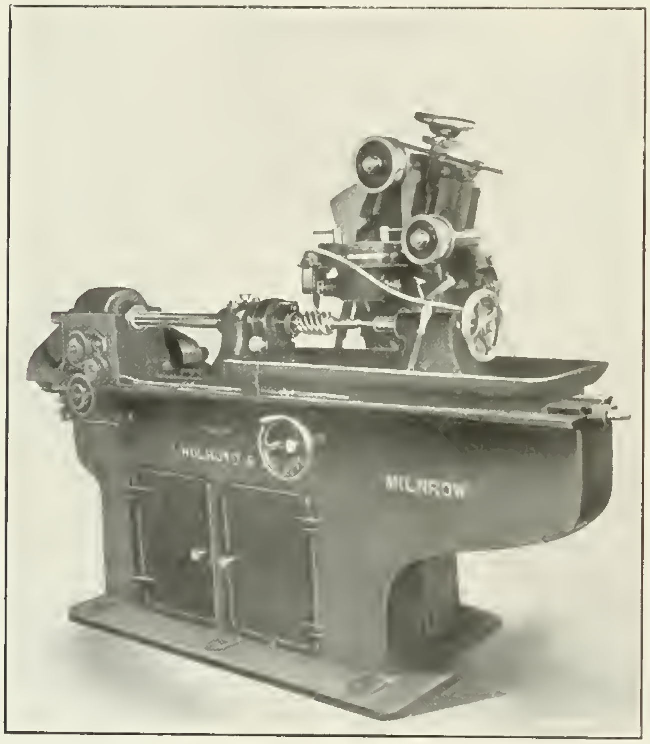
The *Engineering Review* mentions in its November number a case of a large gas engine plant which was some time ago exported from Great Britain to a British colony and erected at the location several thousand feet above sea level. The engines did not give the power expected from them and several reasons were advanced to account for this deficiency. It was finally concluded that the loss of power was due to the altitude of the power station. Upon investigation of the theoretical and practical considerations involved it was found that there is a loss of about one per cent of the indicated horsepower for each 1000 feet increase in elevation. The effect of an increase in elevation on an engine with a low ratio of compression is slightly less than on an engine with a high degree of compression.

BRITISH AUTOMATIC HOB SHARPENING AND WORM GRINDING MACHINE

The illustration shows an interesting British machine designed by J. Holroyd & Co., Milnrow, England, for automatically sharpening all kinds of hobs and for grinding hardened worms. It is also suitable for sharpening cutters within its capacity.

It is a well-known fact that when steel worms are placed in a furnace and casehardened, a certain amount of distortion takes place in the threads which, of course, affects the smooth running of the worm with the worm-wheel. This machine was specially designed to grind the helical surfaces and so insure accurate threads which will run smoothly when in gear. The machine has been taken up by the leading British motor gear manufacturers for grinding the casehardened worms used in the design of motor back axle drives.

The maximum diameter of the worm or hob that can be ground by the machine shown in the illustration is 12 inches and the maximum length, 18 inches. The hobs or worms are carried between centers on suitable mandrels, the maximum distance available between centers being 24 inches. The work is reciprocated past the emery wheel by a screw which is fitted with reversible clutches. These clutches are operated by collars adjustable to vary the length of stroke. A set of



British Automatic Hob Sharpening and Worm Grinding Machine

change-gear wheels is provided to give the required twisting motion to suit the lead of the worm or the helical groove of the hob. The pitch or lead can be varied by the gearing between ½ inch and 250 inches. An important advantage of the machine that will be generally appreciated is that the change gears are the same ratio as those generally provided with universal milling machines; thus the same calculations hold good for cutting the spiral and for grinding it. This means that whatever spiral is cut on the milling machine can be ground on this machine.

Another set of change gears is provided which governs the dividing motion and these come into action when the table is out at its full extent from the driving head, the function of the indexing mechanism then being performed. The emery wheel, which may have a diameter up to 8 inches may be fed down beside hob teeth of an angle up to 30 degrees on either side of the perpendicular. The speed of the emery wheel is 3750 revolutions per minute while that of the countershaft driving it is 375 revolutions per minute. The feed for hob grinding is an extra circular motion put on automatically by means of a weight and lever at the revolutions of the hob. The feed for the worm grinding is a downward motion of the emery wheel, this feed being applied at each revolution of the dividing worm-wheel by a ratchet wheel operated by a pawl on a small worm-wheel which revolves in unison with the dividing wheel. The emery wheel spindle runs in ball bearings provided with adjustment for wear.

The floor space occupied is 9 feet by 3 feet 8 inches, and the approximate net weight 3600 pounds.

* * *

THE PERILS OF AVIATION

To the heavy death toll imposed upon aviators in 1910 were added two fatalities on the last day of the year, John B. Moisant and Archibald Hoxsey, two of the best known and most popular bird men, being dashed to death within a few hours of each other, December 31.

Moisant, who was unknown to the aviation world previous to last August, made himself famous by being the first man to cross the English Channel with a passenger, the machine used being a Bleriot monoplane. What was probably his greatest achievement was his trip to the Statue of Liberty and return, at the Belmont Park meet in October last when, on an unfamiliar machine, his own being out of commission, he won the Ryan prize. Up to the time of his death he had been exhibiting throughout the South. His death at New Orleans was caused by being thrown from his machine when making a sharp dip, his machine being upset by a gust of wind.

Hoxsey has long been in the eyes of the public as probably the most daring of the aviators. He came into prominence at St. Louis by taking Colonel Roosevelt for a short flight. It was he who captured the altitude record by reaching 11,474 feet just six days prior to his death. On the day of his fatal trip he set out with the intention of breaking this record, but apparently things went wrong, for upon coming to the ground in the famous spiral curve, adverse winds were met with. These were fought with success until he was within 500 feet of the ground when he was caught in a bad air disturbance which pitched the machine to the ground.

In the August, 1910, issue of MACHINERY, a list of the aviators that had been killed up to July, 12, 1910, was given. Since that date over twenty deaths have been added to that record, as follows:

August 3. Nicholas Kinet fell 650 feet from his Farman biplane in Belgium.

August 20. Lieut. Marquis Vivaldi killed near Rome in a Farman biplane.

August 27. Van Maasdyk killed by his Sommer biplane turning turtle.

September 23. Georges Chavez died from the result of a short fall from his Bleriot machine at Milan, Italy, after having crossed the Alps.

September 25. Edmond Poillot's machine turned turtle at Chartres, France, while flying with a passenger; the passenger escaped with slight injuries.

September 28. Flockmann died from the result of his machine collapsing at Muhlhausen, Germany.

October 1. Herr Haas killed at Wellen, Germany, by a fall from his machine.

October 7. Capt. Maziewitch fell from a Farman biplane at St. Petersburg, Russia.

October 23. Capt. Madiot killed at Doual, France, by his engine refusing to stop when landing.

October 25. Lieut. Mente killed near Magdeburg, Germany, from a Wright machine.

October 26. Fernando Blanchard at Issy les Moulineux, France, killed while preparing to land.

October 27. Lieut. Sagliette killed at Centosello, Italy, by the aeroplane tipping.

November 17. Ralph Johnstone killed at Denver by the breaking of the left plane.

December 3. Lieut. Cammarata when flying with a passenger in a Farman biplane near Rome, Italy; both were killed.

December 22. Cecil Grace disappeared on a trip across the English Channel from France.

December 25. D. Piccollo, killed in an Antoinette machine at San Paulo, Brazil.

December 28. Alexandre Laffont killed with M. Paulla, both falling from machine.

December 30. Lieut. Caumont killed at Versailles.

December 31. John B. Moisant killed at New Orleans.

December 31. Archibald Hoxsey killed at Los Angeles.

TIMING AN OFFSET AUTOMOBILE ENGINE*

By M. TERRY†

During the last two or three years the practice of offsetting engines has become very popular with many automobile manufacturers.

The main object in offsetting a motor is to reduce and equalize the wear on the cylinder walls. "Offset" is the distance of the crankshaft center line from the path of the wrist pin center. Theoretical investigations by various authorities seem to point to a rather large offset; in practice, the offset is made considerably smaller, and, in general, its amount is purely arbitrary.

The cylinders are invariably offset in the direction of rotation of the crankshaft. Thus, in the right-handed motor (Fig. 1), the cylinders are offset to the right of the crankshaft.

A case taken from practice and completely worked out will bring forth all the points to be considered by a designer in giving the proper timing to his motor.

Specifications

The following are the specifications:

Engine: four-cycle; four-cylinder; right-hand; bore = 4¼ inches; crank throw = 4½ inches; offset = ½ inch; and connecting rod = 9 inches.

Timing:

Exhaust opens 5/16 inch before the lower dead center.

Exhaust closes 1/16 inch after the upper dead center.

Inlet opens 3/32 inch after the upper dead center.

Inlet closes ⅝ inch after the lower dead center.

Valve lift = 9/32 inch.

Base circle of the cam = 1.000 inch.

Diameter of the cam roller = 1.000 inch.

Clearance between valve and valve lifter = 0.005 inch.

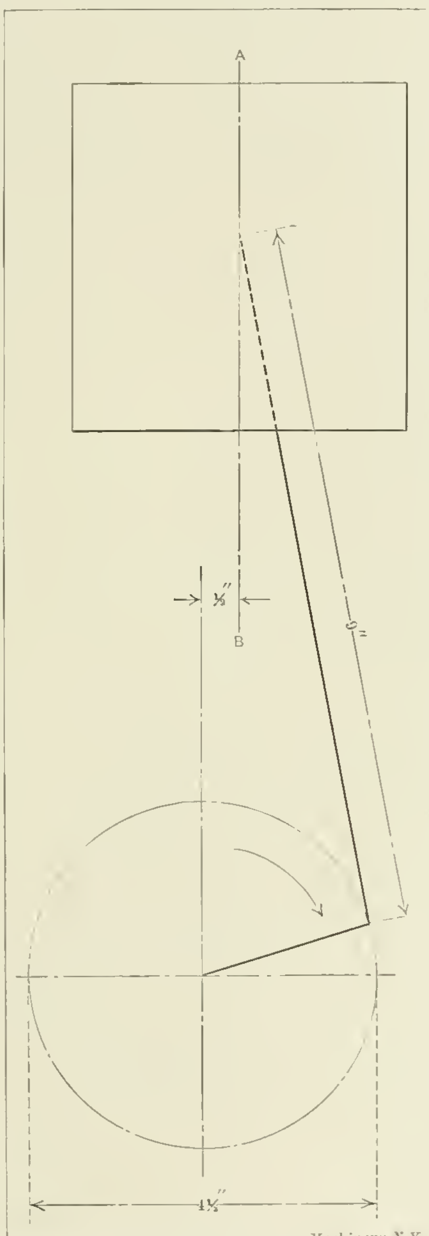


Fig. 1. Diagrammatic View of an Offset Automobile Engine

While the four timing points are chosen arbitrarily, certain considerations are involved in their selection. On present-day pleasure cars the inlet may close anywhere from ⅜ to ⅞ inch past the lower dead center; *i.e.*, the piston is on its upward compression stroke while the inlet valve is still open. In other words, the inertia of incoming gases is utilized for the purpose of "jamming in" more charge than the suction stroke is capable of drawing in. Since an average automobile engine is capable of running at anywhere from 800 to 1800 revolutions per minute, and the "inlet closes" point (like the rest of the timing points) is fixed on any one motor, the inertia of the gases will

Fig. 2. Locating the Dead Center

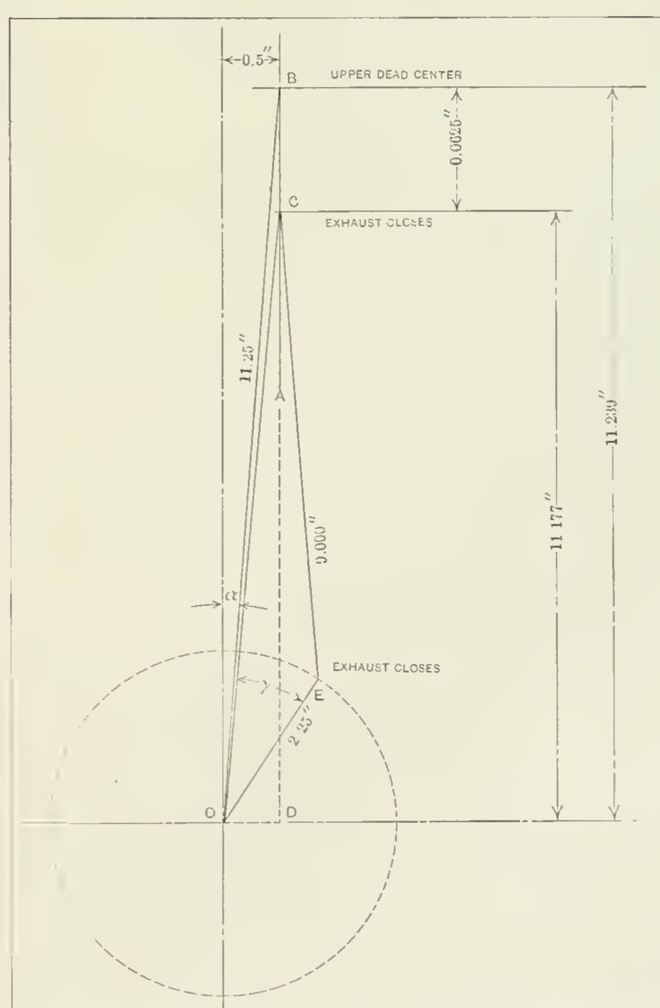


Fig. 3. Determination of Crank Position for "Exhaust Closes" Point

* For additional information on automobile design, see the following articles previously published in MACHINERY: "Offsetting Cylinders in Single-Acting Engines," June, 1909; "Design of Automobile Transmission Gears" (3 articles), October and December, 1910, and January, 1911.

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be fully utilized at some particular speed. The maximum volumetric efficiency of the engine occurs at this speed, which may be termed its normal speed.

Engine Classification

The magnitude of this normal speed determines the classification of the motor, *i.e.*, whether it is fast, medium, or slow. The "inlet closes" point is chosen by the designer in accordance with the type of motor he is to build. A slow motor can be forced to run as fast as some high-speed motors, and the latter can be throttled down to the normal speed of some slow

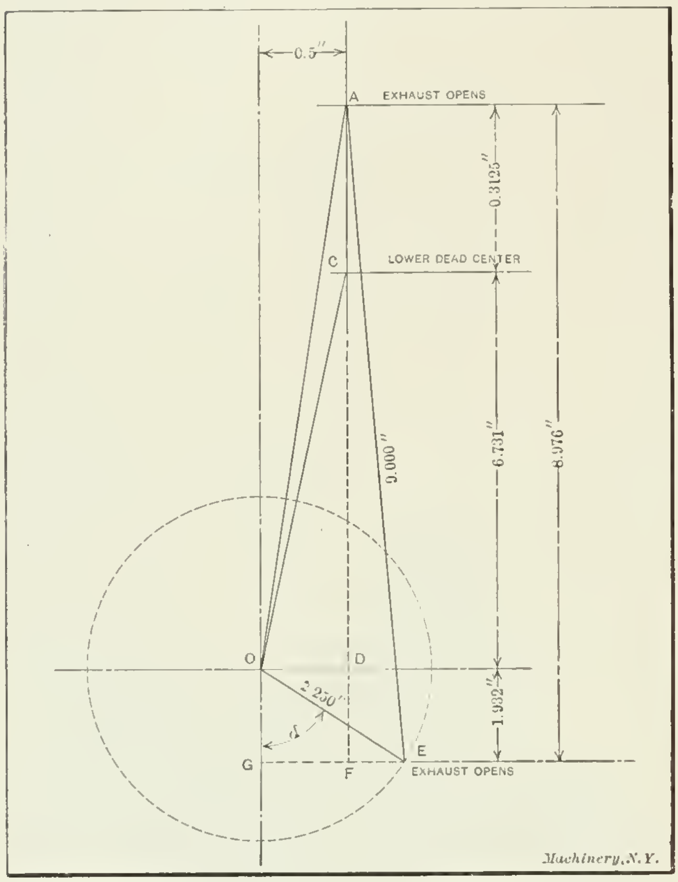


Fig. 4. Determination of Crank Position for "Exhaust Opens" Point

motors, but in either case the end is achieved at a sacrifice of volumetric efficiency. If the speed of the engine is below its normal point, part of the charge taken in will be expelled from the cylinders into the carburetor; and if the speed be above normal, the inlet valve will close before the inertia of incoming gases is fully utilized. In either case it results in falling off of volumetric efficiency. The higher the desired normal speed of the engine, the higher will the "inlet closes" point be above the lower dead center, but within certain limits, of course, its location is a mere guess.

With exhaust opening taking place early in the expansion stroke, the expansion of gases is less complete and waste of fuel greater. On the other hand, early exhaust opening allows of better scavenging. Like the "inlet closes" point it varies with the type of the motor; the faster the engine, the earlier in the stroke the exhaust valve would open.

The "exhaust closes" and "inlet opens" points are, in general, kept the same on both fast and slow motors, and, while the location of each varies with different makers, the two points are placed quite near the upper dead center. For obvious reasons the inlet must begin early in the suction stroke. It is also desirable to keep the exhaust valve open some time past the exhaust stroke, it being another instance of utilization of inertia of moving gases, this time for scavenging purposes. The exhaust valve must also be shut tight before the inlet valve begins to open. Between these three considerations the range of choice for "exhaust closes" and "inlet opens" points is naturally very limited.

A word or two regarding the coming calculations may not be amiss. While the four timing points are practically arbitrary, it is not sufficient to lay out a timing diagram as in Fig. 7, scale off the angles and build the camshaft therefrom, for a slight difference in some angle may cause quite a deviation from desired timing. Also comparison of performances of various motors with different timing is apt to be misleading. It is true that errors in machining and actual construction are bound to occur, but this is no reason why the work in the drafting room should not be accurate.

In order to make their mutual relation clearer, lines, angles, etc., in Figs. 2, 3, 4, 5, and 6 are purposely shown out of scale.

Dead Centers

Consider Fig. 2.

O is the center of the crank circle.

AB is the piston path.

B is the upper dead center.

C is the lower dead center.

OB = length of connecting rod + length of crank = 9 + 2.25 = 11.25 inches.

OC = length of connecting rod — length of crank = 9 — 2.25 = 6.75 inches.

$Y = DB = \sqrt{OB^2 - OD^2} = \sqrt{11.25^2 - 0.5^2} = 11.239$ inches

$X = DC = \sqrt{OC^2 - OD^2} = \sqrt{6.75^2 - 0.5^2} = 6.731$ inches

Piston travel $= Y - X = 11.239 - 6.731 = 4.508$ inches.

To find the angle of offset at the upper dead center

$$\sin a = \frac{0.5}{11.25}$$

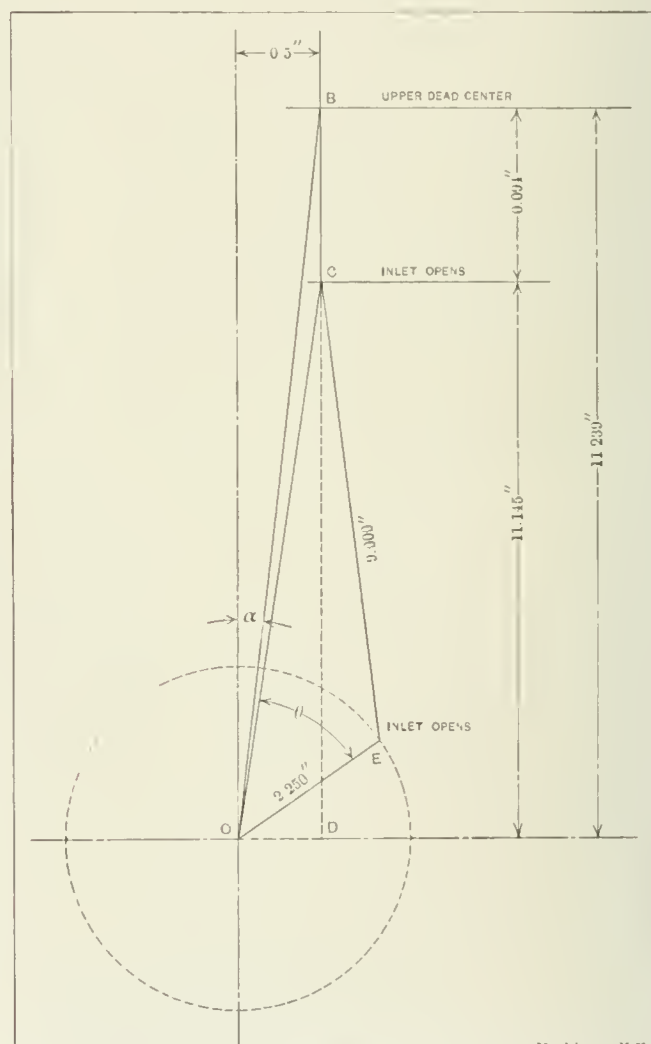


Fig. 5. Determination of Crank Position for "Inlet Opens" Point

Therefore $a = 2° \ 33'$.

To find the angle of offset at the lower dead center

$$\sin \beta = \frac{0.5}{6.75}$$

Therefore $\beta = 4° \ 15'$.

Exhaust Closes

The next thing to do is to find the angle formed by the crank with the vertical for the "exhaust closes" point. All the necessary data are given in Fig. 3.

Angle BOC may be entirely neglected, as from about a dozen different timing diagrams laid out by the writer, with varying offsets, strokes, and lengths of connecting-rods, it has been found that this angle never exceeds three or four seconds, a negligible quantity.

As previously determined,

$$a = 2° \ 33'; \text{ and } DB = 11.239 \text{ inches.}$$

By specification, $BC = 0.0625$ inches.

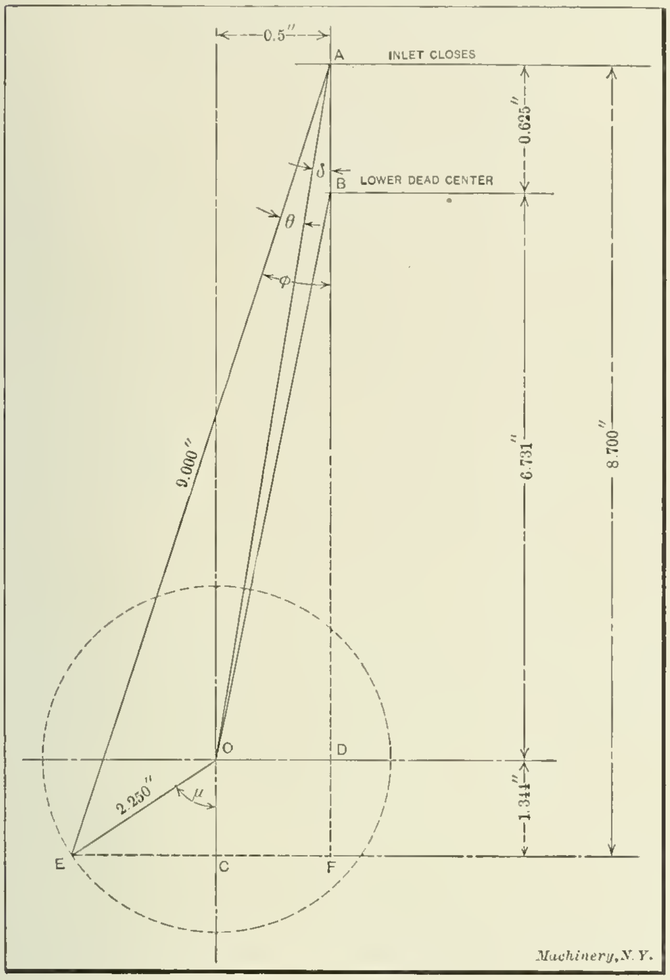


Fig. 6. Determination of Crank Position for "Inlet Closes" Point

Therefore $DC = DB - BC = 11.239 - 0.062 = 11.177$ inches

and

$$OC = \sqrt{DC^2 + OD^2} = \sqrt{11.177^2 + 0.5^2} = 11.188 \text{ inches}$$

and

$$\cos \gamma = \frac{OC^2 + OE^2 - CE^2}{2 \times OC \times OE} = \frac{11.188^2 + 2.25^2 - 9^2}{2 \times 11.188 \times 2.25}$$

Therefore $\gamma = 12° \ 3'$.

and $\gamma + a = 2° \ 33' + 12° \ 3' = 14° \ 36'$, which is the angle made by the crank with the vertical, at the "exhaust closes" point.

Exhaust Opens

Referring to Fig. 4, as before

$OE = 2.25$ inches = length of crank.

$AE = 9.00$ inches = length of connecting rod.

$CD = 6.731$ inches (Fig. 2).

$AC = 0.3125$ inches (by specification.)

Hence

$$AD = CD + AC = 6.731 + 0.313 = 7.044 \text{ inches}$$

and

$$OA = \sqrt{AD^2 + OD^2} = \sqrt{7.044^2 + 0.5^2} = 7.062 \text{ inches}$$

Therefore

$$\cos OAD = \frac{AD}{OA} = \frac{7.044}{7.062}$$

Hence

$$\angle OAD = 4° \ 5' \ 30''$$

also

$$\cos OAE = \frac{OA^2 + AE^2 - OE^2}{2 \times OA \times AE} = \frac{49.868 + 81 - 5.063}{2 \times 7.062 \times 9}$$

Therefore

$$\angle OAE = 8° \ 14' \ 10''$$

Hence

$$\angle FAE = \angle OAE - \angle OAD$$
$$= 8° \ 14' \ 10'' - 4° \ 5' \ 30'' = 4° \ 8' \ 40''$$

Also $FA = AE \cos FAE = 9 \times \cos 4° \ 8' \ 40'' = 8.976$ inches, and $OG = DF = FA - AD = 8.976 - 7.044 = 1.932$ inches.

$$\text{Therefore } \cos \delta = \frac{OG}{OE} = \frac{1.932}{2.250}$$

Hence the angle made by the crank with the vertical at the "exhaust closes" point $= \delta = 30° \ 50'$.

By consulting Figs. 3, 4, and 7, it is evident that the total angle described by the crank pin while the exhaust valve remains open, is

$$(\gamma + a) + 180° + \delta = 14° \ 36' + 180° + 30° \ 50'.$$
$$= 225° \ 26'.$$

Inlet Opens

Fig. 5 represents conditions at the "inlet opens" point. As before

$BD = 11.239$ inches (Fig. 2).

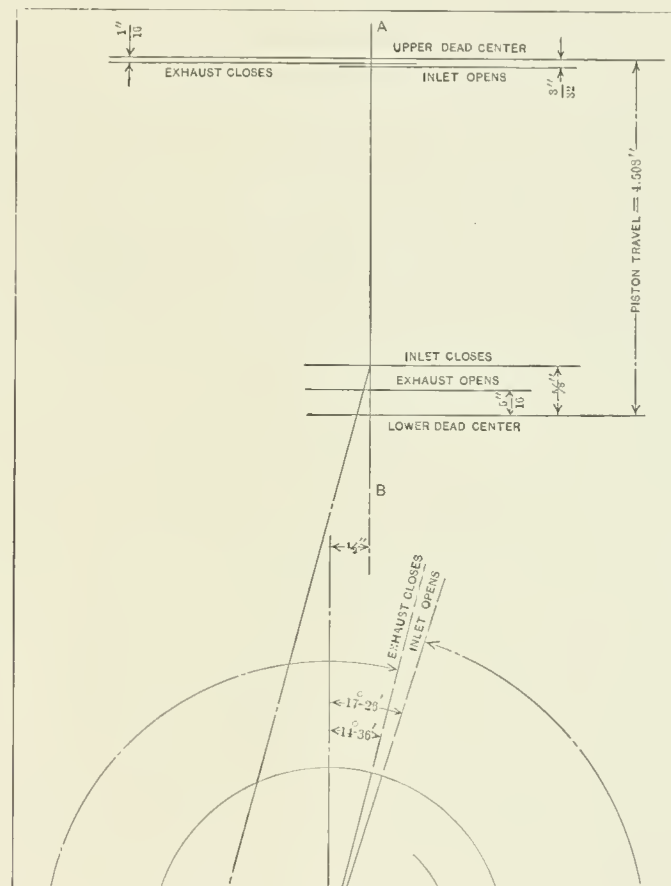


Fig. 7. Timing Diagram correctly laid out

$BC = 0.094$ inches (by specification.)

Therefore $CD = BD - BC = 11.239 - 0.094 = 11.145$ inches.

Hence

$$OC = \sqrt{CD^2 + OD^2} = \sqrt{11.145^2 + 0.5^2}$$
$$= 11.156 \text{ inches}$$

and

$$\cos\theta = \frac{11.156^2 + 2.25^2 - 9^2}{2 \times 11.156 \times 2.25}$$

Therefore

$$\theta = 14^\circ\ 53'$$

and

$$\alpha = 2^\circ\ 33' \text{ (Fig. 2)}$$

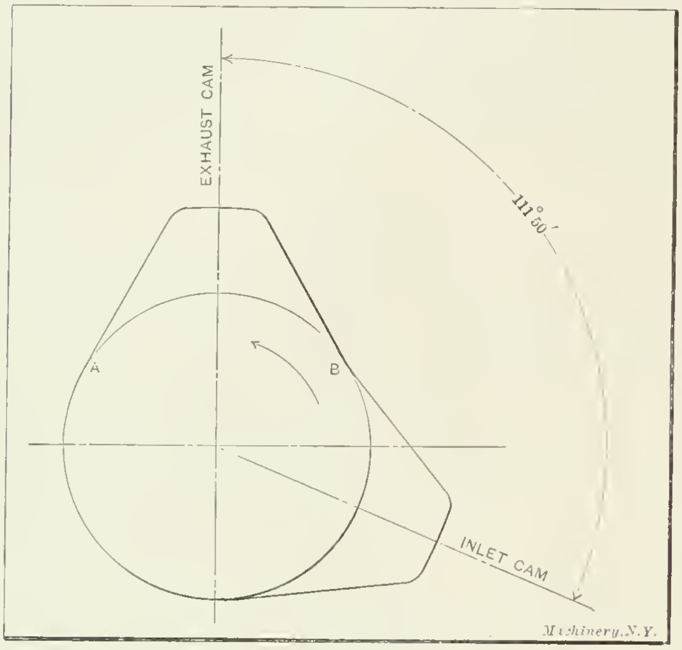


Fig. 8. Completed Set of Cams

This gives the angle made by the crank with the vertical at "inlet opens" position to be

$$\alpha + \theta = 14^\circ\ 53' + 2^\circ\ 33'.$$
$$= 17^\circ\ 26'.$$

Inlet Closes

Conditions for the "inlet closes" point, are shown by Fig. 6. As before

$DB = 6.731$ inches (Fig. 2).

$AB = 0.625$ inches (by specification).

Hence $DA = AB + DB = 7.356$ inches,

and $OA = \sqrt{AD^2 + OD^2} = \sqrt{7.356^2 + 0.5^2}$
$= 7.373$ inches,

and

$$\cos\theta = \frac{OA^2 + AE^2 - OE^2}{2 \times AE \times OA} = \frac{54.3611 + 81 - 5.0625}{2 \times 9 \times 7.373}$$

Hence $\theta = 10^\circ\ 57'$.

Also $\cos\delta = \dfrac{DA}{OA} = \dfrac{7.356}{7.373}$

Hence $\delta = 3^\circ\ 53'\ 30''$.

Therefore $\phi = \theta + \delta = 10^\circ\ 57' + 3^\circ\ 53'\ 30''$.
$= 14^\circ\ 50'\ 30''$.

and $AF = AE \cos\phi = 9 \times \cos 14^\circ\ 50'\ 30'' = 8.7$ inches.

Hence $OC = DF = AF - AD = 8.7 - 7.356 = 1.344$ inches.

and $\cos\mu = \dfrac{OC}{OE} = \dfrac{1.344}{2.250}$

Therefore $\mu = 53^\circ\ 38'$.

By consulting Figs. 5, 6, and 7, it is clear that the total angle described bl the crank pin while the inlet valve remains open, is

$$180^\circ - (\alpha + \theta) + \mu = 180^\circ - 17^\circ\ 26' + 53^\circ\ 38' = 216^\circ\ 12'.$$

Half-time Shaft

The term "four-cycle" is a misnomer. A more suitable name for it would be "four-stroke cycle," *i.e.*, a cycle consisting of four strokes of the piston. The four strokes are usually considered in the following order: suction, compression, expansion and exhaust. The action of the inlet cam takes place simultaneously with the suction stroke of the piston. Similarly, the exhaust cam works in unison with the exhaust stroke of the piston. Thus each cam performs its function once in each cycle; in other words, one revolution of the camshaft takes place in each cycle. In the meanwhile the four strokes of the piston produce two revolutions of the crankshaft.

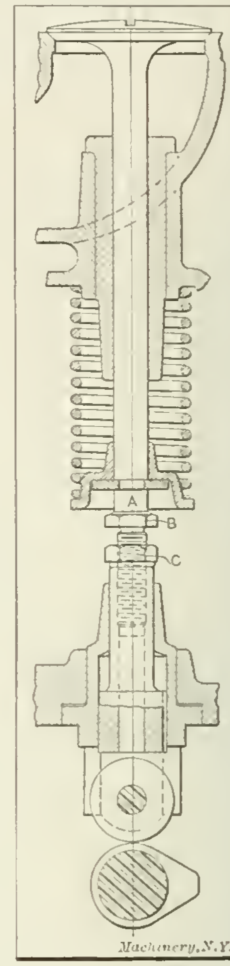


Fig 12. Valve Mechanism

The camshaft, then, makes one complete revolution to two revolutions of the crankshaft; for this reason it is often called the half-time shaft. The two shafts are connected by gears in the ratio of two to one, with the larger of the two gears mounted on the camshaft.

It is clear, then, that while the inlet valve opening, as measured on the crankshaft circle, is equal to 216 degrees and 12 minutes, the inlet cam angle will be half of that, or 108 degrees 6 minutes. Similarly, the exhaust cam angle is equal to 112 degrees 43 minutes. These values are slightly modified by clearance as explained below.

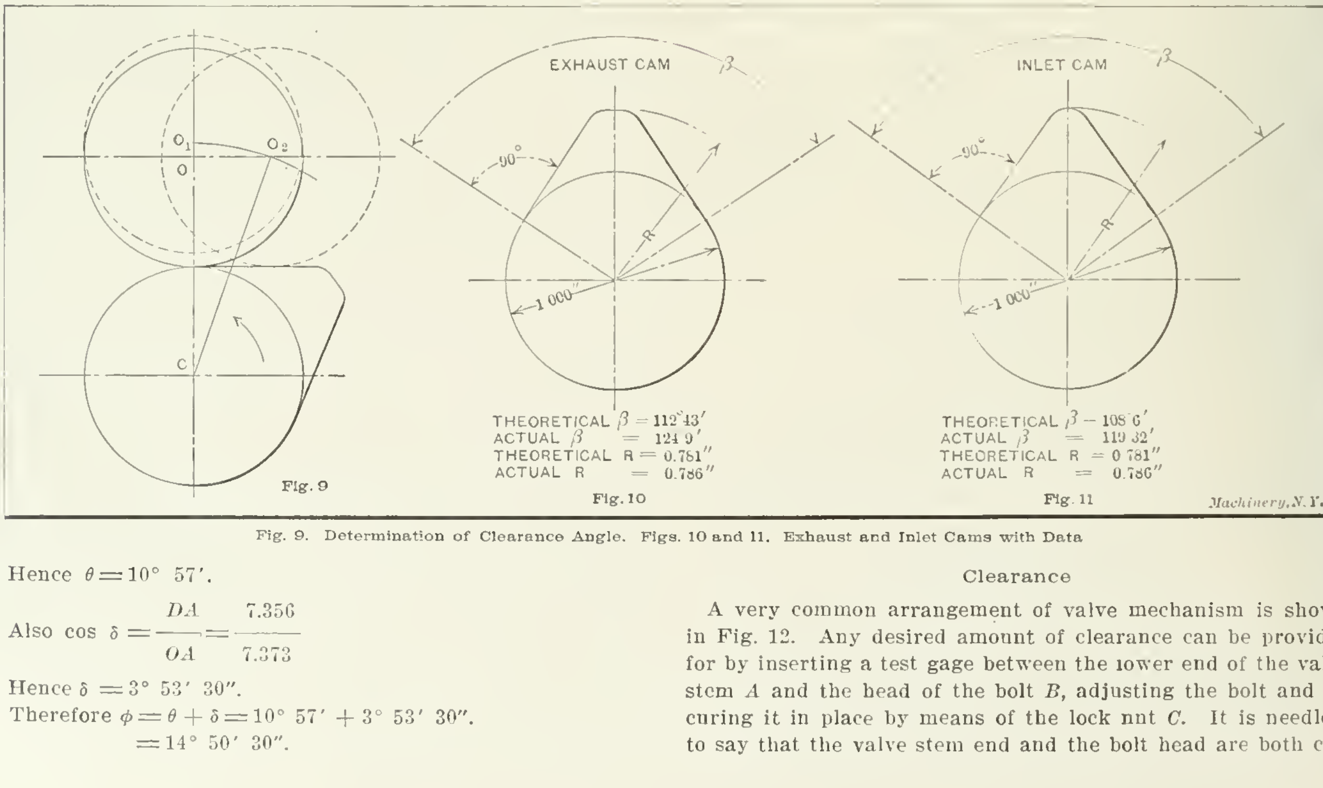


Fig. 9. Determination of Clearance Angle. Figs. 10 and 11. Exhaust and Inlet Cams with Data

Clearance

A very common arrangement of valve mechanism is shown in Fig. 12. Any desired amount of clearance can be provided for by inserting a test gage between the lower end of the valve stem *A* and the head of the bolt *B*, adjusting the bolt and securing it in place by means of the lock nut *C*. It is needless to say that the valve stem end and the bolt head are both car-

bonized, hardened and ground to a mirror finish, and that so small a clearance as 0.005 inch is by no means a conjecture or a guess, but a definitely known quantity, as near as human skill can make it. The main object of clearance is to permit the valve to seat itself. If no clearance were provided, it would be only a matter of short time before the valve seat will wear out enough to make the base circle of the cam bear the spring pressure during the time the valve remains at rest, and this is accompanied, of course, by leakage of gases. In due course of time the seats wear out from constant pounding

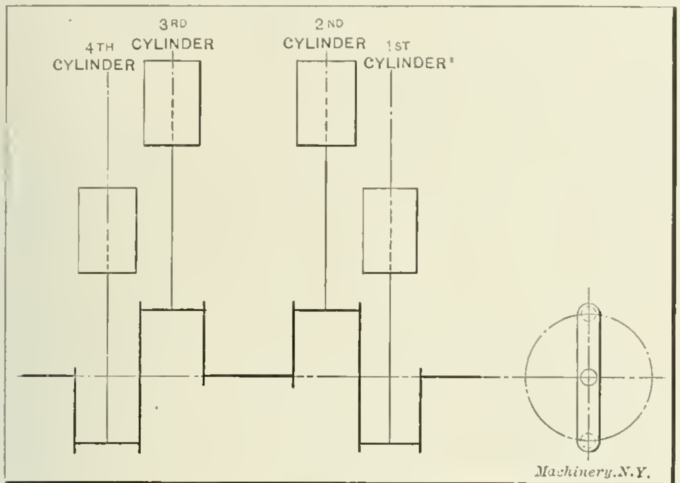


Fig. 13. Crankshaft Construction

of the valves, when they must be ground and new adjustment made.

It will be seen, then, that clearance produces a certain amount of lost motion, which results in shorter time-opening of the valves. To compensate for this lost motion of valves, a certain angle is added to the cam which is known as "clearance angle." Since the lost motion exists on the upward as well as downward travel of the valve, the theoretical cam angle is increased by twice the clearance angle.

Clearance Angle

In Fig. 9, the cam and its roller are shown in a position where the latter begins to rise. The valve however will remain closed till the roller rises 0.005 inch, *i.e.*, from O to O_1. The angle the cam turns through while the roller rises from O to O_1, is the clearance angle. To find this angle, consider the camshaft at rest, and the motor (crankcase cylinders and all) turning to the right. The roller then will move along the face of the cam and the roller center parallel to it. When the roller center reaches O_2 whose distance from C equals CO_1, the valve will begin to rise. The angle OCO_2 is the clearance angle.

By specification:

$OC = 1.000$ inch.

$O_2C = 1.005$ inch.

Therefore $\cos OCO_2 = \dfrac{OC}{O_2C} = \dfrac{1.000}{1.005}$

and angle $OCO_2 = 5° \ 43' =$ clearance angle.

Total angle added to the theoretical cam angle is twice this, or 11 degrees and 26 minutes.

Actual inlet cam angle $= 108° \ 6' + 11° \ 26' = 119° \ 32'$.

Actual exhaust cam angle $= 112° \ 43' + 11° \ 26' = 124° \ 9'$.

Figs. 10 and 11 show the application of these results to the two cams.

Cam Setting

The subject of cam setting may come under two heads: Relative position of inlet and exhaust cams controlling the same cylinder; and relative positions of the various sets of cams operating separate cylinders.

To understand the first more clearly, consider the cycle of operations as taking place in the following order: exhaust, inlet, compression and expansion. It will be noticed that the sequence of operations remains unchanged; the advantage lies in the fact that the inlet immediately follows the exhaust; and, in Fig. 8 the exhaust cam comes first with the inlet cam following, and thus no attention need be paid to compression and expansion strokes.

According to the timing diagram (Fig. 7) the angle between "exhaust opens" and "inlet opens" points is

$$30° \ 50' + 180° \ 0' + 17° \ 26' = 228° \ 16'$$

on the crank circle; on the camshaft the angle will be half of that, or 114 degrees and 8 minutes.

In the case at hand, the crankshaft and camshaft gears are supposed to be in direct mesh (no idler); and since the first turns clockwise, the latter will turn counterclockwise (Fig. 8) and B which is the "inlet opens" point on the camshaft is 114 degrees and 8 minutes distant from A, the "exhaust opens" point. If the two cams were precisely alike, the angle between their center lines would also be 114 degrees 8 minutes; but, since the exhaust cam is the wider of the two, the angle between their center lines would be less by half the difference of the two cam angles. This hardly needs any proof, as a glance at Fig. 8 will suffice.

Exhaust cam angle	$= 124° \ 9'$
Inlet cam angle	$= 119° \ 32'$
Difference	$= 4° \ 37'$

Half difference $= 2° \ 18'$ about.

Therefore the angle between cam center lines is

$$114° \ 8' - 2° \ 18' = 111° \ 50'.$$

Order of Firing

An exhaust and an inlet cam operating the same cylinder constitute a set, and there is one set of cams corresponding to each cylinder on the engine. All sets being exactly alike, it is only necessary to determine the relative positions of, say, exhaust cams. This is determined by the order of explosions taking place on the engine, and this latter depends on the crankshaft construction, *i.e.*, the number and location of crank pins.

Fig. 13 shows the commonest and perhaps the best form of crankshaft construction used on four-cylinder motors. Explosions take place with crank pins on their upper dead centers, and one explosion occurs in each cylinder per cycle. Since there are four strokes in a cycle, and the engine under discussion has four cylinders, there is one explosion for each stroke of the motor.

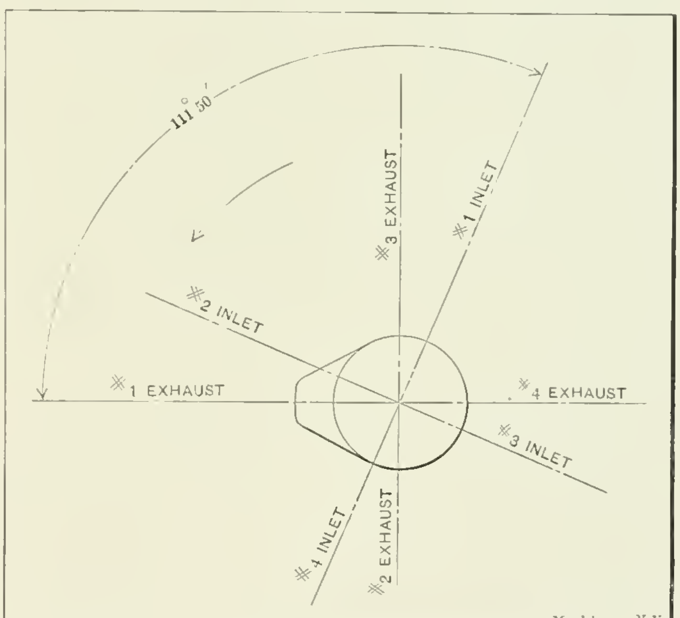


Fig. 14. End View of Camshaft showing Relative Positions of Cams

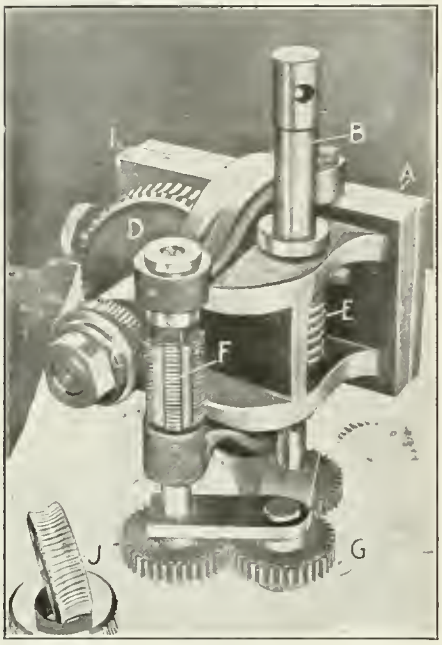
With crank pins arranged as in Fig. 13 there are two possible orders of firing: 1-3-4-2 and 1-2-4-3, numbers 1, 2, 3 and 4 standing for first, second, third and fourth cylinders respectively. The 1-3-4-2 order of firing is preferred by a good many. The explosions are 180 degrees apart on the crank circle, or 90 degrees apart on the camshaft.

Fig. 14 shows the end view of the half-time shaft. With a single exception only, the center lines of the cams are shown. Explanation is unnecessary, as the construction is in agreement with the preceding discussion.

HOBBING SMALL WORM-GEARS ON A DRILL PRESS

By ETHAN VIALL*

A drill press fixture, shown in the accompanying engraving, is used in the shop of the Queen City Shaper Co., Cincinnati, Ohio, for hobbing out bronze worm-gears for lathe aprons, which makes it possible to cut the teeth complete for this particular gear in about one-fourth the time taken by any other method. In using this fixture, the back plate A, is bolted to an angle plate which is clamped to the platen of the drill press, the device being placed high enough to enable the lower gears to clear nicely. It may be well to state here that while in use a chip guard covers these gears and protects them from becoming clogged. The mechanism is driven from the drill press spindle through a compensating universal joint coupled to the shaft B, which, in turn, drives the gear blank C, through the large gear and worm D and E, and also drives the hob F through the spur gearing at G.



Gear-hobbing Fixture for Use on a Drill Press

The hob and its arbor are connected to the back plate by brackets, and have no motion except that of revolution, the necessary feeding being done by a handwheel, which operates the cross-slide I, upon which are mounted the driving shaft, worm-gear and arbor for holding the blank, the give-and-take in the driving connections between the two parts being automatically adjusted, of course, by the train of gears G. Two of the finished worm-gears are shown at J, and for the benefit of anyone wishing to make a similar fixture it may be further stated that the worm-gear that drives the work arbor has the same number of teeth as the gear that is cut on the machine and also that the three gears in the train are alike.

* * *

ALUMINUM VS. COPPER CONDUCTORS

It is interesting to compare the relative advantages of copper and aluminum as electrical conductors. The conductivity of aluminum is only 63 per cent of that of copper, but as an aluminum wire of equivalent conductivity of copper weighs only 48 per cent of the copper wire, owing to the small specific gravity of aluminum, it is advantageous for use where weight is a matter of importance. The strength of aluminum wire for equivalent conductivity exceeds that of copper wire by 60 per cent. The cost of aluminum, of course, is higher than that of copper, pound for pound, but it is cheaper for the same conductivity, provided bare wire is used. When the wire is insulated, however, copper has the advantage on smaller sizes, because in wires of the same conductivity the circumference of copper wire would be so much less than the circumference of the aluminum conductor that much less insulating material would be required. This relation, however, holds true only within certain limits, for on larger sizes aluminum again becomes cheaper even with insulation, due to the fact that conductivity depends upon the cross-sectional area, and this latter varies as the square of the diameter and circumference. Hence it will be seen that in comparing the advantages of aluminum and copper for electric conductors, many factors must be considered, and the relative costs, carefully computed.

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FORMULA FOR LOADED RING

Sometime ago the accompanying formula for the stresses in a loaded ring was discovered in an engineer's private note book, and as the same was credited to Mr. Carl G. Barth, the latter was consulted, that something more might be learned about it.

Mr. Barth's reply was in substance as follows: This formula was developed about thirteen years ago when the newer theories of the strength of curved beams were practically unknown in this country, but it is believed that even if applied to this case, the final results would not be greatly modified, except for rings whose mean diameter is small, compared to the diameter of the stock.

This formula is only a special case of a series of general formulas, developed as before mentioned, to determine the stresses and capacity of a ring of any cross-section loaded symmetrically around its circumference with every alternate force tending radially to open the ring, while the intermediate forces act to close it. In these formulas values are first substituted to bring the points of application of the various forces 90 degrees apart, and then make the forces tending to close the ring, zero. The greatest bending moments in the ring then shift to the points of application of the two remaining forces, at which place the direct tension in the ring at the same time becomes zero.

The expression for this maximum bending moment is $\frac{PD}{2\pi}$ where

P = load on ring.

D = mean diameter of ring.

Therefore

$$\frac{PD}{2\pi} = f\frac{I}{y} \quad \text{or} \quad P = f\frac{2\pi I}{Dy}$$

in which I = the moment of inertia of the section,

y = the distance from the center of gravity of the section to the most remote fiber, and

f = the allowable working stress.

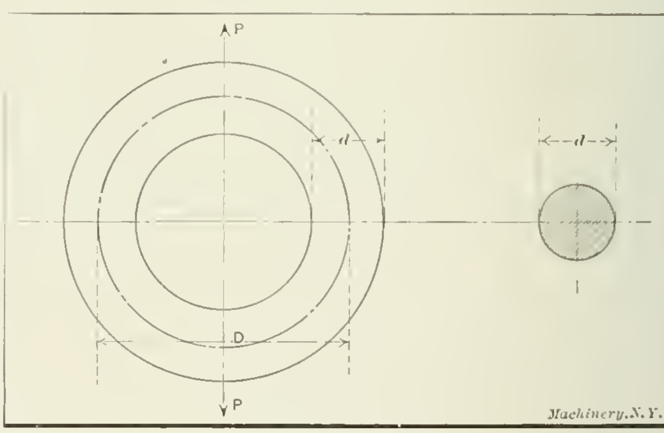


Diagram of Ring Loading

For a circular section of ring $I = \frac{\pi d^4}{64}$ and $y = \frac{d}{2}$

Hence

$$P = f\frac{2\pi\frac{\pi d^4}{64}}{D\frac{d}{2}} = f\frac{\pi^2 d^3}{16D} = 0.617 f\frac{d^3}{D}$$

which gives the capacity of the ring. From this equation also

$$f = 1.621 P\frac{D}{d^3}$$

which represents the extent to which the material is stressed for a given load.

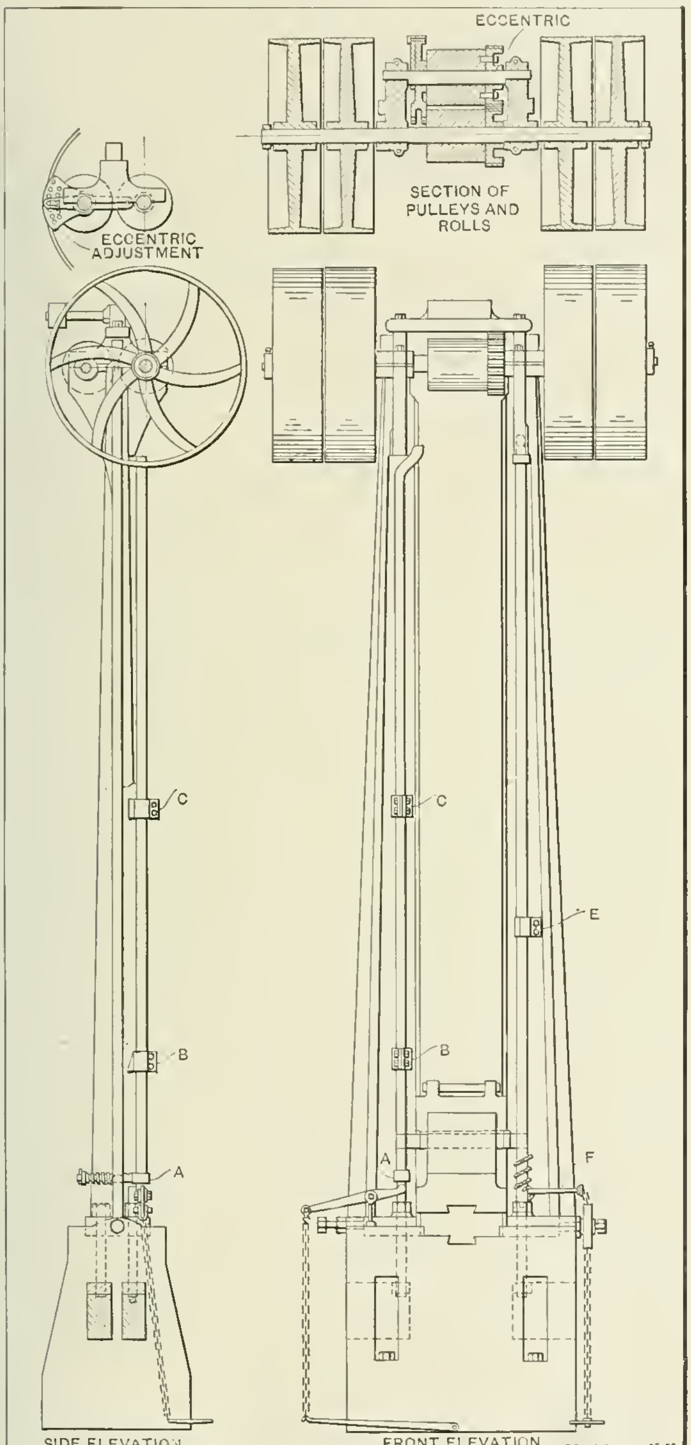
* * *

The Pennsylvania Railroad has now completed or under construction 2000 steel passenger cars. This number includes 600 Pullman parlor and sleeping cars.

A DROP HAMMER OF FIFTY YEARS AGO

By H. TERHUNE

For upwards of a century power hammers have been playing an important part in the working of metals, among the earliest types being the trip, or what is now known as the helve hammer. The steam hammer was invented in 1842 by James Nasmyth but, so far as is known, the first practical working drop hammer was not designed until 1853, when one



Old Drop Hammer built in 1862

was produced by Elias K. Root, superintendent of Colt's Armory, Hartford, Conn. There is no record of a drop hammer patent until that of Goulding and Cheney in 1861, the principal claim of which was the lifting of the hammer by a belt between two friction rollers revolving in opposite directions.

However, duplicate forgings had been made from dies long before this, the method of so doing being clearly described by C. E. Billings† (founder of the Billings & Spencer Co., Hartford, Conn.) in a paper read before the American Society of Mechanical Engineers, when he was its president. Quoting in part:

"A heavy cast-iron block called the 'sow-block' with a suitable opening in the top for the lower die was held fast by keys and stock to guide the upper die termed 'the jumper.' In the face of the die the forms to be forged were cut as at present, the power being applied by hand hammers and sledges wielded by the smith and his helpers on the upper die with the heated bar of metal held between them. Much time was spent in distributing the stock on the end of the bar of metal before the swaging took place, in order to have the metal flow properly to fill the points of the die."

According to present-day standards this would seem very crude. The accompanying drawing of the drop hammer is dated 1862 and was designed by C. E. Billings. It affords an excellent example of an early type of drop hammer for duplicate forgings. Four of these were built and did good service for years, playing an important part in the manufacture of the old muzzle-loading Springfield rifle used throughout the Civil War.

Like all drop hammers of its time, the hammer was raised by a belt between geared friction rolls, the rear one being driven by tight and loose pulleys, while the front one ran free on an eccentric. With the exception of the adjustment shown in the accompanying drawing, it resembles very much some present-day hammers, especially the front rod and its connections and knock-off dogs.

The lug or finger *A* which formed the lower bearing for the front rod, passed through a hole in the upright with a spring on its end to keep the front rod to its seat at the release of the friction which occurred when the hammer reached the top of its stroke, as will be explained. On this front rod are stops or knock-offs *B* and *C*, the lower one *B*, having a beveled face to correspond to a similar face on the hammer. As the hammer neared the lower end of its stroke, these beveled faces came in contact, the front rod being thereby shoved off its shelf or seat, which action brought the rolls together at the top through the front arm, the eccentric squeezing the belt sufficiently to lift the hammer. At the proper moment the friction was released by a projection on the hammer coming in contact with the upper stop *C*, raising the front rod and releasing the friction from the belt. Several makers of board drop hammers use practically this same knock-off today and while it works satisfactorily, the operation is necessarily very slow, for the front rod will have a tendency to crystallize from the frequency of impact. This is an undesirable feature as speed is quite an important factor, often saving reheating.

The "catch-up" was very crude and would not do for a very heavy hammer. It consisted of another bar extending down the right-hand upright, and having a bearing top and bottom. Secured to it was the catch-up block *E*; to the bottom of this upright rod is a lever *F* from the end of which there is a chain passing over a shaft to a treadle. When ready for the first blow, the treadle was depressed sufficiently to rotate the block *E* from under the hammer. A coil spring on the rod caused it to return to the catch-up position upon the release of the treadle.

The uprights show the tendency of the times towards very high construction, the builders believing that a light hammer and great fall would give the best results, basing their belief on the kinetic energy formula $K.E. = \frac{Wv^2}{2g}$.

As work becomes heavier and of a somewhat irregular nature, the reverse of the above is considered the best practice. With a heavy hammer and shorter fall, better work may be produced for equal amounts of kinetic energy at the instant of impact. This is accounted for by the fact that under the slower motion the hot metal has better opportunity to flow into the recesses of the dies. It is for this reason that the hydraulic press has such a wide field.

* * *

The boom in aeronautics is in evidence at the United States Patent Office. The applications for patents relating to various machines and methods of control of aeroplanes and dirigible balloons average ninety a month, or about three a day.

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† For further description, see the historical sketch by Mr. C. E. Billings: "A Bit of Drop Forging History," in MACHINERY, May, 1895.

NOTES ON THE ECONOMICS OF LOCOMOTIVE OPERATION*

Every year the demands on the locomotive are more exacting, but contrary to a somewhat common belief, the modern locomotive, if worked to advantage, is an economical machine for what is required of it. The demand for greater hauling capacity has emphasized and enforced the big problem in operation—that of securing at the track the most from every pound of fuel burned. Some lines of progress leading to a greater economy and higher efficiency will be briefly considered in the following:

It is estimated that 125,000,000 tons of coal, or one-fifth of the production of the entire country, were burned last year in the locomotives of the United States. In a recent test conducted at Purdue University, it was found that practically 40 per cent of the heat in the fuel used in a simple locomotive equipped with a superheater, is not utilized in turning water into steam. Possibilities for effecting a considerable saving in coal consumption lie along many lines, among which are the following: By more perfect combustion; better front end construction; compounding; superheating; and by the use of briquetted fuel. To these may be added the saving from the introduction of a perfected mechanical stoker, which will eliminate losses due to improper hand firing.

Approximately 544,000 cubic feet of air are required to supply the oxygen necessary to completely burn one ton of coal, and less air than this means a waste in the form of unburned carbon; furthermore, the air must not only be supplied in the right quantity, but at the right place. The simple principles of combustion may be studied from a common kerosene lamp. The upper part of the lamp chimney corresponds to the stack and the enlarged part is, in the analogy, the combustion chamber, including the front end of the locomotive. The small space just above the wick is the fuel bed, and the air openings below, correspond to the openings through the grates. After the wick is lighted, if turned low, it does not smoke with the hood open, but when the hood is closed, the flame smokes because the air supply has been cut off, which condition is practically the same as when the locomotive has too much fuel on the grate. When the chimney is placed in position, the smoke ceases, and the flame brightens, showing better combustion. This improved condition is due to the fact that the draft draws more fresh air about the wick where it is needed. If a piece of cold iron is held in the flame, the gases are cooled before combustion is complete, which illustrates the condition when too much cold air strikes the flame. After the air supply is shut off by wrapping a cloth about the hood with the chimney in place, the flame smokes, thus illustrating the condition when the dampers in the firebox are closed too much. If a hole is broken in the side of the chimney, or if it is raised from its seat, the flame is chilled and the lamp smokes, and when the fire door of the locomotive is opened, the same thing happens, the gases being chilled before combustion has been completed.

From these simple experiments we learn that the essential conditions for preventing smoke and securing better fuel economy are: 1. That the fuel be supplied in small quantities, and just enough air be passed through the grates to burn it. 2. That the gases be distilled from the coal at a uniform rate. 3. That the air be heated by passing through the bed of hot coals. 4. That the volatile gases given off be mixed with a fresh supply of air, so that each particle of carbon element gets the necessary air supply.

The kind of fuel—its chemical composition, its size, friability, ash, and moisture—also influences economy. It has been demonstrated that briquettes give from 10 to 15 per cent higher evaporation than the run-of-mine coal from which the briquettes were made. Steam can be kept up easier with briquettes, but there is the disadvantage of decreased storage capacity in the tender, difficulty in shoveling, and in firing.

One hundred locomotive tests made for the United States Geological Survey on a number of western roads, showed, in nearly every instance, that the coal, when burned in the form of briquettes, gave a higher evaporative efficiency than when burned in the natural state. For example, Indian territory screenings gave a boiler efficiency of 59 per cent, whereas briquettes made from the same coal gave an efficiency of from 65 to 67 per cent. Decrease in smoke density and in the quantity of cinders and sparks, are given as the chief reasons for this increased efficiency. Other comparative tests show the saving of 20 per cent in pounds consumed per car mile, and with the elimination of black smoke and clinkers. The development lies in the direction of making it possible to use to advantage the low-grade fuels, and in this the briquettes have just begun to open up a new field. The cost of briquetting is approximately $1.25 per long ton.

Another way of effecting economy in operation lies in adapting the train load and speed to the class of engine best suited to the conditions. An example of economy resulting from the use of the Mallet articulated compound locomotive is shown by a test on the Delaware & Hudson Railway: Four runs were made with two pushers of the E 5 class, 2-8-0 type, having a total weight of 246,500 pounds, 217,500 pounds of which is on the drivers. Four runs were also made with the Mallet type, having 445,000 pounds on the drivers. The tonnage of all trains was practically the same and the results showed that the Mallet locomotives did practically the same work as the two E-5 engines, with a saving of 40 per cent in coal and 27 per cent in water.

The superheater, which supplies additional heat to the steam after the latter has been evaporated by the boiler, effects economy in reducing or eliminating cylinder condensation; in increasing the available temperature range of expansion without increase in pressure; and in increasing the steam volume with a comparatively small increase in heat to superheat. The question of the amount of superheat is a most important one. The Purdue tests show that the first 80 to 100 degrees superheat do not give the same proportional decrease in coal consumption as do the second 80 or 100 degrees. European practice is to superheat until the temperature is from 500 to 600 degrees F., or over; in fact the temperature is made as high as possible without interfering with lubrication, forced lubrication being used for the balanced piston valves.

From tests made on the A. T. & S. F. Ry., the following conclusions were drawn: 1. There is a marked decrease in coal consumption for a superheater engine. The decrease averages 20.8 per cent per thousand ton-miles for up grade runs, 11.5 per cent for down-grade runs, and 19.6 per cent for constant hard working of the engine on heavy grades. 2. A superheater engine uses 10 per cent less water per hour and develops more draw-bar horsepower on heavy work. 3. A superheater engine with 16.6 per cent less heating surface gives an evaporation of 10.6 per cent more water per square foot of heating surface than a non-superheater engine. 4. The superheater engine develops 20 per cent more drawbar horsepower per square foot of heating surface than the non-superheater type.

These tests on the Santa Fé road constitute the most important investigation of superheater equipment for compound locomotives undertaken in this country. Assuming 450 degrees F. as the maximum temperature allowable in the steam chest, the present development, as being worked out, is much more attractive than any of the methods requiring excessively high temperatures.

A theoretical study of the subject shows that a small amount of superheating in the high-pressure cylinder is of little or no advantage; when the pressure drop is large between the cylinders, a material gain is effected by considerable superheat in the low-pressure cylinder; and superheating to 100 degrees or over for the low-pressure cylinder is, theoretically, an attractive proposition.

* * *

A simple method of obtaining the square of a number ending with one-half is as follows: Multiply the whole number of the value to be squared by the next larger whole number, and add $\frac{1}{4}$ to the product. For example, the square of $2\frac{1}{2} = 2 \times 3 + \frac{1}{4} = 6\frac{1}{4}$, and the square of $10\frac{1}{2} = 10 \times 11 + \frac{1}{4} = 110\frac{1}{4}$.

* Abstract of an article by Prof. Arthur J. Wood, published in the January number of *Stevens Indicator*.

NOTES ON DRAFTING-ROOM LIGHTING*

Few classes of work call for more active and constant use of the eye than that of the draftsman. The necessity for continual distinction of fine lines and details and the use of finely divided measuring scales and delicate instruments warrants a system of illumination free from all features likely to produce eye fatigue and eye strain, and capable of promoting ease and comfort in such work. The problem is not altogether one of providing light of high intensity. Too much light may be as harmful as insufficient light.

The general requirements for such lighting are:

1—Good and sufficient light for each person.

2—Uniform distribution of light provided by lamps in such numbers and so arranged as to furnish illumination which is satisfactory without regard to the arrangement of tables.

3—An arrangement of lamps that will avoid glare and subsequent eye strain.

4—A system which will furnish illumination on the drawing boards with a minimum of shadow effect when using instruments and ruling devices.

5—An intensity of illumination which will permit the discernment with ease of fine lines and detail, and which will be sufficiently penetrating for tracing work.

Prevalent Methods of Drawing-room Lighting

Numerous methods have been used for the lighting of drafting rooms, some of which possess several of the features outlined above, but they seldom fulfill all requirements. For example, one method of drafting-room illumination is that in which one or two light units provided with reflectors are placed close to the work. This system, casting an intense light on the paper, is not, however, uniform and it is necessary to change the units when the position of desks is shifted, wiring modifications often being called for in such cases. A system of this kind produces a glare from the surface of certain kinds of paper with subsequent eye fatigue. It should be further noted that the resulting shadows are excessive and this requires a continual shifting of the work or lamps and a consequent delay and annoyance.

In an investigation of drafting-room lighting, tests were made in a typical room with bays 16 by 20 feet and a ceiling height of 11 feet 6 inches. A sectional view and floor plan of such a bay, together with the lighting arrangement, is shown in Fig. 1. This typical drafting room contained an average of four tables per bay and could accommodate four persons per bay. The room was originally equipped with large light units spaced on an average of from 8 to 10 feet apart and mounted 10 feet above the floor or about 5 feet 6 inches above the drawing boards. The arrangement is equivalent to about three lamps per bay, or 2.5 watts per square foot. The complaints from the use of this lighting scheme were threefold:

1—The illumination was not uniform, the intensity on some desks being higher than on others.

2—The low mounting height of the lamps, together with the large size of the units required to furnish sufficient light, caused those working in certain positions to suffer from excessive eye strain, both from the glare of the light source and from the reflected light on the papers.

3—Shadows from the small number of light units were dense and required a constant shifting of the ruling devices so as to receive the light on the work at the proper place.

The problem was to provide illumination possessing all the requirements as outlined above, and with features of such excellence as to be satisfactory in all respects for a class of work which rightfully calls for superior lighting facilities. The study of the requirements will show that uniformity, the absence of shadows, and the reduction of glare are the conditions most difficult to obtain. Several methods were given thorough trial before the final scheme was chosen.

Illumination Experiments

The first step was the installation of nine units somewhat smaller than those originally used, arranged as indicated in Fig. 2. Certain draftsmen were set to work in this trial bay. From the beginning the following items were observed: The intensity was excellent, the light uniform, and the glare inappreciable. It soon became apparent, however, that the shadows cast by the large number of units were an objectionable feature. In drawing circles and in the use of the divider generally, some nine shadows standing out in all directions from the instrument and apparently rotating when a circle was described produced confusion and annoyance. This feature naturally gave rise to considerable complaint and led to the suggestion that the shadows might be diminished by the use of more units arranged in groups for a given floor space. As a second experiment, twelve units in four groups were arranged as shown in Fig. 3, the system being made up of four 100-watt and eight 40-watt tungsten lamps per bay. Draftsmen were then placed in this bay so as to work under the light for some days. The same trouble was experienced with shadows in excessive numbers, as was the case in the first trial, the effect being even more noticeable, due to there being twelve lamps per bay instead of nine as before. The lack of uniformity was even more noticeable in this scheme, since each cluster can be considered as one light source as far as independence of desk locations is concerned, and the superiority of nine over four light sources or groups per bay was demonstrated.

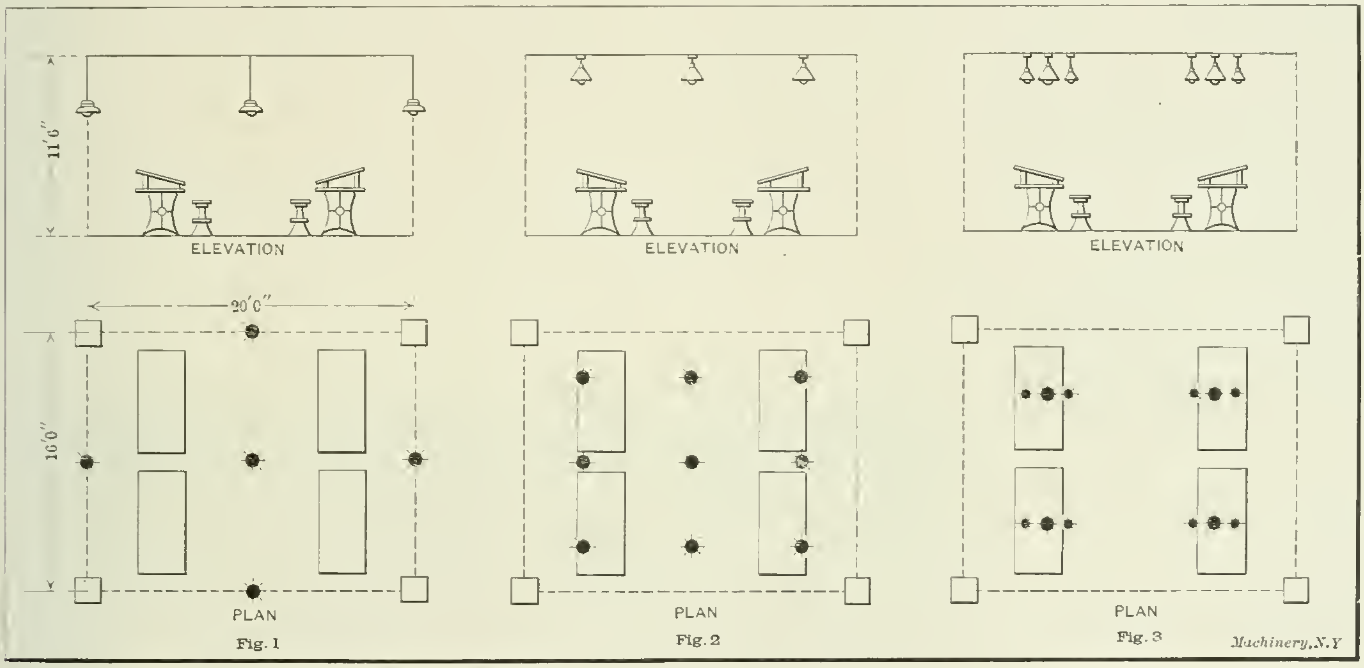

Fig. 1. Typical Bay of a Drafting-room lighted with Large Lamps Fig. 2. Typical Bay lighted by Nine Lamps. Fig. 3. Typical Bay lighted by Four 100-watt and Eight 40-watt Lamps

* Article published in the *Electric Journal* by C. E. Clewell, lighting expert, with Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Other arrangements which were given trial were as follows: One bay was finished as an extreme case with 21 units scattered over the ceiling. Here the shadow effect was perhaps somewhat offset by an excessive intensity, but the use of lamps in such numbers would be prohibitive in point of economy, and even if this were not the case it is questionable whether such large numbers would be admissible from the standpoint of good taste.

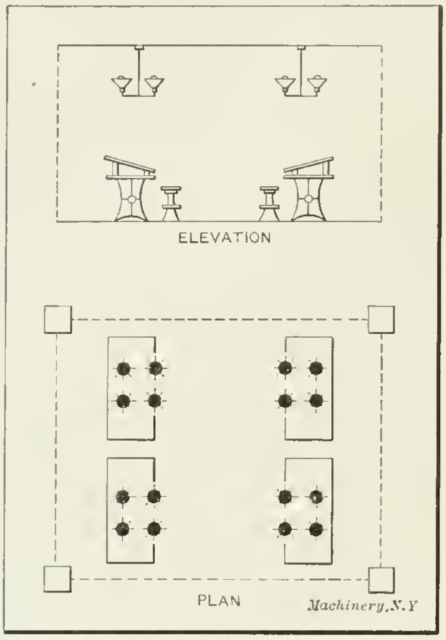

Fig. 4. Arrangement finally adopted Consisting of Sixteen 40-watt Lamps

An arrangement of four 250-watt tungsten lamps per bay, equipped with broadly distributing reflectors, was tried. While possessing some good points, this arrangement made use of units entirely too large for the ceiling height Calculations were made to determine the minimizing of shadow effect in large rooms by the use of broadly distributing reflectors rather than those of a more concentrating type. This involves the building up of intensity at a given point by the light furnished by many distant light sources rather than depending entirely upon the light from one overhead unit. A man leaning over his work will cast a deep shadow, cutting off nearly all of the light if provided by one unit overhead and little or none from distant units; whereas if the units are provided with broadly distributing reflectors, such shadows will be far less noticeable.

The Satisfactory Arrangement

The plan finally adopted consisted of the use of sixteen 40-watt tungsten lamps per bay arranged in clusters of four each, by mounting the units on fixtures so constructed as to make use of the lamps in an inverted position as shown in Fig. 4. The primary thought in this scheme was the attainment of a light free from the shadows found in previous trials. Various types of reflectors and fixtures as well as the effective mounting height of the lamps above the floor were successively tried. With the ceiling freshly painted a yellow tint so as to present a coefficient of reflection of about 0.7, the following items were observed: Opaque reflectors which transmitted all the light coming from ceiling reflection, while providing a shadowless illumination, did not furnish a sufficient intensity for the work in question. The reflectors seemed to give the best results when mounted in a vertical position pointing upward, rather than when mounted in an angular position. Reflectors of a softly diffusing quality of glass and which furnished a considerable amount of transmitted light to the work, seemed to fulfill all the requirements as outlined above. Each draftsman, irrespective of desk or table location, received a good and sufficient light. This light was uniform and was made soft and free from glare by a glass reflector, providing excellent diffusion and a soft yellow tint. The shadows were eliminated and with the use of the correct size of lamp an intensity of proper value was provided throughout the room. This system has been in service long enough to show that, within the limitations of ceiling height and types of units and reflectors available, a very satisfactory result has been obtained.

It is of interest to note that the wattage per bay with this last scheme was practically the same as that found in the original installation. Hence the superior results were obtained by no extravagant installation of larger wattage, but by a carefully arranged plan of the equivalent wattage in another form. The approximate installation expense of the system originally found in use was slightly higher than the new one and the operating expense was sensibly the same as that of the system finally chosen.

It should be stated that the final arrangement of this lighting system was the outcome of experiment rather than predetermination. Much careful study was given to the problem, as it had been anticipated that nine, or at least twelve units per bay, used so as to furnish direct light to the work, would be satisfactory. Draftsmen, without exception, after working for a time under one trial installation after another, favored the final system as furnishing the best illumination of any that had been tried.

Other Influencing Factors

In such a lighting installation as that just described it is likely that different intensities of the artificial light may be needed at different portions of the day and evening. At first thought the usual conclusion is that more artificial light is required at night than on cloudy days. Experience shows the reverse. During the day the eye is subjected to a stimulus from daylight intensities which are ordinarily many times greater than the intensities of artificial light commonly used. In the daytime this causes the pupil of the eye to be in a contracted state so that it requires a greater intensity on the object than is necessary when the eye is relaxed as at night. Thus on a cloudy day, when the daylight is insufficient, a greater intensity of the added artificial light is necessary to produce a satisfactory illumination on the working surface than at night. If the lighting system has been designed for an intensity suitable when used in conjunction with some daylight, it is quite possible that the intensity will be too high for comfort at night. Some way of changing the intensity of the light without destroying its uniform distribution is therefore desirable. If lamps be turned out here and there at random for the purpose of reducing the intensity to the proper value at night, the uniformity of the light is apt to be destroyed.


Fig 5. View of a Drafting-room lighted with Inverted Tungsten Lamps fitted with Diffusing Reflectors—Same Arrangement as that in Fig. 4

One method of varying the intensity, without destroying

the uniformity of the light, consists in installing the lamps in groups, and turning out a part of the lamps in each group. This affords different intensities without disturbing the uniformity. Often, however, the lamps are not in groups.

The tungsten lamp possesses one feature which can be used to advantage in accomplishing this end, whatever the number and arrangement of lamps. From the normal voltage of the lamp to about fifteen or twenty per cent below normal, the light of the tungsten lamp maintains its characteristic white color. The voltage on such a lighting system may be reduced by means of a transformer arranged with a number of secondary taps to give voltages below normal, thus permitting a change from normal intensity to lower values without noticeably affecting the white quality of the light. This scheme has been used and furnishes a convenient method of varying the light intensity without destroying the uniformity of distribution.

* * *

AN INTERESTING BENDING PUNCH AND DIE

By C. H. ROWE[*]

The making of the five bends in the piece shown at *D* in Fig. 1, was thought at one time to require a very expensive punch and die. Upon laying it out on the drawing-board, it was found, however, that while there were a large number of parts required and various movements to be provided for, the punch and die would not be at all complicated, and would come within the limit of cost that was allowed for this operation.

The stock from which this piece *D* was to be made was one-quarter hard brass, ½ inch wide and about 0.023 inch thick. The stock was received in strips of the correct width, and previous to bending, it was cut to required length. After the pieces were cut to the required length, holes were drilled and countersunk for wood-screws. As the positions of these holes were not always the same, it was decided to drill them instead of piercing them, while cutting the blanks off.

A front elevation of the punch and die used for completing the bends in the piece shown at *D* in Fig. 1, is shown in Fig. 2. This punch and die was provided with two 1-inch guide-posts for retaining the alignment. These guide posts are not shown in the illustration, but were located at the rear of the moving parts, so as to be out of the way of the operator. In designing this punch and die the usual plan of bringing all the working parts to the front was observed. This facilitates the operating of the die, and obviates the chance of the operator putting his hand in a dangerous position.

Referring to the illustration Fig. 2, *A* is the cast-iron body of the die, which is machined to receive the spring pad *B* and the bending slide *C*. The pad *B*, as shown, is actuated by a coil spring *D*, and is retained in its upward position by the two fillister-head screws *E*. This spring *D* should be weak enough, so that it will be easily compressed by the punch when descending into the die. The slide *C* for making the third bend is advanced by the cam *F*, fastened to the punch-holder as shown, and is retained in its backward position by a coil spring *G*, which bears against a pin G_1, located in the base of the slide.

Referring to the punch-holder, *H* is the punch which gives the first two bends to the blank; the third bend is accomplished by the slide *C* in the die; the fourth bend is made by the punch *I*, and the fifth bend by the punch *J*. The punch *H* slides on two dowels or guide-pins *K*, (one of which is shown) and works against a coil spring *L*. Two fillister-head screws *M*, one of which is shown in the illustration, limit the position of this punch. The forming punch *I* slides on two dowels or guide-posts *N*, and is operated by a coil spring *O*. The downward movement of this punch is limited by two fillister-head screws not shown. The swinging punch *J* rotates on a stud *P*, and is retained by a closed spring *Q*. This punch *J* is fastened by the stud *P* to the block *R*, which, in turn, is held to the punch-holder by two fillister-head screws, as shown.

In operation, the strip is placed between the locating pins *S* and also between other locating pins not shown, which hold the blank in the correct position. Then as the ram descends, the punch *H* forces the blank down into the die on top of the pad *B*. This forms the blank into the shape as shown at *A* in Fig. 1. On further movement of the ram, the cam *F* comes in contact with the slide *C* forcing it in and bending the blank over the projected part H_1 of the punch *H*. This forms the blank to the shape as shown at *B*, Fig. 1. As the ram descends still further, the punch *I* bends the blank around the punch H_1, giving it the shape shown at *C*, Fig. 1.

The fifth bend is made by the punch *J*, and is accomplished as follows: As the ram still continues in its downward move-

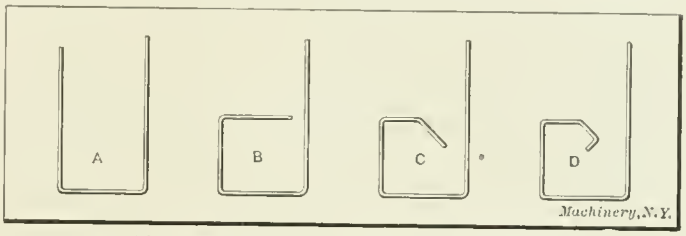

Fig. 1. Successive Bending Operations on Blank

ment, the punch *J* comes in contact with the block *T*, fastened to the die-block as shown. This block *T* rotates the punch *J* on the stud *P*, and forces the blank around the punch H_1. On the up-stroke of the punch-holder all the slides and punches are returned to their normal position, the projection H_1 on the punch *H* carrying the blank out of the die and leaving it in the position shown by the dotted lines, when it is then removed by hand. The forming part of the punch *J* is offset from the main body of the punch as can be seen, so that the blank will slide up past it. The forming part H_1

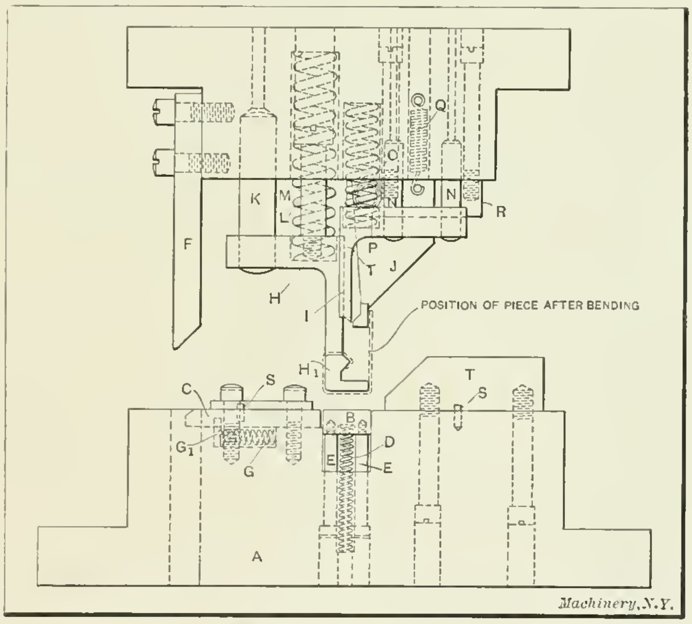

Fig. 2. Elevation of Punch and Die for Making the Five Bends in the Piece shown at D in Fig. 1

of the punch *H* is also offset, thus allowing the blank to be bent around it.

All the springs in a punch and die of this description should be of the best quality and well tempered, so that they will not become fatigued to such an extent as to render any part of the mechanism inefficient to even a slight degree. No trouble, however, was experienced in this regard in the above-mentioned punch and die.

* * *

For nearly seventeen years an oil hole in the quill of an engine lathe back-gear was regularly oiled by its operators. One day a mechanic of a more investigating turn of mind than his predecessors made the discovery that the hole was not quite drilled through. All these years the back-gear, when in use, had run without oil, and no one had been the wiser. There is no particular moral or lesson to be drawn. It is simply one of those cold hard facts that makes one wonder what kind of brains some men have.

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CARE AND MAINTENANCE OF MACHINE TOOLS IN A LARGE PLANT*

The American Locomotive Co. in its various plants have about 9000 machines. It is evident that the maintenance of this equipment requires a considerable organization, if the equipment is to constantly be up to its highest standard of efficiency. A few years ago such an organization was formed for the purpose of increasing the production of the plant with the least possible cost of the maintenance of the machinery. At that time a great number of machines of obsolete and complicated design, were in use in the plant, operated, for the most part, by inexperienced workmen. The growing use of high-speed steel in machines not especially designed for the heavy strains thus imposed, also made the cost of maintenance of these machines very high.

The first step taken was to create an organization dividing the work of maintenance into different departments. In charge of the whole organization is placed the mechanical superintendent, and under him a general engineer of maintenance who, in turn, at each plant has a local engineer of maintenance whose duty it is to look after all equipment such as machinery, buildings, grounds, tracks and rolling stock. The power plant is looked after in a similar manner there being a general engineer of power with a local engineer of power at each plant, his duties being to look after such matters as power production, purchase and distribution of power, heat, light and water, fire protection, watchmen, etc. In addition there is a general small-tool supervisor with a local supervisor at each plant, whose duties are to look after all matters pertaining to the local tool-room, such as taps, reamers, twist drills, milling cutters, tool steel, and the like.

In addition to the officials mentioned there is at each plant an inspector of equipment, whose duties are to investigate and report on all conditions which might tend to cause failures in the operations of machines; he also investigates and reports on all conditions which might cause accidents to employes, on abuses of equipment by the operators, and on equipment which is not kept clean and in order by the operators. The equipment covered by these reports includes machine tools, power equipment, pipes, sewers, buildings and structures, rolling stock, cranes, elevators, etc. By means of this organization it is possible to keep constantly in touch with the conditions of the equipment in all the various plants.

A small printed form is used on which every machine tool failure is reported, showing the time when the machine failed, the cause of the failure and the estimated cost of repair. When the repair has been completed, the actual cost of repair and the length of time the machine has been out of service due to the failure are also reported. These reports are kept for each individual machine, so that there is a perpetual record of the performance of every machine in the plant. The failures are also classified under four heads, as: failures due to negligence, to improper design, to accident, and to ordinary wear. Each of these failures is systematically investigated. Those due to negligence are taken up with the men in charge of the operators with a view to having the machines better cared for. The failures due to accident are investigated, and, if possible, steps taken to reduce the number to the minimum. When failures are due to improper design, the weak parts are redesigned and strengthened. As regards the failures due to ordinary wear, investigations are continually being made to see if it is not possible to simplify the construction of the machines and reduce the number of parts required to the minimum.

The system outlined was installed in 1907. The results obtained have been very satisfactory. The cost of maintenance has constantly decreased since the installation of the system. The present cost of maintenance is about one-third of the cost at the time when this system was instituted. The saving effected in all the plants of the American Locomotive Co. amounts to thousands of dollars a month. At the same time, the number of productive machine-hours that are lost due to failures has been reduced from 12 per cent to 1.75 per cent. To illustrate just what this means, it may be well to mention that out of the 9000 machines in all the plants, about 1000 were out of service all the time on account of repairs when this system was begun, while at the present time this figure stands at an average of 100 machines only. It is interesting to note how these results were effected in one of the shops. By referring to the reports it was found that about 40 per cent of the failures were due to negligence. It has since been possible to reduce this negligence factor to 1.25 per cent.

In another case it was found that a certain type of machine tool was purchased having an error in its design which had existed for ten years on this make of machine and which was costing the American Locomotive Co. something like $5000 a year. This matter was taken up with the machine tool builder and the design changed, eliminating this entire charge of repairs. It was found that the maintenance of some types of machines was so heavy that it was concluded a waste to keep them in service, and they were replaced with modern tools.

The system has also made it possible to determine definitely what is the most economical design of the machines used, from the user's standpoint. Most of the machine tools now purchased by the company are built to specifications prepared by its own engineers, and the aim is to cut out every gear and moving part not actually needed for the work. Planers, for example, are made with only one speed, because the works are so extensive that one planer can be put on one class of work and never changed. On vertical milling machines but one pair of gears is used between the motor and cutting tool, and on large vertical boring mills the gear boxes have been cut out and the drive is equipped with a big plain pulley, the power being obtained from a variable speed motor placed in the ceiling where the countershaft was formerly located. On radial drills the speed of the driving shafts has been lowered and the diameter of the shafts increased, so as to reduce the cost of maintenance of the bearings.

The question of the economic use of power in operating machine tools has been investigated in this connection. In testing out some of the machines it was found that there was a considerable amount of power absorbed through the friction of unnecessary gears. This is one of the reasons why an attempt has been made to cut out every gear possible on all new machines purchased. The result of this policy is that on a new design of radial drill where all except one pair of gears are done away with, the frictional load of the machine when running idle at the rate of about 160 revolutions per minute is only 0.7 H.P., while the same machine running at approximately the same speed drilling a 1¼ inch hole with a cutting speed of 50 feet per minute and a feed of 0.022 inch will use 5 H.P. In another case, a machine running at about 335 revolutions per minute will use 1 H.P. when running idle, while it requires 8 H.P. when drilling a 1-inch hole at a cutting speed of 85 feet per minute and a feed of 0.022 inch. Hence the percentage of power used for the machine when running idle is small.

* Abstract of a paper read by Mr. C. K. Lassiter before the National Machine Tool Builders' Association Convention, in New York City, October 26, 1910.

* * *

The development of flashing electric signs in the last ten years has been remarkable. In New York City, thousands of dollars are invested in electric signs which in some cases are engineering structures of great magnitude. The ingenuity displayed in securing motion effect, both attractive and lifelike, is also remarkable. Galloping steeds hitched to Roman chariots rush madly on, the effect of flying limbs being simulated by rapidly lighting and extinguishing successive rows of lamps representing the horses' legs. One of the best illusions is produced by an electric sign overlooking the North River. This represents an enormous beer bottle emptying into a glass. The liquid apparently flows and fills the glass, and the empty space in the bottle grows before the eyes. The stream twinkles, the foam rises in the glass and the lower part clears so naturally that thirsty ones on their way home to Jersey o' nights sigh appreciatively.

THE PROBLEM OF CONE FRICTION CLUTCH DESIGN*

By OSKAR KYLIN†

Oskar Kylin‡

The following article has been prompted by a certain meagerness of information in the engineering handbooks and other technical literature regarding the various coefficients and constants that are to be used in the calculations of cone friction clutches for different purposes, and also by the desire to induce cone clutch specialists to give their views of the problem that confronts the designer, and thus promote a more thorough understanding of the factors of vital importance in the designing of this important machine part.

In Fig. 1, A represents a cone clutch which constitutes a part of the reversing mechanism of a motor-driven machine tool, more particularly a turret lathe. The clutch B is a part of the speed changing device. The shaft C, carrying the two small gears for the direct and reverse drive, is directly connected to the constant-speed motor, and, hence, runs at a high speed. Referring to Fig. 3, the common way of calculating a cone clutch of this kind is as follows: By previous calculation it has been found that the turning moment to be transmitted through the clutch at full load is M. Let:

D = mean diameter of clutch,
B = width of clutch,
α = clutch angle,
P_n = normal pressure between friction surfaces,
P_s = unit (specific) pressure on friction surfaces,
P_a = axial force on clutch,
μ = coefficient of friction.

Then

$$P_n = M \times \frac{1}{\frac{1}{2} D} \times \frac{1}{\mu} \qquad (1)$$

$$P_a = P_n \sin \alpha + \mu P_n \cos \alpha \text{ (engagement without slip)} \qquad (2)$$

The term $\mu P_n \cos \alpha$ is an expression for the force necessary to overcome the friction between the two clutch surfaces just at the moment of engagement. The method of arriving at Formula (2) was given in MACHINERY, October, 1909, engineering edition, and need not be gone into at this time.

$$P_s = \frac{P_n}{\frac{1}{2} B D \pi} \text{ (approximately)} \qquad (3)$$

The difficulty that confronts the designer at this stage of the problem consists in choosing the right value for the unit pressure P_s, for the material or case in hand, and it is here that engineering handbooks fail to give the required information. Some of the important factors that influence the value of P_s are: where and how the clutch is applied; whether reversing or not; the speed of the friction surfaces; and the inertia of the revolving or moving parts to be reversed or started by the clutch. Fig. 2 tends to give an idea of how these factors have to be taken into consideration. The clutch at A is a reversing clutch and runs at high speed, and has the mass of the following gear train, the chuck, and the work, to reverse, which means a great strain on the friction surfaces; therefore, a lower value for P_s has to be chosen for this clutch than for B, C and D, which clutches have slower surface speeds and smaller masses of machine parts behind them to start, and which do not reverse. However, a lower value of P_s must be chosen for B than for D.

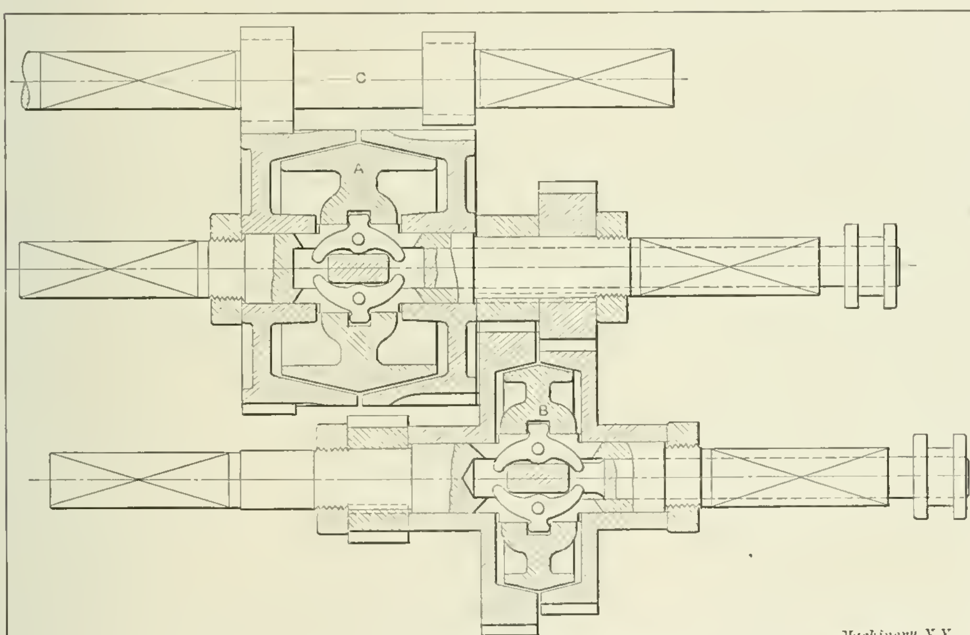

Fig. 1. Design of Geared Turret Lathe Head, with Reversing Friction Clutch

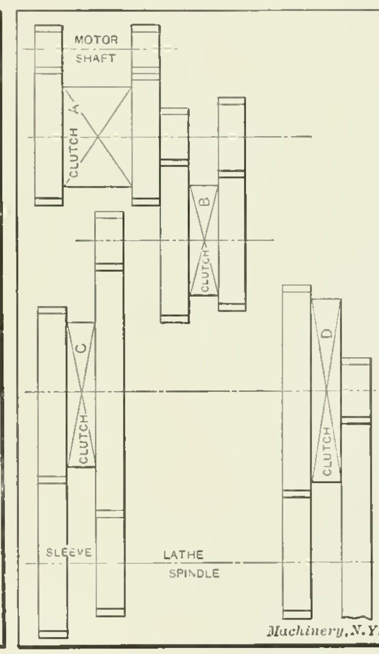

Fig. 2. Diagrammatic View of Friction Clutch

If P_s is chosen much smaller than necessary, the clutch will be disproportionately large, and consequently too expensive to manufacture, and if chosen too large, the friction surfaces will get overheated at the moment of reversal, or starting, and wear out too fast.

Considering the case illustrated by the clutch B, Fig. 1, this is not, as already mentioned, a reversing clutch, and its most severe strain consists of picking up the load from rest. According to the A. S. M. E. *Journal*, a 24-inch clutch of the Falls Rivet & Machine Co.'s make will probably break at 100 R. P. M. when transmitting a load of 200 H.P. or when picking up a load exceeding 110 H.P. Wooden blocks on cast iron are used in this clutch, and whether these data apply to the metal-to-metal friction clutch under consideration is doubtful. However, it goes to prove that the strain produced by the picking up of a load is far in excess of that produced by the mere transmitting of the same load.

* See MACHINERY, October, 1909, engineering edition: "Formulas for Cone Clutches." See also MACHINERY'S Data Sheet Book No. 8, page 24, "Formulas for Cone Clutches."

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‡ Oskar Kylin was born in Ornunga, Sweden, in 1882. After having graduated from the Department of Mechanical Engineering, at the Technical College of Boras, Sweden, he was employed as draftsman and designer by the locomotive works of Nydqvist & Holm, Trollhattan, and the ordnance works of the Bofors-Gullspang Co., both in Sweden. In the spring of 1905 he came to the United States, where he has been employed by the Pratt & Whitney Co., Hartford, Conn., the American Diesel Engine Co., of New York, the Taylor Iron & Steel Co., High Bridge, N. J., and the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. His specialties are the designing of gas engines and machine tools. In the Spring and Summer, 1908, Mr. Kylin traveled extensively in several European countries to study machine building practice, during which time he acted as an editorial representative of MACHINERY.

In the case illustrated by clutch A, Fig. 1, the most severe strain is caused by reversing. At the moment of reversal, slipping between the male and female friction surfaces must be allowed as an instantaneous reversal would create an excessive strain on all parts of the mechanism, and is practically impossible. The less the slippage, the quicker will the reversal be, and the larger the clutch which must be employed; or, in other words, the size of the clutch is inversely proportional to the time allowed for the reversal and to the slippage. As slippage must occur, the clutch has, in the opinion of the writer, several features in common with the journal and bearing. Lubricant applied to the friction surfaces would probably be desirable to prevent cutting while the slipping takes place, but this is in most cases impracticable. The value of the unit surface pressure stands in a more or less close relationship to that employed in journals, but the time factor of slippage, the lubrication, etc., must also be considered.

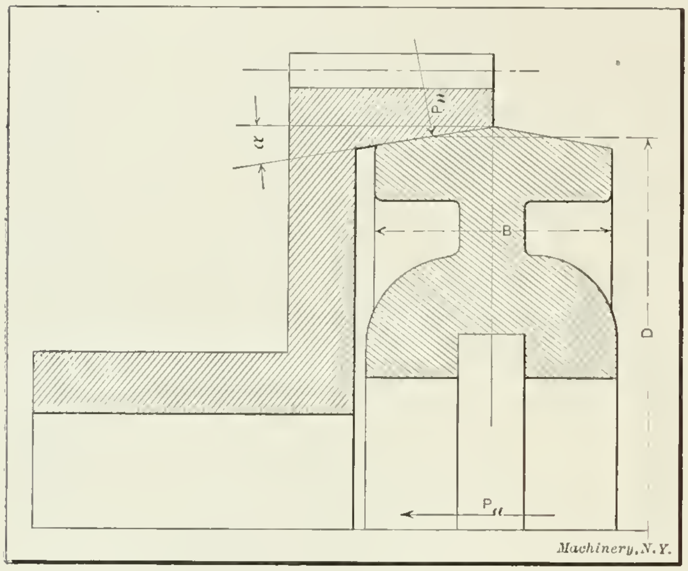


Fig. 3. General Arrangement of Clutches and Gears

In order to arrive at a better understanding of how the various factors influence the unit pressure, we will calculate the clutch A, Fig. 1. A 10 H.P. motor at 1300 R. P. M. will, with the gearing shown, friction losses not being considered, produce a turning moment in the shaft of clutch A of 1460 inch-pounds. This must be transmitted through the friction clutch. The coefficient of friction in this case, for phosphor-bronze on cast iron, can be assumed as 0.15, which probably is a fair value. The angle a should be large enough so that the clutch does not "stick" when the end pressure is released, or, in other words, tan a must be larger than μ. In the clutch under consideration a is equal to 12 degrees, a value frequently employed.

The diameter is in this case predetermined by the size of the adjoining gears, a situation that often confronts the designer. The mean diameter is here 7½ inches. The dimension to be determined by the calculations is the width of the clutch face, or B.

Referring to Equation (1) we have: $P_n = 1460 \times \dfrac{1}{3.75 \times 0.15} = 2575$ pounds.

Assuming, further, the unit pressure P_s to be 150 pounds per square inch, the width will be, from Equation (3):

$$B = 2 \times \frac{2575}{150 \times 7.5\,\pi} = 1.45 \text{ or, say, } 1\tfrac{1}{2} \text{ inch.}$$

The normal pressure of 2575 pounds is, of course, enough only to transmit 1460 inch-pounds as a constant load, and would not be enough to pick up this load without an excessive amount of slippage. To prevent this excessive slippage, a normal pressure of upward of two or three times 2575 pounds might be required. This extra pressure can, however, easily be taken care of by means of the adjusting device, and, if a proper value is allowed for P_s, it does not need to enter directly into the calculations of the friction surface, but it has, of course, to be considered in connection with the shifting or locking mechanism.

Regarding the value of P_s used—150 pounds—the writer considers this a safe value for the clutch B for cast iron on cast iron, with a friction surface speed of not more than 550 feet per minute, but it is too high for clutch A. In fact, a clutch corresponding to that shown at D, Fig. 3, and carrying its highest load at a surface speed not exceeding 350 feet per minute is calculated with a value of P_s equalling approximately 185 pounds for cast iron on cast iron, and this clutch has given entire satisfaction during years of service. A higher surface speed requires a lower value of P_s.

For a reversing clutch, the unit pressure should probably be about half of that for a non-reversing clutch. The writer has no experience to back up this assumption, which is based merely upon pure reasoning. Clutch A runs at about twice as high a surface speed as B, but is cast iron on bronze, and it is very probable that a unit pressure of 60 pounds per square inch is a safe value. Using this, we get:

$$B = \frac{2 \times 2575}{60 \times 7.5\,\pi} = 3.64 \text{ or, say, } 3\tfrac{5}{8} \text{ inches.}$$

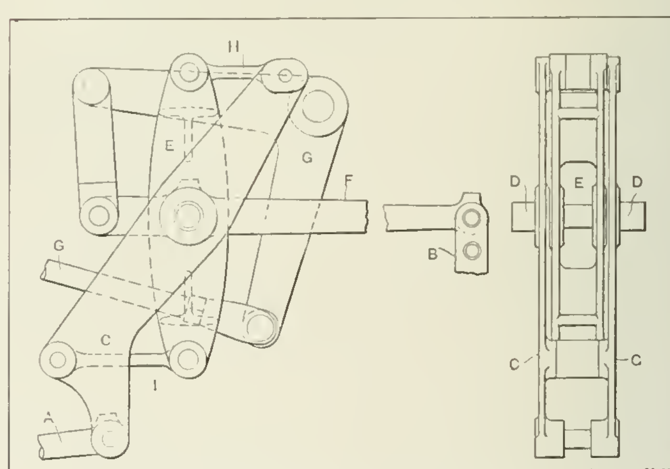
This example is quoted only to demonstrate how the size of a clutch is influenced by the variations of the value of the normal unit pressure on the friction surfaces, and this, in turn, by a load factor that depends on where and how the clutch is used, the surface speed of same, etc. The purpose of this article is only to prompt a discussion of the subject, in order to bring out some valuable data of the nature which the writer has indicated the need of.

* * *

LOCOMOTIVE VALVE GEAR

A modification of the Walschaerts valve gear is described in U. S. patent No. 976,542 (November 22, 1910), by James G. Blunt, Schenectady, N. Y. In general principle these gears are very similar, the principal feature of this one being the absence of a sliding contact, nothing but pin connections being required.

A is the eccentric rod connected to the main driver and B the combination lever connected to the crosshead, both as in the Walschaerts gear. Double levers C are trunnioned at D on stationary bearings. Lever E is pinned at its center on the radius rod F, the latter being suspended from the bell-crank, controlled from the cab by the reach-rod G. Levers C and E are connected by short arms H and I, the latter being slightly longer to effect a substantially radial motion when the radius bar F is moved to change the direction of movement or point of cut-off. These latter operations are performed by raising or lowering radius bar F by means of bell-crank G. This sets H and I at an angle, which, when increased, produces a decreased travel of the lever E, causing a similar decreased valve travel, and thereby an earlier cut-off.



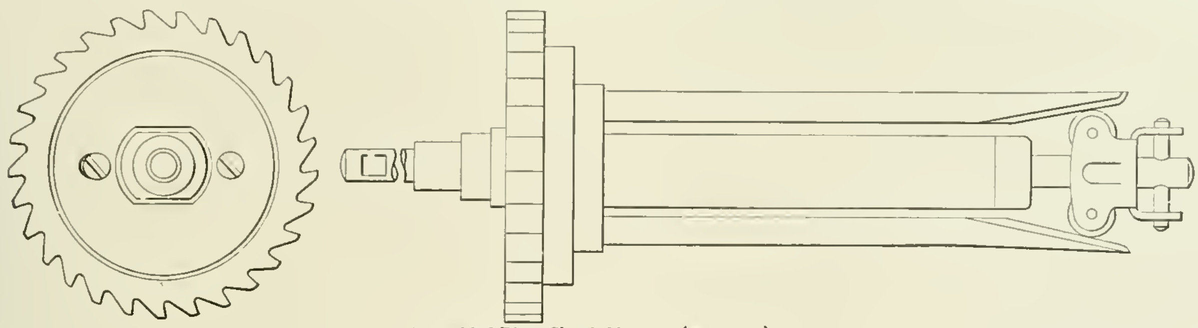
A Modification of the Walschaerts Valve Gear

A SYSTEM FOR ASSEMBLING SMALL INTERCHANGEABLE PARTS*

The direct labor cost of assembling small interchangeable parts is a comparatively large item in light mechanical engineering and repetition work. Economical production demands that easy assembly be kept in view at all stages, from the designing of a mechanism, through the tooling and shop processes, to the delivery of the unit parts to the assembler. The shop shall, from the first, begin the assembling of the mechanism under the most economical conditions.

An efficient assembling system requires that the parts be assembled at the highest possible speed and that the assembled mechanism embody the prescribed quality of work, neither more nor less. These conditions are fulfilled with the best economy when the classes of labor available are properly selected, graded and trained for the various operations.

In many industries the methods used in assembling are ar-



Assembled Piece Clutch No.31531 (Full Size)

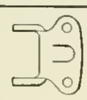
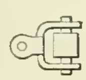
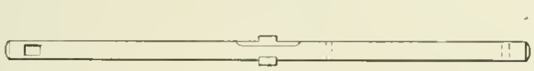
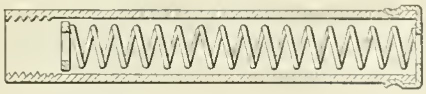
Stage No.	Unit Parts 18 in Number Assembled in 10 Stages	Operations in Sequence	Grade of Labor	Average Time Including Stops, from Records of 100,000 Pieces	
				Min.	Sec.
1		Ream 2 holes 0.073" in Roll Holder No.30670 on speed lathe	Women	0	7
2		Assemble roll holder No.30670 2 rolls No.30680 and 2 pins No.67610 at bench	Boys	0	45
3		Ream 1 hole 0.166" in clutch frame No 30361 on speed lathe	Women	0	5
4		Tap 2 holes 0.08"-56 in clutch frame No.30361 on tapping machine	Men	0	16
5		Ream 2 holes 0.085" and 0.059" in shaft No.31620 on speed lathe	Women	0	10
6		Straighten shaft No.31620 on bench block	Boys	0	8
7		Put pin No.65610 in shaft No.31620 with bench fixture	Boys	0	20
8		Put in washer No.90000 and assemble tube No.31521 and spring No.67210 at bench	Men	2	24
9		Bend and gage clutch jaws No.30690 in bench vise	Men	0	31
10	See full-size sketch	Assemble clutch jaw No.30690 ratchet No.30370, frame cover No.30330, 2 screws No.70402, and roll holder comp., with pins No.64650 at bench	Men	3	52
	The direct labor cost of assembling 1 clutch No.31531 is 3.784 cents	Average time to assemble 18 unit parts to form clutch No.31531	Women Boys and Men	8	40

Chart showing System followed in Assembling Operations

paper abstracted in the following analyzes and illustrates all the elements which should enter into the producer's calculations and outlines the works organization necessary to secure rapid and economical production. It describes the results obtained in the assembly of given pieces and the place that preliminary time and motion study has in assuring that the rived at by indirect means, that is by a tedious and intermittent process of elimination, trials and modifications which are based upon rough, occasional observations by the foreman and the employes in the shop. This course is costly, uncertain and slow, and expensive and inefficient methods adopted at the beginning are likely to be perpetuated. Instead of this method, any plant of moderate size engaged in light interchangeable manufacturing can afford to devote a small inex-

* Abstract of a paper by Mr. John Calder, published in the Journal of the American Society of Mechanical Engineers, January, 1911.

pensive department entirely to the task of deciding upon the operations to be performed and the best arrangement of apparatus and labor in the assembling.

Certain preliminary considerations must be held in view, such as the designing of the form of the parts so that they will lend themselves to rapid assembling processes; the designing and proper maintenance of efficient tools, jigs and fixtures; an efficient inspection system for the parts, securing in every department an adherence to the working limits; and the adoption of a system of routing the work through the shop in such manner that the fitting surfaces will be produced in such condition as to require the least work in assembling. The total abolition of the file or other cutting tools at the bench should be aimed at.

If these conditions have been properly observed, the assembly speed then depends upon the extent to which the division of labor is carried; the thoroughness of the time-study of skilled demonstrators, including the elimination of lost motion and a critical examination of the machined unit pieces; and the efficiency of the mechanical facilities provided for the assembling work.

If the various conditions outlined in the two previous paragraphs are fulfilled, by a suitable organization, for any new piece of work, before it is presented to the regular assemblers, and if the assembly work is accepted only after having passed an efficient inspection, then the straight piece-work system of remuneration is often found to be in the best interest of the employer and employe alike. When a preliminary study such as outlined has been made, there is no such margin remaining as obtains in the rough approximations of premium setting where the processes are left to evolve slowly and partly by chance. For this reason the employes may well be given the whole of the returns on the prescribed standard task.

In the accompanying chart is shown an example of the division of labor and the speed of workers on straight piece-work tasks in the assembling of small interchangeable parts. All the conditions essential to the highest economy have been thoroughly worked out before the assembly task is presented to the manufacturing department. Owing to the minute division of labor and the elimination, by careful study, of all lost motion, most of the assembly stages in the chart, it will be noted, are performed in less time than it takes to describe them. In the works with which the author of the paper is connected, about 750,000 unit pieces of several thousand varieties are handled daily on the principles laid down in the chart. These total operations involve the use of about 20,000 piece rates, each based upon the results of exact preliminary time and method studies.

In the assembling operations the file is conspicuous by its absence. The possession or use, by any assembler, of this mechanical persuader towards a fit is forbidden, unless due cause is shown and special permission given. It has been found that such a prohibition often throws a considerable amount of new light upon the condition of the machined surfaces prepared in other departments, and passed according to the prescribed gage tests. The general result of this course is to raise the whole level of machine shop practice and to help in locating definitely the needed refinements and corrections in the design of jigs and fixtures.

The method pursued in definitely determining the various operations as outlined in the assembly charts are as follows: Prior to the introduction in the shops of any new assembly operations, the prescribed apparatus which is the best that the collective experience of the superintendent, foreman and tool engineer can devise, is handed over to the time-and-motion study department, whose few expert employes proceed to operate it on a manufacturing basis. They handle large quantities of product which is subject to all the usual inspection tests, and which pass into the regular manufacture of the plant. In this way, the cost of the time study department is reduced to a small figure, because the working time of its experts is fully as productive as that of the shop. The few experts have been selected and organized from the ranks of the ordinary shop employes, those having been selected who have shown considerable versatility and the power of comparative observation. When any suggestions of value as to the apparatus and parts supplied have been put into effect, this department determines the following questions:

1. Best height and position of the seat or chair of the operator at the bench or machine.
2. Best position in front or on the right or left of the operator of the pieces to be handled.
2. Best position—in front or on the right or left of the operator—of the pieces to be handled.
4. The advantage, if any, of an ambidextrous operator, and the cultivation of that faculty.
5. The best arrangement for bringing forward and removing the work without interrupting the assembly process.
6. Time study of each of the movements finally decided upon as necessary, and the combination of all of them on the principle of "least work."

When these questions have been fully settled, a straight piece rate is fixed, based upon the investigation made. The rates are so fixed that they will give an industrious worker with average ability an opportunity for normal earnings, while the exceptional operator receives the full amount of his surplus output. In the works with which the writer is connected the entire study staff consists of only six members. The restriction of the shop foremen to solely productive supervision is not favored, but they are encouraged to compete freely with the time-study staff for best results. The co-operation with the foremen is always of the highest value and enhances their administrative ability.

* * *

LEGAL DECISION RELATING TO ELECTRICAL INTERFERENCE

In view of the efforts at the present time to curb amateur wireless telegraphers and the protests of the latter against monopoly of the atmosphere by commercial and government stations, it is interesting to note, says the *Scientific American*, the decision recently handed down in the case of the Lake Shore & Michigan Southern R.R. Co., the Postal Telegraph-Cable Co., and the Western Union Telegraph Co., versus the Chicago, Lake Shore & South Bend R.R. Co. Suit was brought against the latter company because its 6600-volt single-phase trolley line affected inductively the lines of the telegraph companies and the signal system of the railroad company. The court held that the use of single-phase alternating current on one's own premises does not constitute a nuisance, even though the electricity may escape and interfere with the operation of electrical devices on adjoining property; that the companies by bringing suit held no monopoly of the atmosphere; and that if they found their systems interfered with, they should provide such mechanical or electrical devices as would protect their lines.

* * *

CHROMAN-BRONZE—A NEW BEARING METAL

That the addition of a small amount of chromium to nickel alloys imparts some very marked and valuable properties to the latter, was the recent discovery of James Naulty and John Scanlin, of Philadelphia, Pa. It was found that if about 5 per cent of chromium is added to an alloy of copper, nickel and zinc, not only is a strong and non-corrosive mixture obtained, but one that makes an excellent bearing metal. This alloy has been patented under the name of "chroman-bronze." It is made from pure metallic chromium by a secret process, and has the following properties: It is white and capable of taking a high polish; has the toughness of cold-rolled shafting; is capable of resisting acids to a marked degree; and is immune to the action of salt water. Tests of sand castings show a tensile strength of 78,950 pounds per square inch.

* * *

The British Engine, Boiler and Electrical Insurance Co. states that in 1909 of the total number of breakdowns of dynamos and motors insured, one-fourth of the cases were caused by dirt and neglect, one-fifth caused by the age and deterioration, and one-fifth by poor workmanship and design of the machinery.

SOME EXAMPLES OF MODERN DIE WORK

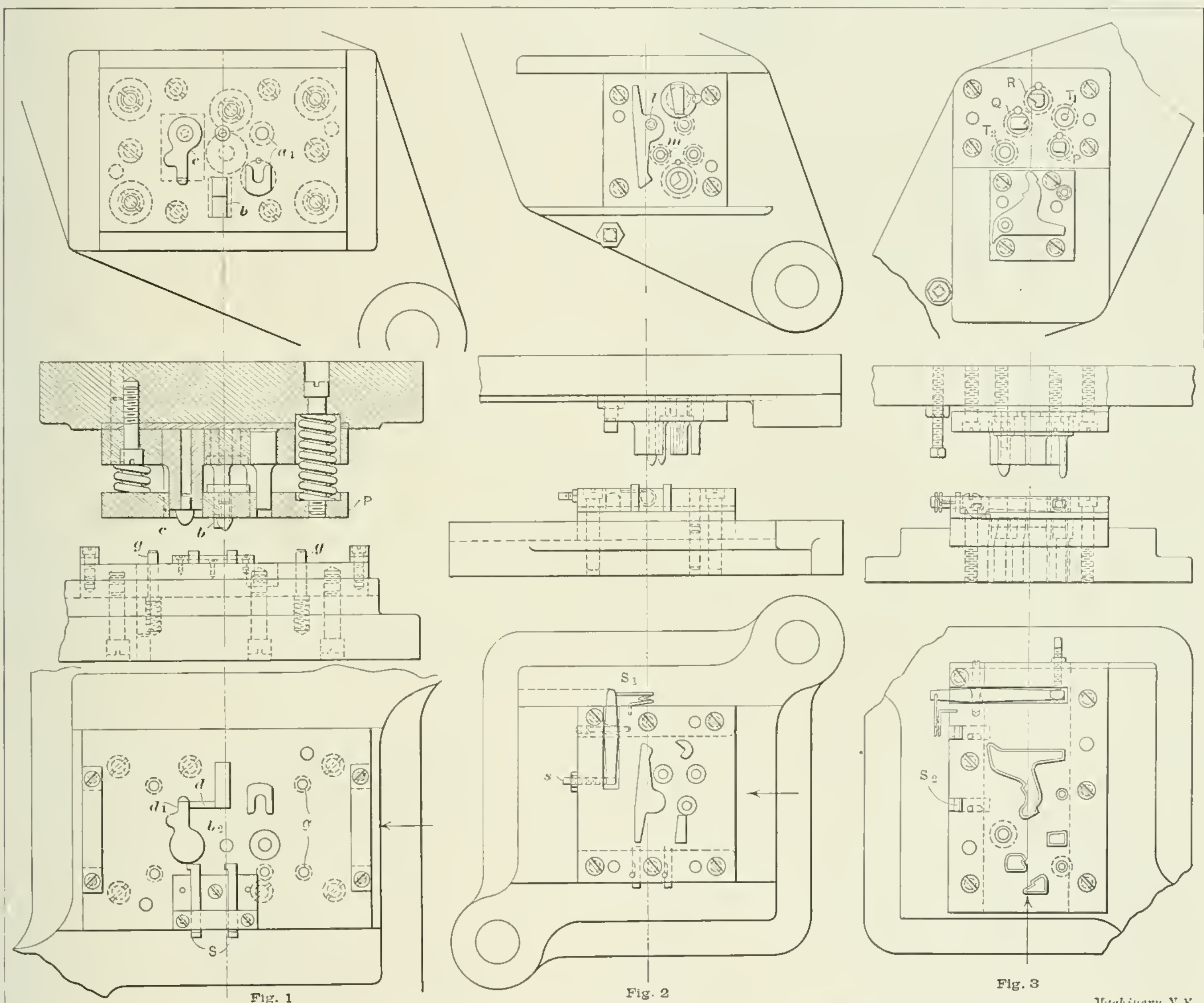
By FRANKLIN D. JONES*

Some interesting examples of die work taken from the die-making department of the Taft-Peirce Manufacturing Co., Woonsocket, R. I., are shown herewith. While the dies illustrated are used to produce comparatively plain parts, there are some points in their construction which may be of interest and value, particularly to those not experienced in the art of die making.

The die shown in Fig. 1 is for producing the part illustrated at *A* in Fig. 4, which also shows the successive piercing, bending and blanking operations. The stock is fed through the die in the direction indicated by the arrow. On the first stroke the piercing operation at *a* is performed by the punches a_1, Fig. 1. On the next stroke the bending punch *b* turns over the part b_1, making a right-angle bend, and, finally, the finished piece is blanked by the punch *c*. Of course these operations all take place simultaneously, except when the stock is first being started, so that a finished piece is blanked out at each stroke. One of the interesting features of this die is the method of stopping the stock as it is fed forward. After the bending operation, which takes place at b_2 on the die, the bent end b_1 which projects downward below the surface of the die, is fed forward through channel *d* until it comes against the end d_1 which forms a positive stop. By this simple method, the stock is located for the pilot pins which accurately position it for the blanking operation. By means of the spring pressure-pad *P*, the stock is held firmly against the die, so that it will not be buckled by the bending operation. When the stock is first being started through the die, stops *S*, which may be moved in or out as required, are used for locating the stock for the first and second operations.

The die shown in Fig. 2 is for piercing and blanking the pawl illustrated at *B* in Fig. 4, which also shows a sample of the scrap. As the V-shaped projection *h* on one end of this pawl, and the straight surface *i*, had to have a smooth finish, a shaving operation on these surfaces was required. This operation is not performed in a shaving die after blanking, as would be necessary if the entire contour of the part had to be finished, but it is done in the blanking die by removing a certain amount of metal adjacent to these surfaces, as at *j* and *k*, during the piercing operation. The result is that when the pawl is blanked, the edges opposite the openings *j* and *k* are subjected to a shaving action which leaves a smooth surface that is entirely free from the roughness found on the other edges where the stock is sheared from the solid. The narrow shavings which are removed from the surfaces to be finished, remain attached to the scrap in this particular instance, as the illustration shows. It will be seen that when this method of securing a finished edge is employed, the stock must be accurately located, as the removal of a shaving that is too thick would roughen the edge. In the die illustrated, the stock is located by the two pilot pins *l* and *m*, the former entering the hole *n*, Fig. 4, and the latter a hole *o* pierced simply to give a two-point location, thus insuring accuracy. In practice it has been found that a shaving equal to 10 per cent of the stock thickness, is about right for mild steel.

This die is equipped with an automatic stop S_1 which is operated by a projecting screw on the punch in the usual way. The hole in this stop for the pivot on which it swivels, is tapered toward the center from both sides, as shown in the detailed view, Fig. 5, thus giving it a movement horizontally



Figs. 1, 2 and 3. Punches and Dies for Producing the Parts illustrated in Fig. 4.

* Associate Editor of MACHINERY.

as well as vertically. With the stop mounted in this way, slight adjustments to compensate for any error there might be in the location of the stop with reference to the pilots in the punch, can be easily made when the die is being tried out, by simply turning the screw s until the stop is properly positioned. The function of the stop is, of course, to locate the


Fig. 4. Blanked Parts and Scrap, showing Successive Operations

stock approximately and its flexibility prevents the pilots from being subjected to any strain. This horizontal adjustment has an additional advantage in that the stop does not have to be located so accurately when this adjustment is provided.

Another punch and die of the piercing, shaving and blanking type is shown in Fig. 3. In this case the work C in Fig. 4 had to be finished in three places, as shown by the perforations at p, q and r. The stock, which is fed in the direction of the arrow, is pierced for shaving by the three punches P, Q and R, while punches T_1 and T_2 pierce the holes t_1 and t_2. The hole t_1 is merely for locating purposes, there being two pilots which give a two-point location. This die is also equipped with an automatic stop similar to the one illustrated in Fig. 5, and it has small hand stops S_2 which are also common to the designs previously referred to.

Fig. 6 shows a sectional view of a swaging die which performs, simultaneously, two swaging operations on the small ratchet shown at C. This ratchet has a square projection on one side, as shown, and four small projections k in a tapering part of the hole on the opposite side. The latter serve as keys and retain a tube to which the ratchet is attached, against rotary movement. The work as it comes to this die is in the form of thick washers as at A. The blank is located by the pilot on the swaging punch S and is firmly held by the spring pressure-pad P, which, as the punch descends, brings up against the punch-plate P_1, thus compressing the metal into the square pocket above plunger p which descends, against the tension of a spring, until it bottoms against the bolster plate. While the square is being formed in this manner, the tapering part of the swaging punch is countersinking and forming the small key-like projections k in the hole. The blank as it comes from this die is shaped as at B; it is then blanked out in another die in which it is located by the square previously formed, thus bringing both the square and the hole central with the ratchet teeth.

A die of the sub-press type is illustrated in Fig. 7, which is used for blanking the part shown at C_1. The stock A_1 is first flattened out as at B_1 and a small projection b is swaged by a punch that forces the metal into a pocket of the required shape, in the die. After this swaging operation, the work is blanked as at C_1 in the die shown in Fig. 7, in which it is located by the projection b which fits into a pocket. The part

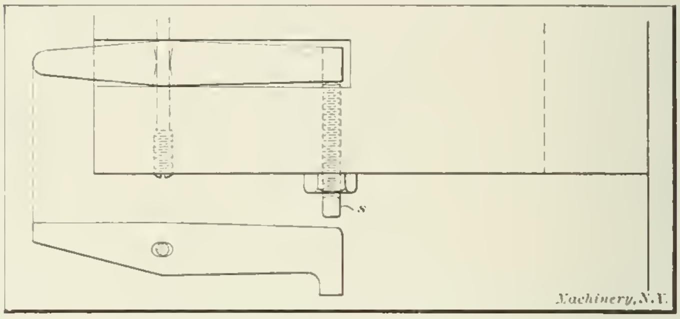
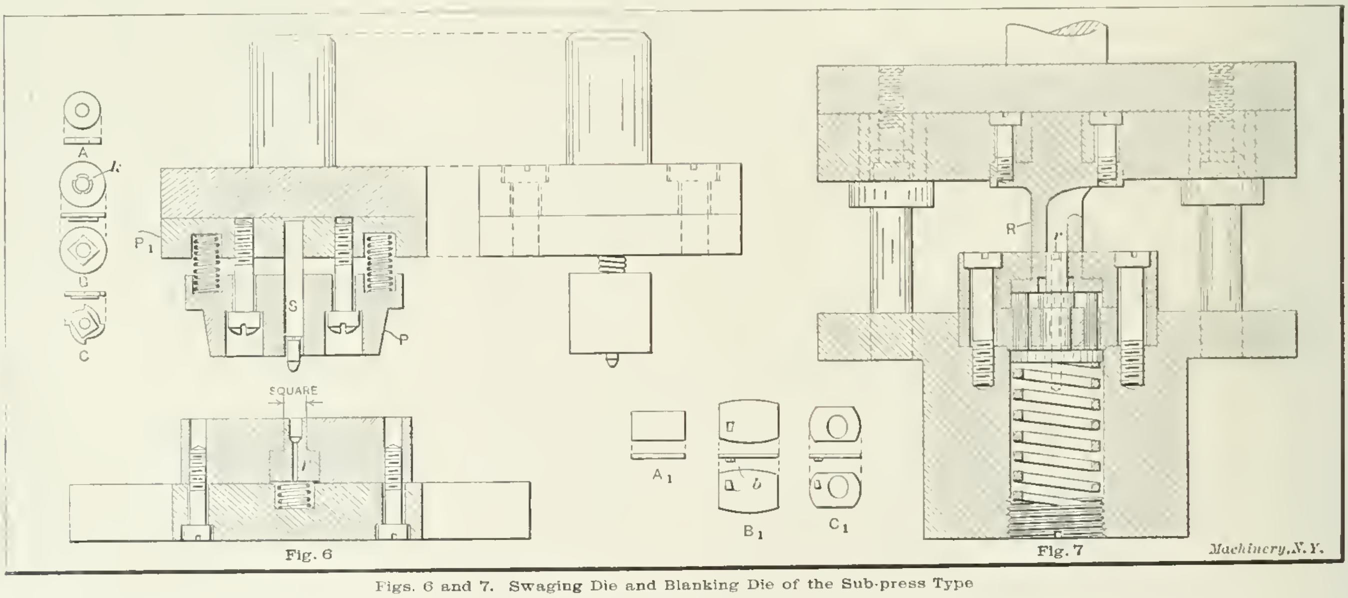


Fig. 5. Automatic Stop with Horizontal Adjustment

is blanked by the punch R and pierced by punch r which forces the scrap up through the opening shown in the blanking punch.

* * *

In a paper on street traffic conditions in London, read before the Institute of Mechanical Engineers (Great Britain) Mr. L. A. Legros, as reported by the *Engineering Record*, stated that *congestion of traffic generally takes place in districts where land values are high*, and he considered the condition anomalous that tenants pay extremely high rates for offices in the same localities where traffic regulations put a premium on very slow vehicular movements. Mr. Legros' discovery is indeed most atsonishing, so much so in fact, that it puts us in mind of an old Swedish poem written some 150 years ago and entitled "Remarks of the Blessed Fool" in which he sagaciously comments on the extreme wisdom and foresight of Providence "who made great rivers flow, where later great cities were to grow."



Figs. 6 and 7. Swaging Die and Blanking Die of the Sub-press Type

AUTOMATIC LATHE WORK*

In machine tool work the development of automatic machinery has been somewhat slower than in a great many other industries, due to the fact that there has been a considerable variety in the product dealt with, and hence the number of similar pieces has been too small to call for automatic machinery except in the case of ordinary small screw work. The tendencies toward a higher degree of specialization which have become pronounced during the last few years, have, however, brought with them a development of other automatic machine tools, especially the automatic lathe or turning machine—by which is meant an automatic machine for turning, boring, and facing operations on detached pieces of work, as distinguished from work made from a bar. Such detached pieces may be castings, forgings, stampings or blanks previously cut off from the bar on a cutting-off machine.

Development of Automatic Turning Machines

The earliest machines for this work were simply converted automatic screw machines, and the work, which was generally castings, was fed automatically into the chuck from a magazine attachment. As the advantages of this kind of machine became obvious, a demand arose to use them on larger articles, but experiments with magazines for large work have not been successful. In the place of a magazine, what is known as a transfer chuck is frequently used, this transfer chuck consisting of a spring holder into which the work is placed by hand. At the proper point in the cycle of operations, this transfer chuck places the article in the automatic chuck on the spindle of the machine. An attendant is, of course, then required to go around from one machine to another feeding the chucks the machine of course, running continuously.

The difficulty of holding rough castings varying in size has been overcome in some cases by the use of spring chucks, in others by the use of compressed air. In a type of chucks of a design recently brought out and successfully operated, the irregularities in the castings are compensated for by using a system of automatic spring-operated wedges. All these devices have been successful on work of moderate size, but no one would attempt to hold, say, an 18-inch casting in an automatic chuck, and on such large work hand chucking is used. This is not a marked disadvantage, because in the case of large pieces, the actual time required for the chucking is usually only a small fraction of the time required for the whole work, so that but little time could be saved by automatic chucking.

Comparison of Cost of Work done on Engine Lathes, Turret Lathes and Automatic Turning Machines

One question to be answered in regard to automatic turning machines is whether work can be done on such a machine quicker than in an ordinary hand-operated turret lathe, and in reply to this question it may be said that on work for which the turret lathe and the automatic machine are both set up in the best way, the time is estimated to be approximately the same for both machines for each piece, but in the ordinary every-day practice the output of the automatic turning machine, per day or per week, would materially exceed that of the turret lathe. There are two reasons for this, the first being that the automatic turning machine, when once set up, works at the same rate all day without getting "tired" and without suffering from any of the usual casual interruptions which interfere with the output of a hand-operated machine; the second reason is that in actual practice the turret lathe is seldom set up as efficiently as it might be, whereas the automatic turning machine must be set up more or less correctly in order to do its work at all, and, th refore, in itself, exercises a kind of automatic discipline on the operator, which is absent with a hand-operated machine. As a general estimate it may be said that work which will take four hours on an engine lathe and one and one-half hour on a turret lathe, can be produced in one hour on an automatic turning machine.

Of course, the fact that work can be turned out quicker on this machine does not in itself prove its economy. In order to determine the question of cost, the prices of the machine and of labor, depreciation, and running expenses, must be considered. On an average it may be said that the prices of engine lathes, turret lathes and automatic turning machines, properly equipped with standard tools, are in the ratio of 100 to 350 to 450. The interest and depreciation allowances are in the same ratio. If the time to do certain work is assumed to be in the ratio of 4 to $1\frac{1}{2}$ to 1 in the three machines, and it is assumed that one operator can handle four automatic machines, then the labor cost per piece will be in the ratio of of 4 to 1.5 to 0.25. If all the factors are thus considered it is found that the ratio of cost of labor, interest and depreciation for engine lathes, hand-operated turret lathes and automatic machines is in the proportion of 4.5 to 2.1 to 0.8, approximately, for each piece of work, which is strikingly in favor of the automatic turning machine. Of course, it is to be understood that these results can be obtained only when a considerable number of duplicate parts are to be made on the automatic machine, so that the cost of setting up the machine becomes a very small item per piece.

Makers of automatic turning machines have frequently been charged with using, too freely, glowing descriptions of the economy of labor cost, and carefully avoiding any reference to machine and tool charges, but the proportions given above show that even after allowing for machine and tool charges the same as for other machines, these charges amounting to more than twice the cost of labor in the calculations leading up to the ratios given, the economies resulting from the employment of machinery of this class on suitable work are too great to be overlooked. The economies are so great that automatic machines may properly be employed even where the relative figures for hand and automatic machines would vary largely from those assumed above. For instance, even if the costs upon which the author has based his calculations were doubled, there would still be a saving in the use of the automatic machines.

The running expenses charged against the work include such items as the floor space occupied, the power consumed, the amount of repairs, the cost of tool renewals and the cost of supervision. In this respect the three machines appear about as follows: The automatic turning machine occupies less floor space per unit of work than the engine lathe and somewhat less than the turret lathe; the cost of power *per unit of work* will be about the same for all three classes of machines, and the same applies to the question of repairs. The cost of tools, of course, will be higher for the automatic and the turret lathe than for the engine lathe; but a sum of $50 a year per machine spent for additions to the original outfit of standard tools would mean less than two cents per hour in running expenses, which is not enough to seriously affect the savings due to the use of the machines.

Requirements for a Successful Automatic Turning Machine

The requirements of a successful automatic turning machine are more exacting than those of automatic screw machines on account of the great variety of work and materials for which the machine is made. The automatic turning machine consists essentially of a turret lathe in which the chucking is performed by hand, but in which all operations required for the performance of the work proceed automatically. It should be possible to start the spindle by hand without starting the automatic movement so as to be able to test whether the work runs true in the chuck before the machine begins to operate. The chuck must be exceedingly strong and powerful on account of the number of tools which may be operating at the same time.

The spindle gearing should have automatic speed changes for different cuts on the same piece of work. All tools should have independent feeds so that if one tool should happen to be feeding too fast, the reducing of that feed does not reduce the feed of all the other operations, which would seriously reduce the output of the machine as a whole. The turret should be strong enough to carry very heavy tools, should index without shock, and should be clamped after indexing. The cross-slides should be capable of independent adjustment along the bed, and every tool movement should have its own

*Abstract of a paper read by Mr. P. V. Vernon before the Rugby Engineering Society (England), November 10, 1910.

adjustable dead stop. The spindle of the machine should be capable of reversal when required.

A most important point, and one which is overlooked on too many machines of this class, is the provision for automatic lubrication. When an operator has a number of machines under his charge it is clear that he has not a great deal of time to attend to oil holes and lubricators all over the machines. The headstock and other gears should preferably run in oil, and all bearings should be of the self-oiling type.

Another point sometimes overlooked is the provision of means for stopping the machine should anything happen to any of the tools. A tool may occasionally break during the operator's absence, and in such a case, means should be provided so that the breakage is confined to this tool and is not followed by a breakdown of the machine itself. Some form of slipping device should be used for this purpose, and the simplest form of such a device is to drive the speed motion and the spindle of the machine by means of belts which would slip and be thrown off in case of accident.

General Considerations

Attention may profitably be called to the material to be machined. An occasional hard casting in a lot may necessitate slowing down the machine for every casting with a consequent decrease in output. The same may be said of castings which are irregular, as the machine must, of course, be set for the outside dimensions of the largest pieces; hence time is wasted on all the castings on account of an occasional lump on one. The user of automatic turning machines, therefore, can increase the output of these machines by inaugurating some improvements in his pattern shop and foundry, and the time spent in these places will be regained over and over again in the machine shop.

Cast-iron articles should be annealed, and when this is done they may be made of a much harder grade of cast iron, and hence are stronger, but as easily machined. Castings should also be pickled to save tool grinding. Most of these recommendations are applicable to work machined by any method, but are especially necessary when continuous running is aimed at, as in automatic turning machines.

Lastly, looking at the question of the desirability of automatic turning machines from the workman's standpoint, it may be said that their use enables reasonable wages to be paid, and there is more change, variety and opportunity for mental exercise in the running of four machines by one man—all, perhaps, employed on different jobs—than there is in the operation of an ordinary engine lathe using a single cutting tool.

* * *

The Bureau of Steam Engineering, Navy Department, Washington, D. C., has recently issued new specifications covering the composition of metals and materials supplied to the United States Navy Department. The specifications cover the composition of commercial brass, Muntz metals, brazing metal, gun-bronze, journal-bronze, valve-bronze, ingot-copper, manganese-bronze, monel-metal, cast naval brass, phosphor bronze, screw pipe fittings of brass, metallic nickel, tin, lead, thrust-rings, monel-metal ingots, admiralty metals, benedict-nickel, sheet brass and tubing, brass rods, copper, manganese-bronze and rolled naval brass. The specifications also give the required tensile strength, yield point and elongation of the various metals, together with other general information relating to the tests to which the metals are subjected in order to determine their qualities.

* * *

As a result of recent tests, Prof. F. M. Goss estimates that of 90,000,000 tons of coal consumed by 51,000 locomotives in the United States in 1906, 720,000 tons were lost through incomplete combustion of gases, more than 10,000,000 tons were lost through the heat of the gases discharged through the smokestack, more than 8,600,000 tons were lost through cinders and sparks, and the equivalent of nearly 3,000,000 tons were lost through unconsumed fuel in the ashes. These figures indicate the economy that might be possible with improved furnaces insuring more perfect combustion.

MACHINE SHOP PRACTICE

HAND SCRAPING

By H. P. FAIRFIELD*

Hand scraping in metal working is done to accomplish three specific objects:

1. To produce an ornamental surface for the sake of appearance only. This is known in shop nomenclature as "frosting," "snow flaking," or under the general head of "spotting," and consists in using the hand scraping tool in such a way as to obtain "spots" upon the surface to be ornamented. The

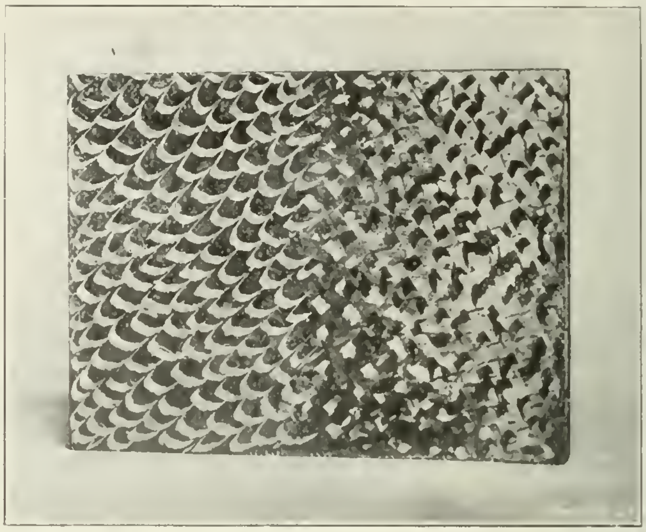


Fig. 1. "Frosting" and "Snow-flaking," as produced by Scraping Operations

spotted surfaces, as shown in Fig. 1, are of two kinds, one having small square spots arranged as indicated, and one having "half-moon" spots. The former is termed "snow-flaking," and the latter "frosting." In the former, the scraping tool is pushed squarely ahead to give spots of an established size and at established intervals. Similar spots are then made to fill the intervening spaces, using the scraper at right angles to the previous direction of motion or push. Frosting is accomplished by giving the scraping tool a peculiar "wiggle," as the cut is made; this is not easy to do, and dif-

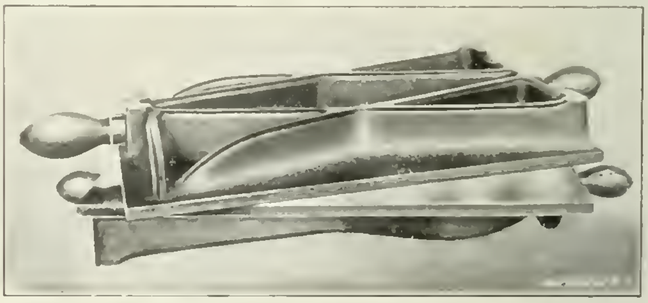


Fig. 2. Hand-scraped Surface-plates—Note the Tripod Principle of Support

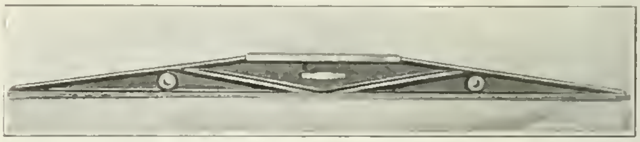


Fig. 3. Hand-scraped Straightedge; when not in Use, it is supported from the Holes shown, to prevent Unequal Stresses

ficult to describe. However, if well done, it leaves a very handsome finish. A surface ornamented in this manner may have been most carefully hand scraped to an accurate and precise plane, or it may have been left as it came from the machine. Ornamenting by spotting a surface that has been hand scraped, is done to give a regularity to the impressions left by the tool. When a surface is ornamented without previous hand fitting by scraping, it may be done wholly as an ornamentation or, as is sometimes the case, to deceive the uninitiated, who are apt to consider it as proof of previous careful fitting.

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2. To fit two surfaces to each other more accurately than they can be fitted by machining. Examples of this kind are seen in such bearings as spindles and their boxes, in cylinders where a solid piston must fit without the presence of high spots or ridges on the surfaces, and in cases where it is impossible to use machinery for smoothing or finishing surfaces. An example of this latter case may be seen in repair jobs on babbitt-lined bearings, replaced in localities distant from all shop conveniences.

Fig. 4. Hand-scraping the Front of a Drill Post

3. In the case of plane surfaces, where the surface is finished by hand scraping to conform to a previously prepared master plane surface, termed a surface plate. The hand scraping of plane surfaces is undoubtedly one of the most skilled of the regular machine shop operations, and is always performed by a specially trained corps of employes. Perhaps the art of hand scraping plane surfaces can be illustrated in no better way than by describing the methods of producing a master surface-plate.

Commercial firms that produce standard surface-plates for sale have a large master plate to which all the master plates used by them in producing surface-plates can be referred. This plate, which might be termed "an original master plate," is used for test purposes only, and cared for as religiously as possible. Where no master plate is available for test purposes, it is necessary to make three plates if but one is desired. This is easily understood if one considers that two curved surfaces can be made to fit each other, but that a third surface could not fit both the curved surfaces. In other words, a surface cannot at the same time be concave and convex. Therefore, if each of three surfaces or straight edges will match each other, they must all be straight or plane surfaces.

Surface-plates are usually made from gray iron castings. The pattern is made with uniform ribs upon the back or under side, as shown in Fig. 2, if it is to be finished upon one side only. (If it is to be finished upon all sides, as, for example, a long bar of rectangular cross-section, it is built as a hollow box with suitable internal ribbing.) Besides having ribs, the under side is provided with three bosses used as feet, as shown, for resting the plate upon the bench or other support. These feet are so located as to evenly support the weight of the plate, and it should, at all times, whether in use or not, rest upon these spots. The castings are first rough-planed to approximately the finished size, and allowed to season for a period of several months that all internal cooling strains may adjust themselves. This process can be hastened somewhat by heating in an annealing oven, if care is used not to overheat. When suitably seasoned, a light finishing cut is made on the surface to be scraped, and a seasoning period is again allowed. Each plate is then carefully scraped to a smoothly finished surface, taking care to remove even amounts all over each surface. They are then scraped to fit one another by placing one upon another and rubbing the surfaces together until the high spots on each plate are located, and then scraping these off.

As an aid in locating the high spots upon the surfaces in contact, use is made of some pigment, as for example, venetian red. A thin film of this is rubbed over the surfaces before placing them together. The points at which the two plates touch are thus readily indicated. The workman with his hand scrapers removes a small amount of the stock at the indicated points, and repeats the process of locating the high points of contact between the several plates and afterward scraping them off, until the surfaces are interchangeable each with the other and are completely "freckled" over their upper surfaces with points of contact. These points of contact should be uniformly distributed over the entire surface, and the fitting should continue until at least 60 per cent of the surface of the plate is in contact with its mates. Evenness of distribution is of prime importance, as is also the requirement that all parts of the surface not actually in contact shall be an unmeasurable distance below the level of the parts which actually are in contact.

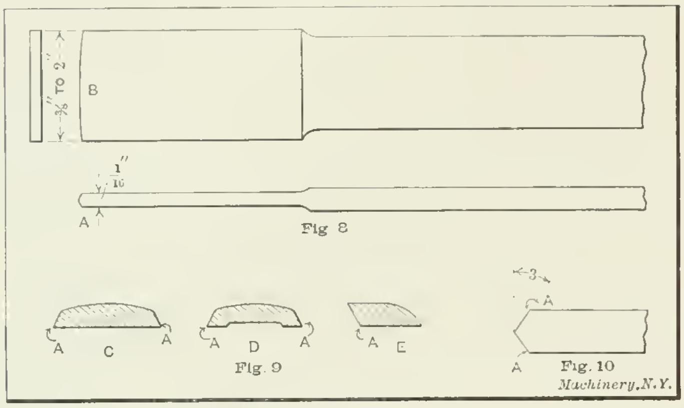
Fig. 5. Method of Holding a Scraper

Fig. 6. Honing a Scraper

Fig. 7. Honing the Scraper on the End

For this class of hand scraping and for the spotting processes first described, tools resembling in outline a file, are ordinarily used, held as shown in the accompanying illustrations, Figs. 4 and 5. They are ground square across the end and are afterward honed upon a hard oilstone. When the honing is being done, they are held in a vertical position and inclined alternately to the right and to the left about 3 degrees. (See

Fig. 7.) The cutting edges are thus given a negative rake of 3 degrees, and the tendency to chatter in use is reduced. In this, as in all other purely hand operations, the personal element is supreme, and the difference between workmen in respect to quality and quantity of production is very marked. Fig. 4 shows a workman hand scraping the front of a drill post for its table and spindle brackets. In work of this character the surface plate, or straightedge, Fig. 3, is placed upon the surface being scraped, but in the case of small pieces, the work is rubbed upon the plate instead. Whichever is done,



Figs. 8, 9 and 10. General Appearance, Sections and Enlarged View of End of Hand Scrapers

the surfaces should be carefully wiped to remove loose particles, and a light coating of pigment given them.

Hand scrapers, as shown in Fig. 11, resemble files in form and are often made from old files. This is not, however, good practice, and new special stock should be used. They are hardened glass-hard on the cutting edge and not "drawn" afterward. Then the cutting end is ground and honed upon an Arkansas oilstone, as already mentioned, leaving a cutting

Fig. 11. Collection of Hand Scrapers for Flat Surfaces and for Journal Bearings

edge as shown exaggerated in Fig. 10. In use, the hand scraper is held at a sufficient angle with the work to make it "bite" the surface, and is then pushed from the workman along the surface being scraped. The length of stroke varies from that of several inches, when roughing off the surface, to almost no distance when the finishing touches are being made.

Flat hand scrapers vary in size to fit the jobs on which they are used. The usual range is from ⅜ inch wide by 6 inches long, to 2 inches wide by 24 inches long. The ordinary size used on machine tool work is about 1 inch by 18 inches.

The curved scrapers shown in cross-section in Fig. 9 are used in finishing spindle boxes. Scrapers of this type are of a variety of cross-sections. They are used by pushing or pulling with a combination motion both around and lengthwise of the bearing.

In Fig. 8 is shown the ordinary flat hand scraper. It will be noticed that there is a slight curvature at the end *B* of the tool. In Fig. 9 are shown cross-sections of scrapers for spindle boxes, as mentioned; *A* represents the cutting edge in all cases. The cutting edges make an angle of from 3 to 15 degrees with the vertical. The cross-sections at *C* and *D* are for scrapers for roughing, and that at *E* for finishing spindle boxes.

* * *

FIVE YEARS OF MACHINE TOOL TRADE

The accompanying chart is based upon the sales of the Frevert Machinery Co., 18 Dey St., New York City, dealers in machine tools. The chart shows the variations in the business activity of this firm during the past five years, and it

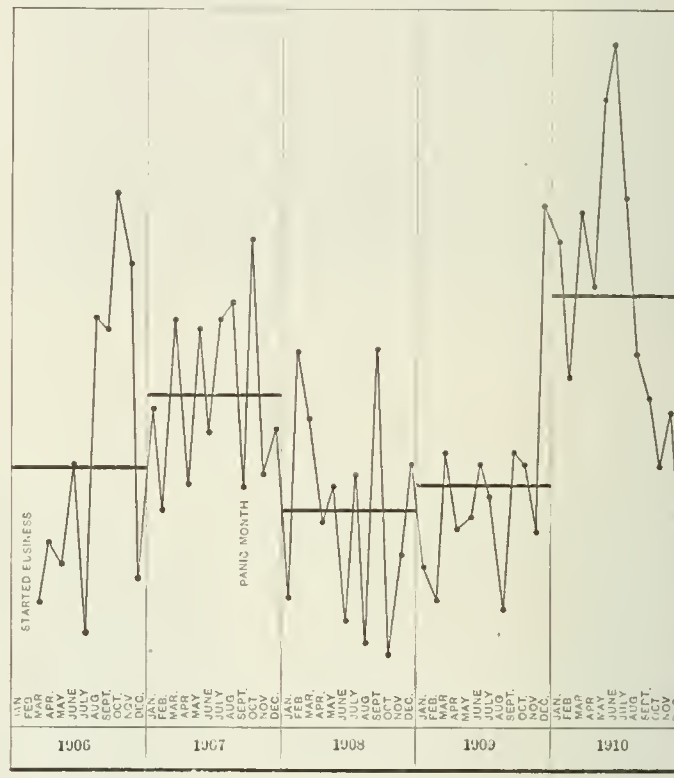


Diagram of the Machine Tool Business of the Frevert Machinery Co., New York

may be reasonable to assume that this diagram in a general way indicates the state of the machine tool business throughout the country during this time. The heavy horizontal lines show the average yearly sales for these five consecutive years.

* * *

PEAT AS A FUEL FOR LOCOMOTIVES

The experiments undertaken in Sweden to determine the possibilities of peat as a fuel on locomotives have now been completed, and the State Railway Department reports that the attempts have not been successful. It has been found in these experiments, as well as in experiments und rtaken elsewhere, that while theoretically 1.64 ton of peat is equivalent in heating value to one ton of coal, it was practically necessary to use 1.95 ton of peat to one ton of coal. The result is that, at the present time, the cost involved in the use of peat fuel exceeds that of using coal. It is evident that while the increased weight and bulk of peat for use on locomotives is a serious objection, apart from its cost there would be no such objection to its use in stationary power plants. The problem of how to get the peat into a state where it is suitable as boiler fuel without incurring excessive cost in the operations necessary for its preparation, eems, however, still to be unsolved.

DRAWING DEEP CYLINDRICAL SHELLS

By SIRIUS

I was much interested in the article which appeared in the December number of MACHINERY on drawing deep cylindrical shells, and the auxiliary-punch idea is one that will find a place in my note-book.

The ratio as given between the diameter of the blank and the diameter of the first cup seems to me to be rather low, judging from my experience which has been mostly on small work and on work where the ratio between the thickness of the metal and the diameter of the blank is not so great. The ratio between the thickness of the metal and the diameter of the blank in the case referred to, is 1 to 368. With a greater ratio—1 to 475—that is, with stock which is 0.015 inch thick and a blank $7\frac{1}{8}$ inches in diameter, it was possible to draw a cup nearly 4 inches in diameter. This gives a ratio of approximately 1.8 between the diameter of the blank and the diameter of the first cup. In a certain case where the stock was slightly thicker in proportion to the diameter of the blank than that given, a ratio of 2 was used successfully. The stock in this case was a composition of tin plate on a base of special-quality open-hearth steel, and the dies were well fitted to a toggle-press which had a smooth action. This leads me to believe that the ratio of 1.6, as given by Mr. Davis, is too low.

Referring to the redrawing operations, Mr. Davis states: "The reduction of the shell in this and the successive operations is determined by practical experience more than anything else, as it is a very difficult proposition to know just exactly how much the metal will stretch under varying conditions." I have not found this to be the case. Redrawing operations are as simple as plain drawing operations, and for years I have used a ratio of 1.3 between the diameter of the cup and that of the shell in the first redraw, and also for the successive redrawing operations. In one case a ratio of 1.41 was used successfully for reducing, that is for reducing a portion of the body only, not for redrawing, which reduces the entire length to a smaller diameter. Where new stock is used, that is, metal that has not passed through a drawing operation, or been otherwise strained, the ratio can often be as high as 1.65.

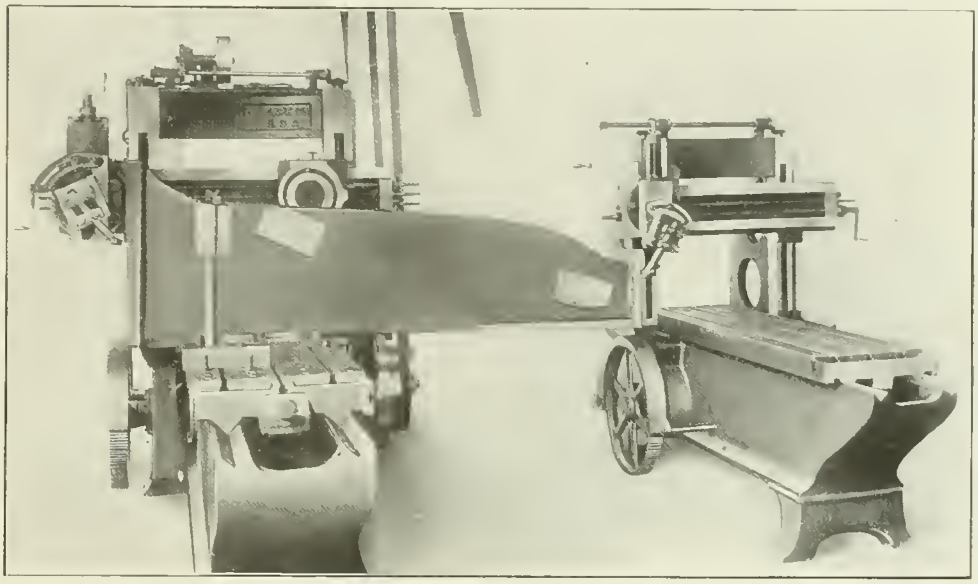
By calculating, it will be found that the ratios given by Mr. Davis for the redrawing operations are 1.23, 1.27, 1.23 and 1.25. This is close enough to 1.25 to show that this figure is practically constant and was probably used to determine the diameters for the successive redrawing operations. Perhaps the material used will not stand more, or probably this may be the limit under the specific conditions for this particular case, such as temperature, lubrication, conditions of dies and press, faulty heat treatment, excessive scaling or injurious pickling. Whatever the cause may be, a higher ratio could probably be used, but I would like to know the absolute limit which can be used under the best commercial conditions, as that is the most important factor.

Judging from my experience it seems that it would be possible to complete the drawing of the shell in four draws, eliminating one redrawing operation. This could be done by using a ratio of 1.3 for the there redraws which will give $(1.31)^3$, the index representing the number of redraws as well as the third power of the ratio. By multiplying the final diameter of the shell, 6 inches, by $(1.3)^3$ and dividing the result into the diameter of the blank, 23 inches, $\frac{23}{6 \times (1.3)^3}$, gives a ratio of 1.744 for the first draw—the making of the cup from the blank. Using this ratio 1.744 gives a cup 13.18 inches in diameter. Applying the ratio 1.3 for the successive redrawing operations, we obtain for the first redraw a shell 10.13 inches in diameter; for the second redraw a shell 7.79 inches in diameter; and for the third redraw, a shell 5.99 inches in diameter, or approximately 6 inches, which is the desired diameter of the shell.

* * *

AN INTERESTING PLANER JOB

The illustration shows a peculiar planer job recently met with in the Hoefer Mfg. Co.'s shops, 120 Jackson St., Freeport, Ill. This company built a cylinder boring machine for the automobile trade in which it was necessary to plane both the top and the bottom of the column, as indicated in the illustration. The widest planer in the shops of the company, however, was a 33-inch x 33 inch x 10-foot Cincinnati planer. As the column was over eight feet long, there was no way in which the top could be planed, as ordinarily set up on the planer. Beside this Cincinnati planer in the shop stood a 24 inch x 24 inch x 6-foot Gray planer, turned, however, so as to run in the opposite direction. After many methods had been thought of and discarded, it was decided to turn the Gray planer end for end into the position shown in the illustration. The column to be planed was then bolted rigidly to the table of the larger of the two planers, aud then both ends of the column were planed with tools held as indicated in the half tone. Of course, the cut taken on the smaller end of the column was necessarily very light, because of the liability to chatter. A boy was placed at the feed lever of the small planer, as all belts had been previously removed. The small and large ends were theu planed simultaneously, and the work was not only rapidly, but also accurately completed.



A Novel Method of Planing a Large Cylinder Boring Machine Column

* * *

STRENGTH OF OLD TIMBER

Tests undertaken by Mr. C. P. Buchanan on white pine show that souud timber a quarter of a century old is materially stronger than new timber. While the experiments were undertaken on white pine, there is no reason to suppose that oak, hard pine or any other wood commonly used in building construction would act differently. This is an interesting fact because ordinarily one would assume that new timber would be stronger. The differences in strength as found by Mr. Buchanan were quite remarkable. Where the average crushing load in pounds per square inch of new timber was 4260, the average strength of timber 25 years old, and which had been used in a wooden bridge, was 5300 pounds per square inch. While it may be assumed that the timber from the bridge was of a better quality than the new timber tested, and while this may be a correct assumption, it would hardly account for such remarkable differences in strength as shown by the figures quoted above.

"INS AND OUTS OF GEAR HOBBING"

An article by Mr. Ralph E. Flanders, entitled "Ins and Outs of Gear Hobbing," which was published in the January number of MACHINERY, page 369, engineering edition, has created wide comment, especially from manufacturers of hobbing machines. Mr. Flanders was for a number of years an associate editor of MACHINERY, leaving this paper last July to become connected with the Fellows Gear Shaper Co.; and some manufacturers have felt justly that his relation to the latter firm was not made plain in connection with the article, and that it appeared as an editorial opinion of MACHINERY, which was not the case.

We know Mr. Flanders too well not to believe that the opinions expressed represent his honest belief, irrespective of his business connection; but it is only fair that the readers of MACHINERY should understand the circumstances, and also that ample space and opportunity will be given for the presentation of the other side of the case.

* * *

THE SELDEN PATENT DECISION REVERSED

In the October, 1909, number of MACHINERY, the decision handed down by Judge Hough of the United States Circuit Court, upholding the famous Selden patent on gasoline engine automobiles, was referred to. The United States Circuit Court of Appeals on January 9, this year, reversed this decision, and overthrew the suit brought by the holders of the Selden automobile patent against C. A. Dueer & Co., the Ford Motor Co., the O. J. Gude Co., Panhard & Levassor, the Société Anonyme des Anciens, Andrew Masseibal, John Wanamaker and others concerned in the automobile industry. The Selden patent was granted in 1895 to George B. Selden, for an improved road engine.

The decision of the United States Circuit Court of Appeals was written by Judge Noyes. It describes, as the feature of the Selden automobile patent, the engine, inasmuch as the carriage element was ancient and the drive element dated back at least as far as 1879 Gas engines also were old then, according to the court, and liquid hydrocarbon engines, both of the compression and non-compression type, were no novelties. Practically speaking, there were two types of gas engines then in use, the so called Brayton constant pressure engine and the Otto engine. Selden chose the former on which to apply the ideas that constituted his patent; later the Otto engine came in and superseded the Brayton engine. Judge Noyes declared that if Selden had based his patent on the Otto engine he would have obtained a grant that covered the modern automobile, but as he did not, the claim of the plaintiffs must fail. In his opinion he says:

"The patent was applied for in 1879 and granted in 1895. For over sixteen years the application lay in the Patent Office, and the applicant took full advantage of the periods of inactivity permitted by the rules and statutes. It is apparent that he delayed just as long as possible the issue of the patent to him. During this long time the automobile art made marked advances along different lines, and when, in 1895, the patent was granted it disclosed nothing new.

"Others had then made the patentee's discovery, and had reduced it to practice in ignorance of what he had done. While he withheld his patent, the public learned from independent inventors all that it could teach. For the monopoly granted by his patent he had nothing to offer in return. The public gained absolutely nothing from his invention, whatever it was. From the point of view of public interest it were even better that the patent had never been granted.

"It is urged that we should favorably consider the patent on account of the delay in the Patent Office, and should seek to avoid giving it a broad construction, and should permit the a leged abuse of the law to weigh against the standing of the complainants in a court of equity. But the patentee acted wholly within his rights. He merely took advantage of the delays which the law permitted him.

"He followed strictly the statutes and rules of procedure, and the courts cannot exact a greater amount of diligence from him. When the patent was granted under the law it became entitled to the consideration accorded to any other patent. If the statutes and rules permit unnecessary delays they should be changed, but we reject the view that this court owes any duty to relieve against their operation. This patent, even if it be useful only for tribute, must be viewed without prejudice and with absolute judicial impartiality.

"While the conclusion of non-infringement which we have reached leaves the patentee empty-handed with respect to the patent for the short time it has to run, it cannot be regarded as depriving him through any technicality of the first reward for his labors. He undoubtedly appreciated the possibilities of the motor vehicle at a time when his ideas were regarded as chimerical. Had he been able to see far enough, he might have taken out a patent as far-reaching as the Circuit Court held this one was. But, like many another inventor, while he had conception of the object to be accomplished, he went in the wrong direction.

"The Brayton engine was the leading engine at the time, and his attention was naturally drawn to its supposed advantages. He chose that type. In the light of events we can see that, had he appreciated the superiority of the Otto engine and adapted that type for his combination, his patent would cover the modern automobile. He did not do so. He made the wrong choice, and we cannot, by placing any forced construction upon the patent or by straining the doctrines or equivalents, make another choice for him at the expense of these defendants, who neither legally nor morally owe him anything.

"The decrees of the Circuit Court are reversed, with costs, and the causes remanded, with instructions to dismiss the bills, with costs."

Hence, according to the Court of Appeals, the Ford Motor Co. and the other defendants have never infringed the Selden patent. It is also interesting to note that the court finds that these companies gained nothing from the Selden patent when it actually came out of the Patent Office.

The Association of Licensed Automobile Manufacturers has announced that the Columbia Motor Car Co. and Mr. Selden are preparing to apply for a writ of certiorari with a view of having the case go to the United States Supreme Court for final decision.

* * *

TABLE OF LA POINTE STANDARD ROUND-CORNERED SQUARE HOLES

The accompanying table gives dimensions for what are called "standard round-cornered square holes," the standard given having been established by the Lapointe Machine Tool Co., Hudson, Mass. These holes are used for shafts of the

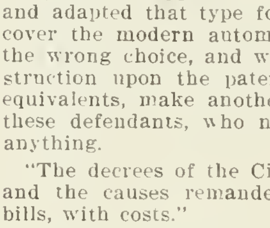


TABLE OF LA POINTE MACHINE TOOL CO.'S STANDARD ROUND-CORNERED SQUARE HOLES

No. of Square	Size of Square A	Size of Shaft B	No. of Square	Size of Square A	Size of Shaft B
1	1	1 1/4	10	1 9/16	1 15/16
2	1 1/16	1 5/16	11	1 5/8	2
3	1 1/8	1 3/8	12	1 11/16	2 1/8
4	1 3/16	1 [illegible]	13	1 3/4	2 1/4
5	1 1/4	1 9/16	14	1 13/16	2 5/16
6	1 5/16	1 5/8	15	1 7/8	2 3/8
7	1 3/8	1 3/4	16	1 15/16	2 7/16
8	1 7/16	1 13/16	17	2	2 1/2
9	1 1/2	1 7/8	..	...	...

square form, especially where sliding gears or other parts of similar nature are placed on the shafts, thus eliminating the use of keys. The reason why square shafts are not adopted to a greater extent than is at present the case, is to be found in the difficulty of producing square holes. The automobile business, however, has made the use of square shafts imperative, and holes made to the standard dimensions given in the table can be produced by the broaching machine and tools made by the Lapointe Machine Tool Co.

* * *

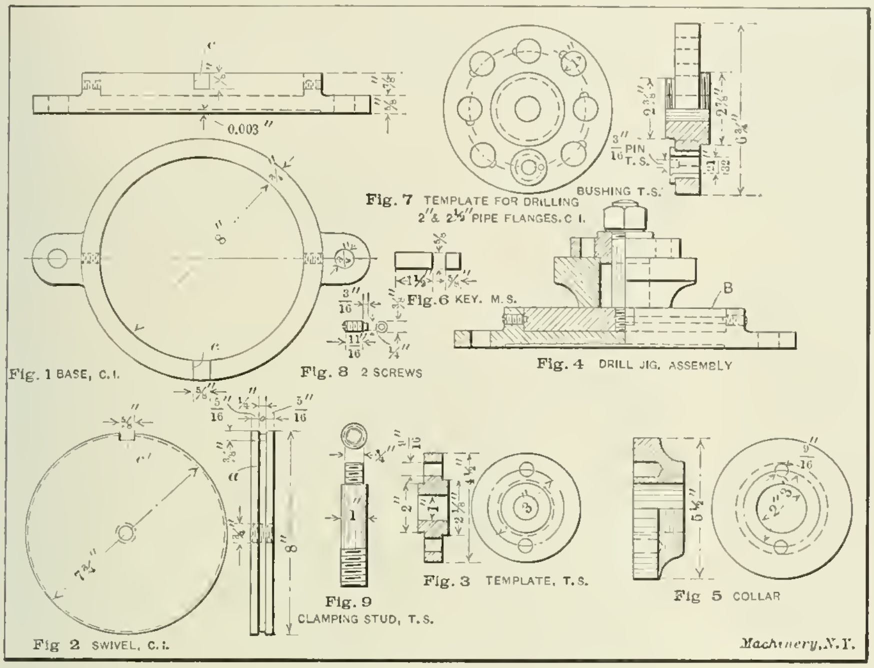
At the annual meeting of the stockholders of the New York, New Haven & Hartford R. R. Co., last fall, it was decided to inaugurate a pension system for old employes.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

AN EFFICIENT CIRCULAR DRILL JIG

It is sometimes necessary to drill a number of holes in a circle at a certain distance from the center, and a jig which will be found very convenient for this class of work is shown in detail in the accompanying illustrations. It is not always an easy matter to set a drill concentric with a bushing when the jig is of large size and the drill small in diameter, as it is easy for the drill to be bent out of the perpendicular by the jig bushing, which condition, if slight, would not be noticed by the operator. Having had considerable work of this nature to do, the writer designed the jig shown herewith, which proved to be very satisfactory. This jig was originally used for drilling spanner holes in tight and loose collars. The assembled jig shown in Fig. 4 consists of very few parts. Fig. 1 is the baseplate, the bottom of which is recessed to give a good bearing on the table, so that the tightening of the bolts which clamp the jig to the table will not cause the plates to spring, which would bind the swivel.



Figs. 1 to 9. Details and Assembly Views of Circular Drill Jig

Fig. 2 is the swiveling part. This is turned to fit the baseplate and to insure its being true, the clamping stud, Fig. 9, must be first fastened into the swivel and both turned together. Ths slots c in the baseplate and c' in the swivel-plate are for the purpose of holding the two parts together with the key, shown in Fig. 6, when removing or putting the work in the jig, as the key keeps the jig from rotating when loosening the nut. The recess a in the swivel-plate is to facilitate the easy dismantling of the swivel-plate from the baseplate. The two headless screws, Fig. 8, are used for holding the swivel-plate in the baseplate, fitting in the recess a.

Fig. 3 is a templet made of tool steel and hardened which is used for centering both the tight and the loose collars in the jig. The collar shown at Fig. 5 is the loose collar and it can be seen how the boss on this templet is located in the hole so that the two 9/16-inch holes are spaced the correct distance from the center.

Fig. 4 shows the drill jig assembled ready for use. After the drill is set for the first hole all the movable parts of the drilling machine are tightened, and after this it is not necessary to loosen them until all of the holes are drilled. All that is necessary to drill the holes is to swing the swivel-plate B into the desired position when, if necessary, it can be locked with the small headless screws shown. This is a decided advantage in several respects over the ordinary drill jigs, and not only can holes be drilled more rapidly, but they can be drilled more accurately as well.

With the ordinary jig or templet the movable parts of the drill press must be left loose, and owing to this it is a difficult proposition to drill holes which will have the same center distances on both sides of the work. This means that to bring the holes back to their true relation they must either be filed or reamed, which is not a very practical way of doing such work. For the class of work just mentioned, the circular drill jig shown, overcomes these defects and can be used for a considerable range of work having two or more holes drilled in a circle.

The chief advantage of this jig is that the drill press table can be kept tight during the whole job, it only being necessary to move the swiveling-plate around to bring the jig into position for each hole.

Fig. 7 shows a templet which is applied to this type of jig for drilling pipe flanges. The templet shown here is for drilling 2- and 2½-inch flanges, one bushing being used for both sides. A templet of this kind could also be used to advantage for drilling bonnets, cylinder covers and small cylinders of varous sizes by using interchangeable bushings to fit over the stud.

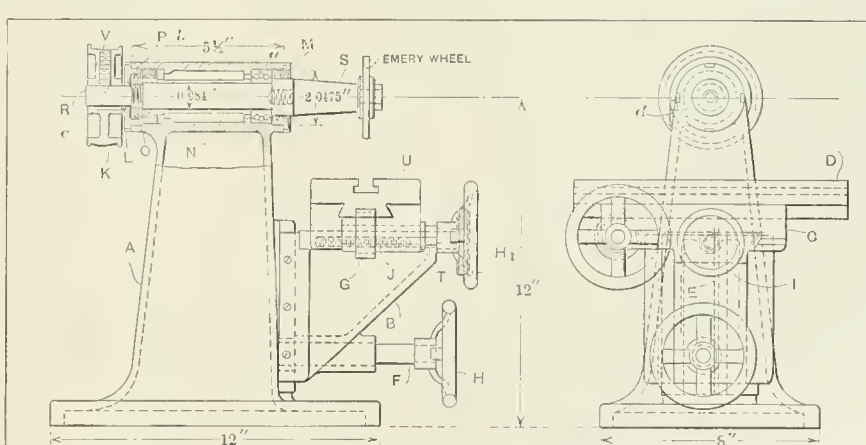
By graduating the baseplate of this drill jig into 360 degrees, templets and jigs can be drilled, and their holes will be equally and accurately spaced.

JOHN W. BRANDLE

Jackson, Tenn.

A SMALL BENCH SURFACE GRINDER

The accompanying illustration shows a small bench surface grinder of improved design, which will be found very useful in tool-rooms where small work is to be ground. It is particularly adapted for typewriter, adding machine and cash register work, for grinding the small interchangeable parts composed in their make up. Although this grinder is limited to small work, it has a wide field of usefulness in the average tool-room.



Small Bench Surface Grinder equipped with Ball Bearings

The design of the spindle is out of the ordinary; and it is well supported and equipped with "New-Departure" bearings. The writer does not know of any grinder on the market in which the bearings shown in this design are incorporated. The forward bearing a is a double-row bearing, and takes the

end thrust as well as the radial thrust of the wheel, while the bearing b is a single-row bearing and takes the radial thrust of the pulley. The forward bearing has very little clearance between the outside of the bearing and the bore in the head, only 0.0008 inch being allowed. The rear bearing b is forced into the main casting or pillar A.

The knee B has two slides—a cross-slide C and a longitudinal or top-slide D. The knee is raised by the handwheel H fastened to the shaft F, the latter having a pinion attached to it which works in a steel rack screwed to the column A. The cross-slide is operated by the knurled knob I fastened to the screw J. The top-slide is operated by the handwheel H_1 through pinion G, held on shaft T. The pinion G works in the rack U attached to the top-slide.

The spindle R is made of a good grade of tool steel and is hardened and ground throughout. The bore in the bearing is made 0.002 inch larger than the spindle. A steel sleeve N is forced on the spindle between the two bearings. The bearing a is put in place and securely held by the bronze lock-nut M, the shoulder of the spindle pressing up against the bearing. The lock-nut M also acts as a dust cap to keep the emery from cutting into the bearings.

This grinder is driven by the pulley K which is 3½-inch diameter by 1¼-inch face, held to the spindle by a Woodruff key not shown and the headless set screw V. P is a locking-wire that goes three-quarters of the way around the lock-nut O, and thence into a keyway which is cut in the spindle. L is the dust cap for the other end of the head, and the recesses c are filled with packing. This not only keeps the dust out, but also keeps the oil inside the head. The oil is fed into the head from an oil cup (not shown) through a brass tube screwed into the hole d, thus keeping the spindle well lubricated at all times. S is an adapter or arbor screwed into the end of the spindle for holding the grinding wheels. For external work a 3-inch wheel can be used, and for internal work a smaller wheel can be used by making a smaller arbor.

Bristol, Conn. WALTER J. OLDROYD

CUTTING A MULTIPLE-PITCH WORM

In the department "Letters on Practical Subjects" of the November number of MACHINERY, a short article appeared under the heading "Cutting a Multiple-pitch Worm." The rule given in this article has its limitations, however, and cannot be universally applied. A better rule, and one that will work in all instances where it is possible to "catch" the proper thread by moving the carriage back a whole number of inches, is as follows: Multiply the pitch of the thread by a whole number which is either 1 more or 1 less than a multiple of the number of starting points of the worm and screw; and which, when multiplied by the pitch, gives a whole number for the product. It should be understood that by "pitch" is meant the distance from the center of one thread to the center of the next. The pitch must not be confused with the lead, which is the advance in one turn of the worm or screw.

As an example, apply this rule to the worm mentioned in the article in the November number. Here the lead was 2⅝ inches and the worm triple-threaded; the pitch then is $2\frac{5}{8} \div 3 = \frac{7}{8}$ inch. We now multiply ⅞ by trial whole numbers which are not multiples of 3, until we obtain a product expressed as a whole number. We find that the first number by which we can multiply, and which complies with the conditions imposed, is 8. Thus $\frac{7}{8} \times 8 = 7$, which indicates that if the lathe is stopped at the end of the cut and the carriage moved back 7 inches, we will enter the thread at its second starting point. If the piece of work is longer than 7 inches, we can move the carriage back 14 inches, 21 inches, 28 inches, etc., as required.

In some cases it is not possible to find a number by which to multiply the pitch which complies with the conditions and gives a whole number for the product. In such a case the cutting of a multiple thread by moving the carriage back a whole number of inches is impossible. Such a case, for example, is that of a triple thread with 1¼-inch lead; the pitch of this thread is 5/12 inch. We find that 5/12 cannot be multiplied by any number not a multiple of 3, that will produce a whole number. O. G.

GRIP CHUCK FOR A PRATT & WHITNEY HAND MILLER

We had a Pratt & Whitney hand miller and insufficient work to keep it going all the time, and we also were hard pressed for small capstan lathe work. One of the jobs wanted was a large quantity of key-pins A, shown in Fig. 1. These pins were driven under the shoulders of the studs to keep them from turning while screwing the nut on. One end of the key-pin had to be rounded, and a tool was used which rounded the end while cutting them off. To utilize the Pratt & Whitney hand miller for cutting off these pins a grip chuck, as shown in Fig. 2, was made. This consists mainly of a body C, sleeve A, cap B, and small spring chuck E, these parts being operated by the handle F.

The body C screws onto the nose of the spindle and is bored out tapering to receive the spring collet E, which has three

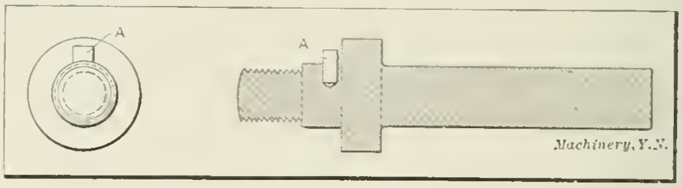


Fig 1. Views showing the Key-pin and its Use

tapered slots cut in it, so that the toggles D can be operated easily in them. A seat for the top of the toggles is made by beveling the edges of the sliding collar A and cap B as shown. The gun-metal pads a, shown fastened to the handle F, operate in the groove b cut in the sliding sleeve A. The outer end of this handle is attached to a bracket fastened to the machine (not shown) so that by pulling the gripping part of the handle the sleeve A is forced back and forth on the body C. It can therefore be seen that by sliding this sleeve back and forth, the toggles D are changed from an angular to a perpendicular position, and that when in a perpendicular position the chuck is closed.

A threaded washer G is provided to stop the movement of this sliding sleeve A, so that the toggles will be forced a slight amount past their perpendicular position. If this stop were

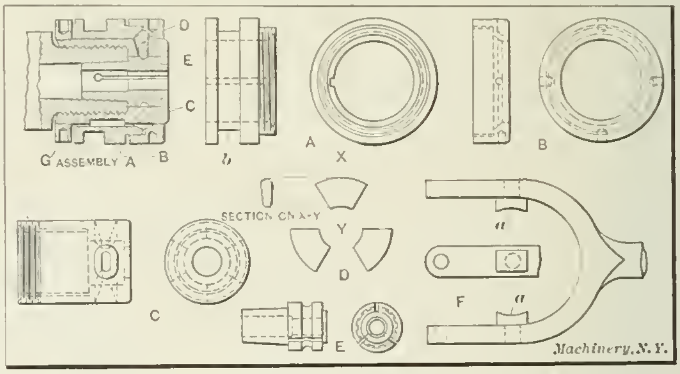


Fig. 2. Details of the Grip Chuck used on the Pratt & Whitney Hand Miller

not provided, it can easily be seen that the toggles would pass over the center to an angular position on the opposite side, when the chuck would again open. The cap B, while acting as a seat for the toggles, is also used for changing the diameter of the chuck. This is accomplished by screwing it up on the sliding sleeve A, thus forcing the toggles D downward and decreasing the diameter of the chuck.

This chuck answered the purpose very well and after a little practice a boy was able to cut off key-pins in one-third the time that was required to cut them in the capstan lathe. The parting tool for cutting off the key-pins was held in the milling machine vise, as was also the stop for gaging the length of the key-pins. G. H. GIBBS

Leicester, England.

A REVOLVING TURRET DRILL-HOLDER

The accompanying illustrations Figs. 1 and 2 show a four-hole turret drill-holder, which was used in a turret lathe for drilling the four holes A, and reaming the hole B in the casting shown to the left of the illustration Fig. 1. This cast-

ing was made from brass and was finished complete in the turret lathe. It was held in the chuck by the arms C. The half-hole D cast in it, acted as a driver on the dog F, for the drill-holder.

In operation, the shank E of the holder, Fig. 1, is held in the turret, and after the other machining on the casting has been done the spindle is stopped, the dog, or driver, F located in the half-hole D in the casting, and the spindle run backwards. The turret is then advanced, when the reamer G reams the hole B, and on further movement of the turret, the reamer shank G_1 is forced back into the holder against the tension of a spiral spring. The stripper plate, or rather the bushing carrier, H, then comes up against the face of the casting, and is forced back allowing the drills I to project, thus drilling the four holes A simultaneously. The bushing carrier H is forced outward by three spring-pins J and the dog F. The drill-holders K can be seen projecting from the top of the holder in the illustration.

A clearer idea can be obtained of the working mechanism of this tool by referring to Fig. 2. All the parts mentioned in Figs. 1 and 2 bear the same reference letters. The cross-sectional view shows this tool clearly, giving a good idea of its complicated mechanism. The reamer G, which reams the hole B in the casting, is screwed to the shank G_1 which is

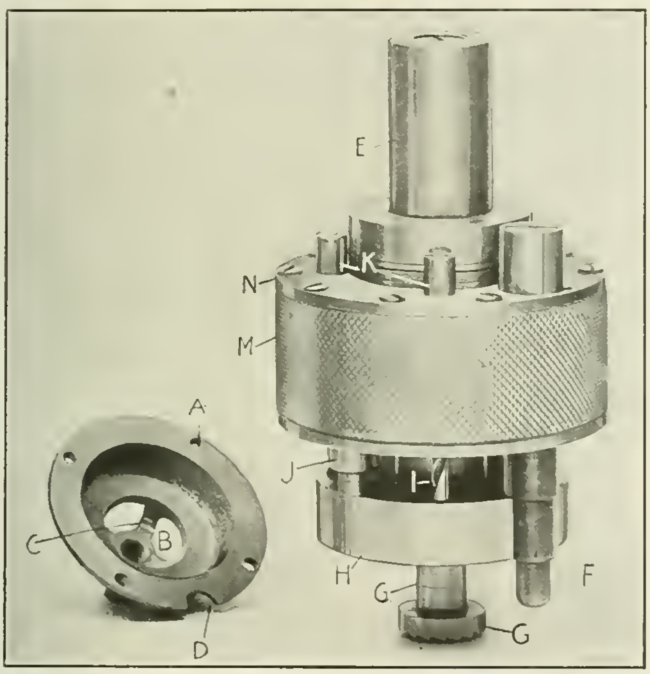


Fig. 1. Four-hole Turret Drill-holder and Work on which it was used

forced outward by the spiral spring G_2. G_1 also has a key G_3 inserted in it, which prevents it from turning in the body E. The stripper-plate H, or the guide for the drills I is cut out to fit around the dog F, and is also made a sliding fit on the body of the holder E. Connected to the body of the holder E by a key, is a spur gear L. This spur gear drives the four drill-holders, or spindles, K which have teeth cut in their peripheries meshing with the large gear. The drills I are screwed in the spindles K, and have a left-hand thread cut on them. The outer casing or body M of this holder is counterbored from the rear, and a cap N is screwed onto it as shown. The gears L and K work in this counterbored space. Sleeves are provided for the spring-pins J and dog E, so that springs may be inserted behind them, to force them out. Eight pins O are driven half into the hub of the knurled casing or body M, and half in the stripper H, to prevent the stripper H from rotating independent of the revolving parts of the holder. A nut P holds the stripper H to the body E, but allows it to turn with the revolving parts.

This holder is provided with ball bearings as shown, which are held in the retainer P_1. Two hardened steel washers Q are also provided. If left-hand drills had been used, it would not have been necessary to reverse the spindle of the machine. However, the man who paid the bill was so disgusted at the cost of such a complicated device, considering the simple work which it had to perform, that he dispensed with its services, and the writer arrived just in time to reclaim it from the scrap-heap.

Considering the simple drilling to be done, for which this tool was designed, it seems to be a very extravagant piece of work, as with a simple jig and a four-dollar-a-week boy to operate it, these castings could be finished at a smaller cost than would be possible by using this complicated device. The writer cannot imagine why the outer body M was knurled, un-

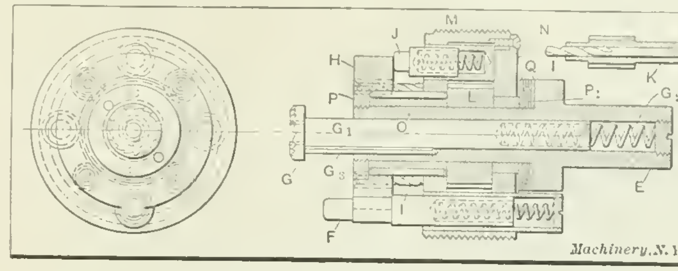


Fig. 2. End and Sectional Views of the Four-hole Turret Drill-holder, showing its Construction

less it was to make the customer think that he was getting something good for his money.

In conclusion the writer would state that he has found by long practical experience that the best way to manufacture is the simplest way no matter how much accuracy is required. This principle also applies to parts which are made by the use of dies in power or foot presses. Some manufacturers make a sub-press die for some insignificant piece, which could be made in an ordinary open die at perhaps one-tenth of the cost, considering the output. CHARLES WESLOW

Buffalo, N. Y.

SPACING THE CUTTING EDGES OF REAMERS

In the November number of MACHINERY appeared an article by "H. M.," on spacing the cutting edges of reamers to prevent them from chattering, in which he suggests that reamers with 5, 7, 9 and 11 teeth give the best results, but he does not offer any reason why this should be the case. Without taking up the cause of reamers chattering, let us consider the effect of chattering in use. When a reamer with cutting edges spaced the same distance apart chatters, it forms "hills and valleys" the same distance apart. It can therefore easily be seen that the cutting edges, being the same distance apart as these "hills and valleys," will follow in the same chatter marks. Now on the other hand, if the reamer has an odd number of teeth, or an even number of teeth unevenly spaced, there is less chance that it will chatter. In the latter case

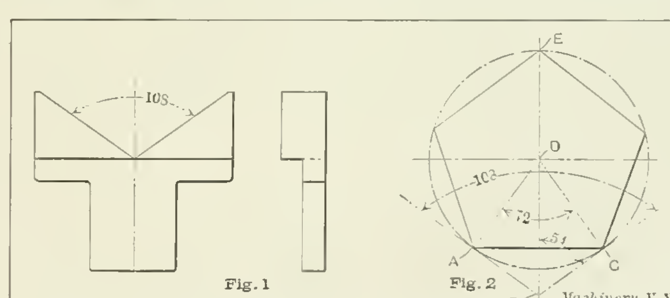


Fig. 1. Gage used in Measuring Reamers having Five Cutting Edges

Fig. 2. Method of Deriving Constant for Finding the Diameter of the Reamer

this is especially true because each tooth will only come in line with the previous mark when the reamer is in one position.

The best use which the writer has found for the reamers with odd number of teeth, is in reaming a split box or a hole which has grooves running its entire length. Reamers having five cutting edges have been used satisfactorily for this work.

In regard to the measuring of reamers having an odd number of cutting edges, the easiest and cheapest way to measure them, is to use a segment of a ring which has been bored out to the finished size of the reamer, and then measure from

the outside of the segment over the opposite teeth; deducting the thickness of the segment, will, of course, give the size of the reamer. If more than one size of reamer is to be made, a V-gage, shown in Fig. 1, can be made which will facilitate the measuring of reamers having an odd number of flutes. In using this gage for reamers having five flutes, the size of the reamer equals the micrometer reading divided by 1.118.

The method of obtaining this rule is as follows: Assume that the radius of a circle is 1 inch. Then for a reamer having five flutes, as shown in Fig 2, the distance D-B equals the radius, or the distance D-C, divided by the sine of 54 degrees, or $\frac{1}{0.80902} = 1.236$. Then the distance E-B, or the micrometer reading $= 1 + 1.236 = 2.236$. Now for a circle 1 inch in diameter, the distance E-$B = \frac{2.236}{2} = 1.118$, which is the constant required.

Other gages could be made for reamers having an odd number of flutes, and the same method used for finding the constant, which would simplify the problem of obtaining the diameter. W. S. P.

CAM MILLING FIXTURE

The accompanying line drawings show the main parts of a motor cycle engine cam milling fixture. The cam to be machined is shown at the bottom of Fig. 2, and is a combination drop-forged gear and cam.

A base A and stand B, Fig. 1, are bolted to the milling machine table which remains stationary throughout the operations. On the base A there is a sliding housing C through which pass an arbor D and a shaft E. In this housing there is a gear F meshing with a corresponding pinion G on the lower shaft E with a ratio of two to one. Pinned to the large gear F is a master cam H on the arbor. On each end of this arbor D there are reduced sections over which the work (which is shown in broken lines and also in Fig. 2), is slipped and secured in place by tightening up the end nuts. On this arbor there are also steel templets I in alignment with the master cam so that the rough cam and gear when placed on the arbor may be readily trued up, adjusting so that the same amount of stock may be removed on all sides.

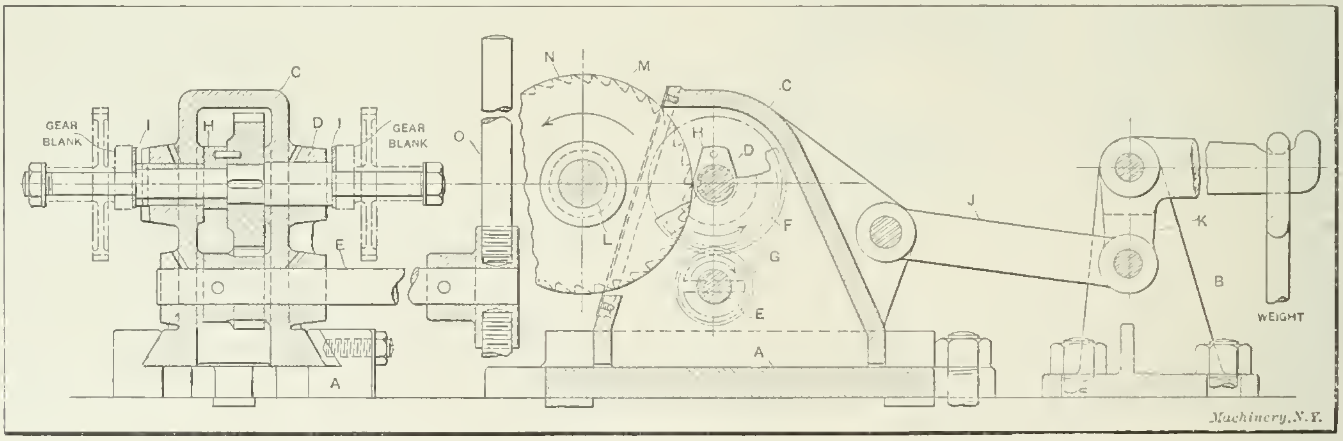


Fig. 1. Cam Milling Fixture ready for Operation, with the Master Roller in contact with the Master Cam

On the back of the housing C are ribs to which the link J is attached, the other end of the link being attached to the lower arm of a bell-crank K, this latter being pivoted on the stationary stand C, before mentioned. The outstanding arm of the bell-crank is notched to receive a weight. This weight acting through the bell-crank tends to keep the housing C to its extreme left position.

The milling machine arbor L has on it two milling cutters M and a master roller N placed opposite, respectively, to the rough cam blanks and the master cam. This milling arbor with its master roller and cutters is shown more in detail in Fig. 2. The previously mentioned weight on the end of the bell-crank keeps the master cam up against the master roller, thereby giving the correct contour to the cams being machined. The cam blanks are fed up against the cutters by revolving shaft E through wheel O, two revolutions of this being necessary for a complete revolution of the cam blank.

It will be noticed that the cutters and master roller must of necessity be of the same diameter. Another point to be

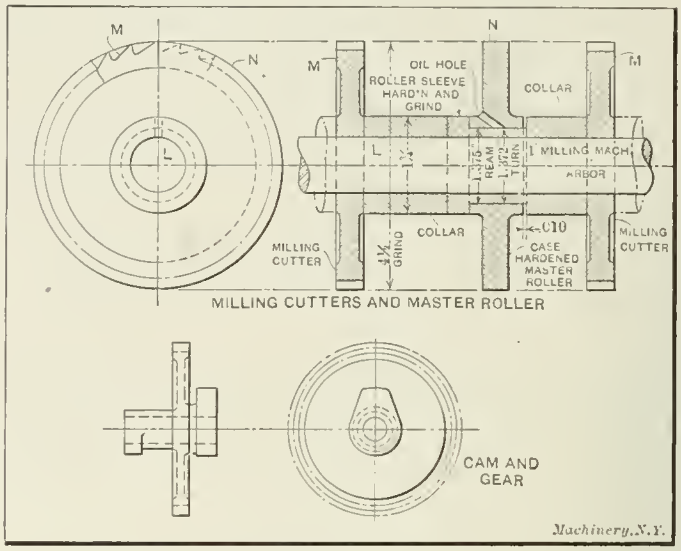


Fig. 2. Details of the Cam to be milled, and Arrangement of Cutters and Master Roller

noted is the fact that nothing is required to hold the cam blank in position against the templet I other than the friction between these two; this has proved to be quite sufficient from long service. V.

ALTERATION OF PATTERNS

The article in the December issue of MACHINERY by C. S. Bourne in regard to "Alteration of Patterns" is a step in the right direction. In many shops where a change is made during the erection of a machine, no record is made, and this leads to trouble in later machines. Sometimes the foreman will tell the patternmaker to make a certain change to a pattern, but the drawing-room is not notified. When at some future time the part is needed for repairs, the pattern is not like the drawing and the question is raised as to which is correct.

In one shop where the writer was employed, all changes were reported to the drawing-room and, if important, were made on the tracings and blueprints at once. If not important, or on a large piece, a record only was made on a card, for future reference. In case an order came in for a duplicate machine, the order first went to the drawing-room, and the card of that particular machine at once gave all particulars regarding changes.

This system worked satisfactorily to all concerned, as it tended to keep the record correct and relieved the shop of the responsibility. This was soon appreciated as it saved many a "call-down" for not sending a repair part the same as that shipped with the machine. BENJ. WORTH

MOUNTING BLUEPRINTS

The same trouble as that referred to by J. B. & Co., in the How and Why department of MACHINERY for December, has been experienced by the writer in mounting blueprints. Good results, however, have been obtained by using tin, galvanized iron or strawboard sheets. These sheets should be about one inch larger each way than the print, thus allowing a margin of half an inch. After applying common library paste to the tin or sheet, making certain that the paste is not lumpy, lay the blueprint in water and hang up to partially dry. When about as dry as a sponge that has had the water squeezed out of it, lay it on the metal and carefully smooth out the wrinkles by hand and then set aside to dry. The print will shrink slightly in drying, and will therefore be very smooth. Finally give one coat of white shellac, and in a few minutes it is ready for use.

This method of mounting was accidentally discovered one day when the writer did not have the time to thoroughly dry the blueprint before mounting. Previously considerable trouble had been experienced through wrinkled prints, but this method has entirely overcome that difficulty. E. H. R.

In the December number of MACHINERY, J. B. & Co. ask a question regarding the mounting of blueprints for shop use. Common strawboard is a good and cheap material for mounting prints. For prints 14 x 20 inches or smaller, use No. 20 (20 sheets 26 x 38 inches to the bundle), which is a scant 1/8 inch thick. Trim the print 1/2 inch larger all around than the cardboard, notch the corners of the print, and fold over and paste the 1/2 inch edges on the back of the card. Use stiff library paste rubbed onto the edges of the card with a flat stick or with the finger, and work the print down tight to the card with a putty knife having a smooth rounded edge. The stiff paste sets quickly, and holds the edges of the print, and there is no moisture to stretch the face of the print out of shape. This leaves the print held to the cardboard by the back edges only, the face or printed side simply lying close to the card. Prints so mounted answer all requirements for shop use. They are easy to mount, light to handle, stack nicely in racks, and look neat. When they get dirty or torn, run a knife under the face side, cut the print off, and paste on a new one. Do not shellac prints; they are not worth it. Do not make changes on prints unless for a hurry job, when there is not time to change the tracing and make a new print.

Niles, Cal. F. A. DEW

In the December number of MACHINERY, J. B. & Co. ask for a simple and efficient method of mounting blueprints. In reply to this the writer would say that he has found nothing more satisfactory for backing, than strawboard, or better still, pressboard which has a harder and smoother surface, to which the blueprint will more readily cling. This has a decided advantage over a metal backing where the prints are kept flat, one lying on top of the other, as there are no sharp corners or edges to mar the surface of the prints, when one is being withdrawn from the pile. Both sides of the pressboard may be used for mounting.

Another very convenient and successful method is to mount prints on ten- or twelve-ounce ducking. This is accomplished by first preparing the ducking by giving it a coat of glue sizing, such as is ordinarily used by paper hangers, and then allowing it to dry. The print is then mounted on this ducking, by using a good flour paste, or still better, prepared library cream paste. After the paste has been thoroughly dried the surface of the print may then be coated with white shellac. This has one advantage over pressboard, in that it will either lie flat or may be rolled without injury, for carrying or storing.

Changes on a shellaced blueprint may readily be made by rubbing the portions to be changed with a fine sandpaper, thus making a dull spot, which will readily take drafting ink. After the changes have been made, the print can again be coated with shellac.

A simpler and quicker method than that given above, is to make the prints directly on heavy blueprint cloth, which may be obtained from any manufacturers of blueprint paper. Prints made on this, after receiving two or three coats of shellac are quite stiff and serve very nicely as shop prints, especially where a board is provided to which they may be hung for display. P. F. LUETH

Everett, Wash.

MACHINING SPUR GEAR BLANKS

The plan followed by the Acme Machine Tool Co., Cincinnati, in turning change gear blanks, is to first bore and face one side of the blank in a screw machine, after which the blanks are held on the expanding stub mandrel shown in

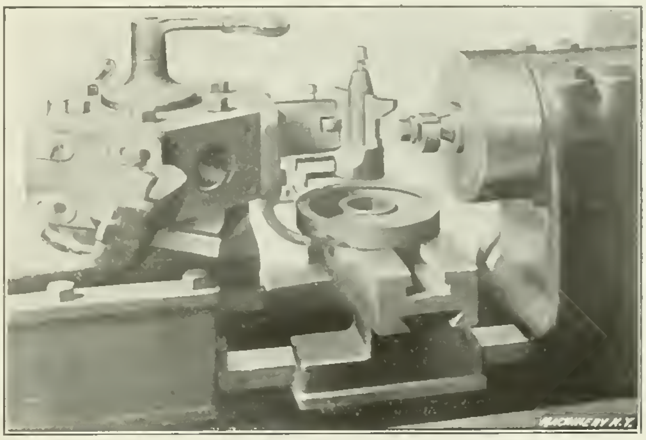


Fig. 1. View showing the Stub Mandrel used in holding the Gear Blanks for the Second Operation

Fig. 1. When held on this stub mandrel, a roughing and finish cut is taken from the other side with the two turning tools on the cross-slide shown in Fig. 2. The periphery of

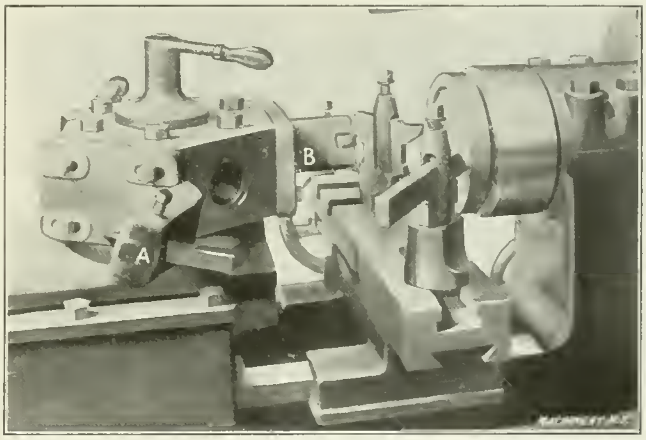


Fig. 2. View showing the Tools used in Finishing the Gear Blanks

the blanks is also roughed and finished in this operation to the exact diameter by the two turret tools, *A* and *B*. For turning the periphery it is only necessary to draw the cross-slide tools back a little further than the cutting position in order to let the turret tools pass. E. V.

THE CARE OF OIL DRIP CUPS

A correspondent in the January number of MACHINERY calls attention to the fact that oil drip cups work loose, due to vibration, and offers a suggestion for holding the drip cups in place so as to prevent the cup from falling to the floor.

The best method in the writer's mind is to have the thread on the bolt of the hanger a tight fit in the tapped hole in the hub of the drip cup, and then to screw the cup up "good and tight," and *let it stay there*. When the drip cup requires to be emptied, a large-sized hand-pump is used. One pull of the plunger empties the cup, and one push empties the contents of the pump into a pail. By this method all chances of getting a free oil bath, or of the cup dropping, are eliminated. It may not be amiss to say that the best time for emptying drip cups is during the noon hour, or at some other time when the work is discontinued, so that the man doing this work will not get in the way of the machine operators, and time will not be wasted by stopping the machine in order to facilitate the task.

Waterbury Mass. CHARLES DOESCHER

BORING-DIMENSIONS FOR LARGE THREADED HOLES

If a machinist has a piece to bore and thread, he often has difficulty in obtaining the allowance to leave for the threads, in boring the hole. To get accurate results, he would, of course, have to consult a table, which may not be within convenient reach, in which case he may have to refer the matter to the drafting-room.

In a certain shop the writer noticed that one particular man was often applied to for information of this kind. He would quickly give the correct amount to allow for the thread, without hesitation and without consulting any tables or handbooks. It did not seem clear what method he used, but, in fact, his method was so simple that it is a wonder that it is not more generally applied. He carried in his head the amount that would have to be allowed for a thread of 1-inch pitch, and he divided this figure by the number of threads per inch in each particular case. In a case, for example, where 10 threads per inch, 4-inch diameter, were to be cut, the amount to be allowed would be $\frac{1.299}{10} = 0.130$ inch, and the hole would be bored to $4 - 0.130 = 3.870$ inches diameter. The advantage of the method is that only one figure need be carried in the head. It is easily remembered, and there is no need to look up tables which are generally out of the way when required. The constant 1.299 used above is the double depth, in inches, of a United States standard thread of 1 pitch. In fact, the man who was using this method had not the slightest idea of what the figure 1.299 represented, but he knew that by dividing it by the number of threads per inch, he obtained the required result. The constants for the other standard forms of thread are as follows:

Whitworth	1.2806
Sharp V	1.732
French and International standard	1.299
Acme	1.000

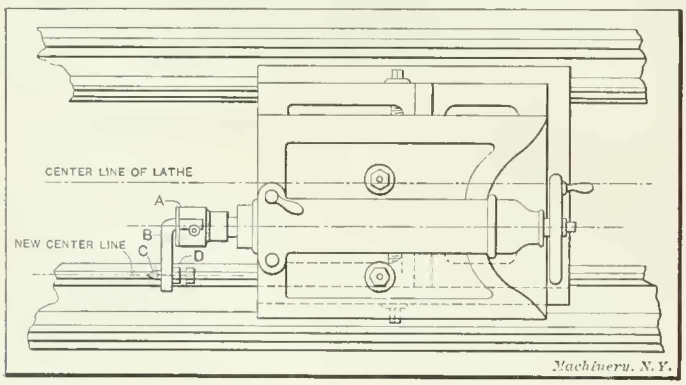
With the French standard the constant is multiplied by the pitch in millimeters and the result obtained will then be expressed in millimeters. If required in the English measure, divide the result obtained by 25.4.

Coventry, England T. BARTON

A DIFFICULT TAPER-TURNING JOB

The writer at one time had occasion to turn up two cast-iron cones for a variable-speed friction drive, and not having a lathe with a taper-turning attachment, nor being able to set the tailstock over far enough to obtain the desired taper, he adopted the following scheme.

A drill chuck, *A*, was inserted, as shown, in the tailstock spindle of the lathe, and clamped in the chuck was a bar bent at right angles and forged round on the shank, so that it could



Method of Turning Tapered Cones for Variable-speed Friction Drive

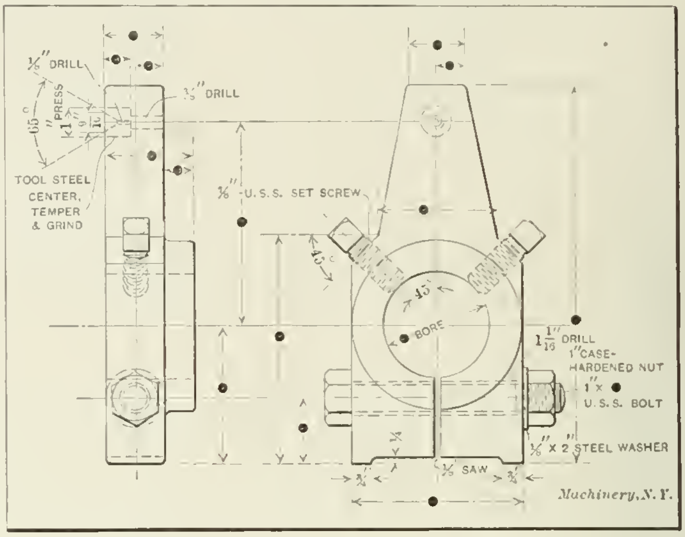
be held securely. A cone-pointed screw, *C*, was screwed into the projecting leg and was checked by a nut, *D*. The point of this screw was casehardened and was set off from the center of the lathe a distance sufficient to give the desired taper.

To prevent the bar *B* from turning in the chuck a block, not shown in the illustration, was placed under it and on top of the ways of the lathe, and a C-clamp used to hold the bar *B* down on this block.

Dallas, Texas. SIDNEY HETHERINGTON

TIME-SAVING METHOD FOR DUPLICATING WORK

At the present time there is a tendency in manufacturing to standardize drawings. The illustration shows a drawing of a center for turning crankshafts of large sizes. The design is not a new one, as I have seen it in several different factories, but it illustrates a convenient time-saving method for duplicating work of this or various kinds. It saves a great deal



A Convenient Time-saving Form of Drawing for Duplicating Work

of time where many drawings of articles of practically the same design are needed, but with different dimensions. This idea involves only the time for making one drawing and tracing, and several blueprints may be printed from it, and the required dimensions inked in, in the blank spaces shown. Blank spaces at the lower right-hand corner should also be provided for a change of title. JIG AND TOOL DESIGNER

CARE OF LATHE CHUCKS

In the December number of MACHINERY John Homewood draws attention to the fact that three-jawed universal chucks are abused and sprung out of true, by putting a pipe on the chuck wrench, when tightening the jaws on the work.

Inasmuch as there are other abuses that this handy and useful tool is often put to, it seems that mention of them should be made through the columns of MACHINERY, together with a few suggestions regarding the elimination of the troubles. While lathe chuck abuses are usually due to carelessness on the one hand, they are more often the direct result of employing cheap and inexperienced help.

The most common abuse to which a lathe chuck is put, is that of screwing it up against the shoulder of the lathe spindle with a bang, and then because it won't come off readily, a long bar of steel or iron is placed between the jaws to loosen it, thereby springing the jaws and injuring the scroll. All chucks should be screwed lightly up against the lathe spindle. In order to remove them without springing the jaws, a hole should be drilled in the neck of the chuck faceplate, so that the chuck can be loosened by a spanner wrench.

Forcing the chuck on the spindle regardless of chips or grit that may be in the threads, is another abuse that does not tend toward the welfare of the chuck or lathe spindle. Chucking rough bar stock that is considerably out of round, forgings, castings, etc., in a four-jawed universal chuck is another common abuse that should not be tolerated, for the reason that the jaws and scroll are either sprung or bruised. Using a piece of sheet steel or brass under one or two jaws, in order to make an eccentric pin or punch from a piece of stub wire, is still another abuse that does harm to the chuck. Cutting off work with a parting tool that is set under the center, often causes the work to spring up and ride on the tool, when it is almost cut off, particularly when the spindle is a trifle loose. This also causes the chuck to spring out of true. Lathe chucks should be taken apart when necessary and thoroughly cleaned and oiled, in order to prolong their life.

Waterbury, Conn. CHARLES DOESCHER

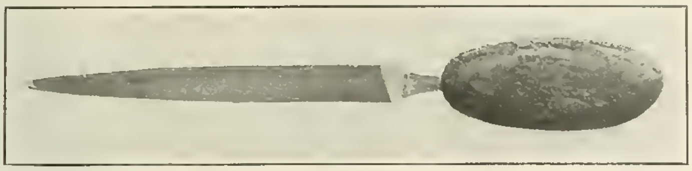
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A HANDLE FOR SMALL FILES

The accompanying illustration shows a very convenient handle for use on small files. It is made from two pieces of stiff leather, ⅛ or 3/16 inch thick, which are held together by small



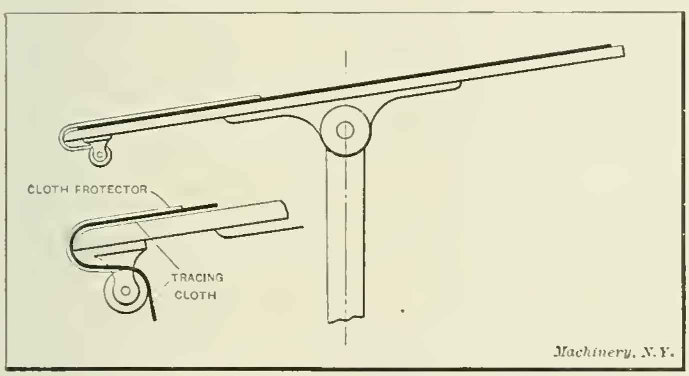
brass nails or screws. The corners of the handle are rounded off, making it convenient to hold in the hand. The tail of the file is slipped in between the two pieces of leather, thus holding it effectively.

East Syracuse, N. Y. C. W. Shelly

PROTECTING TRACINGS AND DRAWINGS

A very convenient means of protecting a drawing or tracing from being soiled by constant leaning on it is shown in the accompanying illustration.

It is in every way superior to using various pieces of paper, as is usually done. As shown, this device consists simply of an ordinary spring-roller curtain fastened underneath the

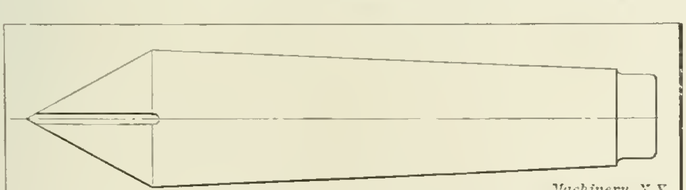


drawing-board, in such a manner as to permit the tracing to hang over it when occasion demands. The curtain material can be of curtain linen, paper or tracing cloth; the latter is preferable, however, owing to its transparency, and also to the fact that it can be easily cleaned when soiled.

Winamac

PREVENTING DEAD CENTERS FROM BURNING

The accompanying illustration shows a method of preventing dead centers from burning when turning fast revolving stock or where excessive pressure is applied, as, for instance, in taking a heavy cut on large stock. The center shown has a groove ⅛ inch wide by ⅛ inch deep cut to the extreme point and the sharp corner filed off, so that it will not ream out the center in the work. It is obvious that as the work revolves



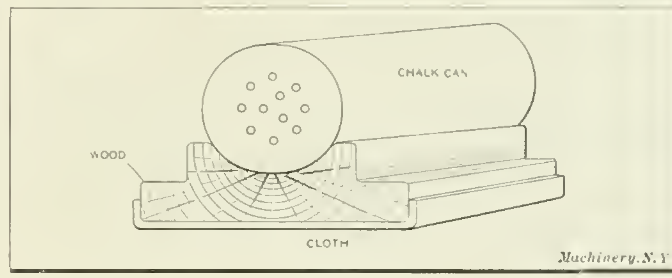
the turning tool has a tendency to raise it so that it pulls up against the bottom of the center, thus preventing the dead center from reaming the center in the work. For small work it is sometimes advisable to reduce the depth and width of the slot, depending on the diameter of the work. A good lubricant is prepared by mixing together, in equal proportions, beef tallow and graphite. This should be well mixed, and if applied in the groove of the dead center will prevent it from burning.

L. J. Getz

Salem, Ohio.

A CHALK PAD FOR DRAFTSMEN

As I found it inconvenient to use a chalk can and rag for chalking tracings, I made a little device which is neat in appearance, and inexpensive for any draftsman to make. It consists of a wooden block shaped as shown in the accompanying illustration to hold a chalk can, and has a piece of cloth glued



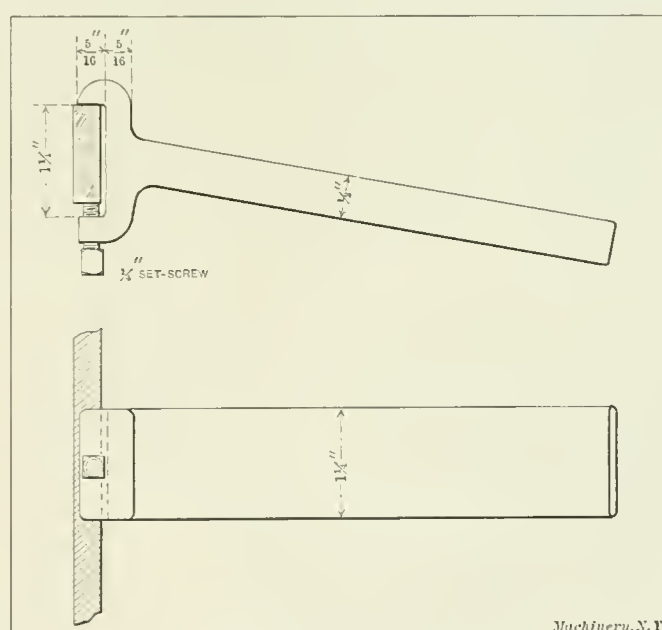
to it, similar to that used on pool and billiard tables. This makes a very convenient chalking device.

Toledo, Ohio. George J. Ney

A TOOL FOR FACING CAST GEARS

More or less trouble is experienced in facing off the sides of cast gears with ordinary turning tools, because of the chatter as the tool jumps from one tooth to the next. The tool shown in the accompanying illustration, however, was designed especially to overcome this tendency, and has been found to give satisfaction.

The tool consists of two parts, a piece of broken file about 3 inches long and a wrought-iron or steel holder made to fit



in the regular toolpost of the lathe. The holder is made in such a way as to hold the piece of file vertically against the side of the gear as it revolves on the lathe centers, thus grinding or filing off to the proper finish. The broad bearing surface presented to the work effectually prevents all jumping and chattering.

C. A. Allen

Linwood, Mass.

* * *

By using tantalum lamps for car lighting the Chicago Railway Co., it is stated, finds that it can save about $18 a year per car. A thousand cars have been equipped with these lamps already, and when all the cars of the company are equipped this way, a saving of $35,000 a year will be accomplished.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address The latter are for our own convenience and will not be published.

UNUSUAL FORMS OF GEARING

J. W. M.—What is the practical value to the engineer of the logarithmic sector gear; the lobed wheels formed from logarithmic spirals and ellipses; and the skew gear formed by rolling hyperboloids of revolution? Where are these gears used and how are they manufactured?

A.—The question is submitted to the readers.

TINNING CAST-IRON CROSSHEAD SLIPPERS

M. H. W.—Can any of the readers give a good method of tinning cast-iron crosshead slippers, so that the babbitt will hold while being planed? I do not mean a slow process by which a man spends considerable time on one, over a small fire; but some quick method of tinning a number at once. A good proportion of these slippers are old ones in the repair shop for rebabbiting, and are greasy.

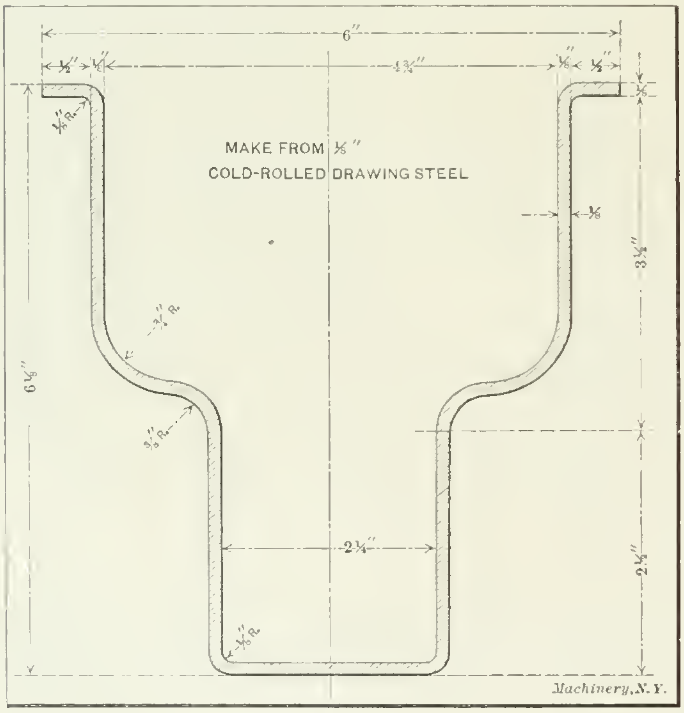
RESTORING OVER-EXPOSED BLUEPRINTS

Draftsman.—How can over-exposed blueprints be saved? I understand that by the use of certain chemicals a blueprint, totally spoiled by being over-exposed, can be restored.

A.—An over-exposed blueprint can be restored to an acceptable tone by a bath consisting of a teaspoonful of crystals of potassium bichromate in one-half gallon of water. The blueprint is first washed in the usual manner, and then immersed for half a minute—or less—in the bichromate solution. After having been treated, it is washed in clear water and hung up to dry.

DRAWING A COLD-ROLLED STEEL SHELL

C. H. R.—I would like to ask the readers of MACHINERY how they would draw up a steel shell like the sketch; how many operations would be required; what are the sizes of the



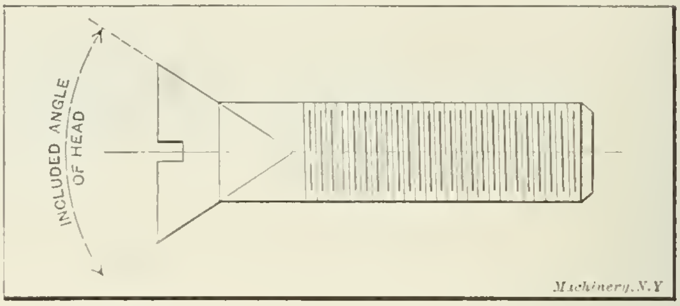
Steel Shell to be drawn

dies and how should the work proceed? The writer has estimated that twelve operations would be required. These include turning at right angles and the trimming of the flange after drawing. Of course the walls of the 2 1/4 inch diameter part will be drawn slightly thinner than 1/8 inch, but this is permissible.

FLAT-HEAD CAP AND MACHINE SCREWS

C. A.—Is there any accepted standard for the included angle of the heads of flat head cap screws? What is the difference, if any, between a flat head machine screw and a flat head cap screw?

A.—As regards general appearance, there is no difference between the flat head machine screw and the flat head cap screw. They both have the appearance indicated in the accompanying engraving. There is, however, a distinction made between these two classes of screws in the screw manufacturing field. The cap screws are made in sizes varying by 1/16 inch, up to 1 or 1 1/4 inch diameter, while the flat head machine screws are made to the regular standard machine screw dimensions. The American Society of Mechanical Engineers has recommended an included angle of 82 degrees for the head of flat head machine screws. For flat head cap screws,



General Appearance of Flat-head Cap, and Machine Screws

no standard has ever been officially recommended or recognized, but 70 degrees included angle has been assumed by many manufacturers as being a standard established by usage. A great deal of confusion, however, seems to exist in regard to the angle for both cap and machine screws. In order to place on record the present conditions in this respect, information has been gathered from a number of screw manufacturers; it will be seen that there is as yet no thoroughly accepted standard either as regards machine or cap screws.

The Atlas Bolt & Screw Co., Cleveland, Ohio, states that there is little call for flat head cap screws or machine screws made with the 82-degree (the A. S. M. E. standard) angle. The standard used by this company is about 84 degrees included angle for both cap screws and machine screws.

The Chicago Nut Co., Chicago, Ill., in making machine screws, has adhered to the 82-degree angle recommended by the A. S. M. E. ever since the society's report was issued.

The Cleveland Automatic Machine Co., Cleveland, Ohio, states that in filling orders for tools for cap screws and machine screws it has been found that the angle called for is usually the 82-degree or the A. S. M. E. standard angle.

The Columbia Screw Co., Pullman, Ill., has made screws with the 82-degree included angle for the last twenty years, and does not make use of any other angle.

The Critchley Machine Screw Co., Worcester, Mass., makes the included angle of flat head cap screws about 80 degrees.

The Hartford Machine Screw Co., Hartford, Conn., makes the included angle of flat head cap screws 70 degrees, and considers this to be the standard angle.

The National-Acme Mfg. Co., Cleveland, Ohio, has for some time past made all regular flat head cap screws with an 82-degree included angle.

The National Sewing Machine Co., Belvidere, Ill., has always used a 76-degree included angle for flat head cap screws. This company has had but one call for screws with an 82-degree angle in the last year.

The Philadelphia Machine Screw Works, Philadelphia, Pa., uses the 82-degree A. S. M. E. standard angle only when requested by customers; otherwise cap screws are made with a 90 degree included angle.

The Reading Screw Co., Norristown, Pa., uses the 82-degree angle for all flat head countersunk machine screws.

The Reed & Curtis Machine Screw Co., Worcester, Mass., does not make screws to any extent according to the A. S. M. E. standard angle, nor does this company make regular machine screws. For cap screws a 70-degree included angle is used.

The Screw Machine Products Corporation, Providence, R. I., states that there is but little demand for screws with the 82-degree angle, and that, in fact, but one order has been made to specifications calling for this angle.

The Worcester Machine Screw Co., Worcester, Mass., uses a 76-degree angle for flat head screws. The call for screws with the A. S. M. E. standard angle has been very limited.

As will be seen from the foregoing it is hardly correct as yet to speak of an angle as being standard, as different screw manufacturers use different angles. There seems to be a tendency, however, to adopt the 82-degree angle for flat head machine screws, but not for the flat head cap screws.

"INS AND OUTS OF GEAR HOBBING"—A COMMENT

By PERCY C. DAY*

Gear-men are indebted to Mr. Flanders for so much useful and impartial information on their pet subject, that they will be inclined to forgive him for his latest contribution. But those who are interested in the hobbing process can hardly be expected to let it go at that. Those who read Mr. Flanders' article in the January number of MACHINERY (engineering edition) entitled "Ins and Outs of Gear Hobbing," might reasonably expect to find some illuminating truths about a much abused process. What they will find is a record of some experiments which have been carried out under peculiarly unfavorable conditions.

In the first place, the blank appears to have been chosen for a gear of 21 teeth with standard addendum and 14½-degrees pressure angle. So much information has emanated from Springfield, Vt., in regard to the greater suitability of stub-teeth and high-pressure angles for all generated gears, that it is hard to understand why an expert from that neighborhood should have chosen to conduct his experiments on other lines. It should further be noted that Mr. Flanders, in a paper which he read before the American Society of Mechanical Engineers in December, 1908, (see MACHINERY, January, 1909, engineering edition) clearly demonstrated that the smallest number of teeth in an interchangeable series of standard form is 32. In spite of this he chooses for his test an uncorrected hob for a standard gear of 21 teeth.

The experiments are described as having been carried out on a hobbing machine of the highest grade, with a hob which represented the best of American practice. The adjustment of the machine was, however, admittedly slack at all points. This alone is sufficient to account for the results obtained. How an investigation of this character could be undertaken, and such an important detail as the adjustment of the machine overlooked, is difficult of explanation.

The results obtained on a loosely-adjusted hobbing machine are compared with the work done on a Fellows gear shaper under similar conditions, to the detriment of the former. This kind of comparison can only be misleading, because, when once a machine is out of adjustment, the quality of the work turned out is merely a question of how much slackness exists between the various parts. Nothing is said with regard to the hobbing machine when properly adjusted; in fact, the machine used for the experiments appears to have remained out of adjustment during the whole investigation.

Frankly speaking, the writer is interested in the hobbing process, particularly in reference to helical gearing. In several years' experience of gear hobbing on a large scale he has never seen teeth which bore the faintest resemblance to the corrugated outlines exhibited in Figs. 4 and 5, of the article referred to.

Regarding the effect of centering the hob teeth, there is much useful information to be gathered from the article, particularly if reference is made to the article on a similar subject previously referred to. The practical experiments are, however, quite inconclusive, and the results obtained appear to have been of an arbitrary nature, due to the want of adjustment in the machine used. The suggestion that the discrepancies may be due to inaccuracies in the hob itself, produced by distortion in hardening, while quite in accordance with general experience, cannot very well be proved in this particular case. Every gear cutting process, whether generating or otherwise, has its own peculiar disadvantages, but the hobbing process is not any more handicapped than others in this respect. Mr. Flanders points out as faults in principle some details which are really only faults of design.

The reason why imported hobs are reputed to be superior to the domestic article is probably to be found in the fact that foreign hob makers have equipment suitable for accurately gashing, relieving and grinding their hobs. Straight-fluted hobs are rarely used abroad, and the teeth are almost invariably gashed and relieved on lathes specially designed for the purpose. The writer does not know of a single American firm who manufactures a complete relieving lathe, although one or two supply relieving attachments for ordinary tool lathes. Those who require to manufacture accurate hobs are obliged to import the necessary equipment from Germany. This little fact alone is sufficient to account for a good deal of the hobbing troubles which seem to be experienced here.

There does not seem to be any reason why the hobbing machine should be at a serious disadvantage as compared with other generating machines. Is it not true that all generating machines require the preservation of a definite relationship between the motion of the cutter and of the blank to be cut? In the hobbing machine, when used for cutting a straight spur gear, there is undoubtedly some restriction in the size of the gears, shafts and bearings which can be used to transmit motion to the hob on its turntable. As a set-off against this, the motions in the hobbing machine are all continuous rotations in one direction; there is no reversing of rams or intermittent division of the blanks.

The amount of overhang of the hob arbor from the face of the vertical slide is a matter of design only. It is true that machines are built with excessive overhang, resulting in loss of rigidity, which produces poor work; but if the makers of hobbing machines would cease to try to cut small pinions on machines designed for work of a large diameter, this trouble would disappear. Hobbing is the only strictly generating process which is adaptable for large work. With all reciprocating systems, the difficulties encountered when starting and stopping heavy blanks and work tables, between strokes of a reciprocating tool, limit the range of successful application. It is probably for this reason that gear wheels of more than four feet in diameter are rarely generated on any but hobbing machines.

A large hobbing machine offers fewer difficulties to the designer than a small one. The shafts, gears and bearings become less restricted in proportion to the rest of the machine, and accurate work can be turned out without difficulty. It would therefore appear that the future of the hobbing machine lies rather with heavy than with light work. When used for the production of helical gears of constant spiral angle, the hobbing process offers peculiar advantages over all others. Helical gears are being regularly hobbed in England up to 14 feet in diameter, 40-inch face and 4½-inch pitch. Is there any other generating process which could successfully tackle work of these dimensions?

* * *

ANNUAL MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The annual meeting of the Society of Automobile Engineers was held in the Assembly Hall of the Automobile Club of America, New York City, January 11 and 12. More than 300 members from all parts of the country attended the meeting The total number of members of the society at the time of the meeting was about 600. The chief work of the society is the standardization of the technical and constructive work pertaining to the domestic motor car field. Papers were read at the meeting by Joseph Schaeffers, "Electro Steel"; by E. K. Rowland, "Leaf Springs"; by E. P. Batzell, "Novelties in Valve Systems"; by H. N. Anderson, "Hot Rolled Gears"; by F. H. Floyd, "Commercial Gasoline and the Impurities that are Being Encountered"; by G. N. Jeppson, "Development of the Grinding Wheel"; by John C. Spence, "Methods of Grinding"; by Charles E. Duryea, "'Frictionless' Friction Drive"; by N. B. Pope, "The Fire Protection Question"; by C. S. Ricker, "Automobile Contest Timing and Coaching"; by E. A. Myers, "Advantages of Long-Stroke Motors"; by A. J. Slade, "Foolproofing the Commercial Car Mechanism and Its Control"; by R. C. Lanphier, "The Ampere-hour Meter for Electric Vehicles." The paper by L. R. Evans and R. P. Lay on "The Test of a 20-horsepower Franklin Air-cooled Motor, which was postponed from the last meeting of the society, was also concluded. On Wednesday, January 11, the society had its annual dinner, followed by an entertainment arranged by the local committee.

* Address: 53 32d St., Milwaukee, Wis.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

CINCINNATI BORING MILLS

The Cincinnati Planer Co., of Cincinnati, Ohio, is now manufacturing the boring mill illustrated in Fig. 1. This machine has a normal capacity of 10 feet which can be increased to approximately 16 feet, by shifting the housings along the extension base. This design is also built without the extension base in the 10-foot size. The capacity of both machines for height is 5 feet 6 inches.

The drive is either by belt to a single constant-speed pulley at the rear, or a motor may be employed, as shown in Fig. 2. Power is transmitted to the table through a speed box, which connects with a horizontal shaft transmitting the motion through bevel gears to a driving pinion, the latter meshing with an internal gear on the table. Fig. 4 shows a view of the base with the table removed, while Fig. 5 shows the under side of the table and its large internal gear. This gear is located near the periphery, so that a good driving torque is obtained, which is necessary when turning large diameters. By the use of an internal gear drive, a comparatively large tooth contact between the driving and driven gears is obtained, which gives a smooth and steady motion. With the internal drive, the gears are also protected from dirt and chips by the table. The speed box is mounted between the housings, as shown in Fig. 2, the machine being entirely self-contained, and a minimum of floor space being required. When a constant-speed motor is used, the speed box is arranged so that nine speed changes are obtained, giving the table a ratio of 1 to 36. When driving with a 2 to 1 variable speed motor, a ratio of 1 to 18 is obtained which is doubled by the speed variations of the motor. The levers, by means of which the speed changes are effected, are provided with an interlocking device so that no two speeds can be engaged at one time. A speed plate is mounted near these handles showing the revolutions of the table, and also the surface speed for a given diameter. When a motor drive is employed, a twenty horsepower motor is required.

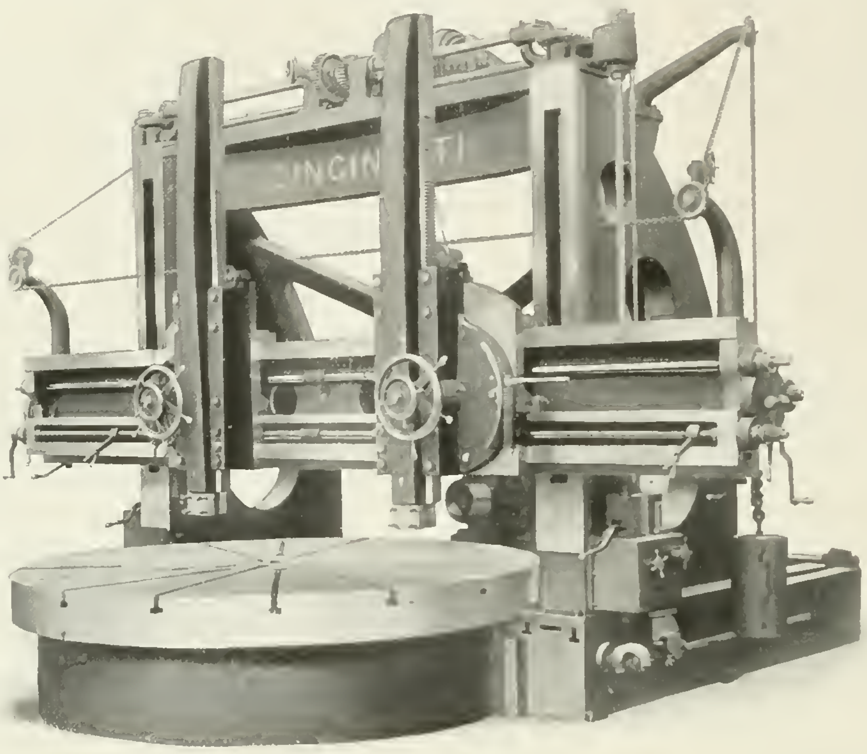


Fig. 1. Cincinnati 10- and 16-foot Extension Boring Mill

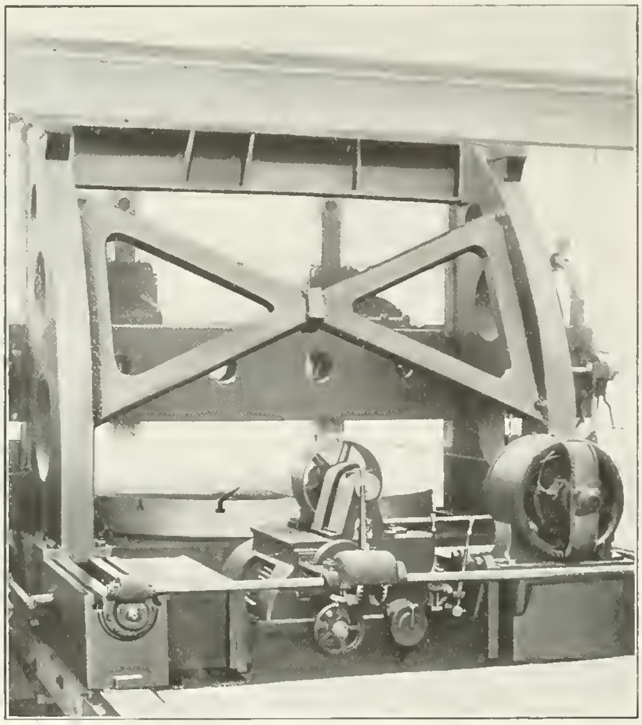


Fig. 2. Rear View showing Drive and Speed Box

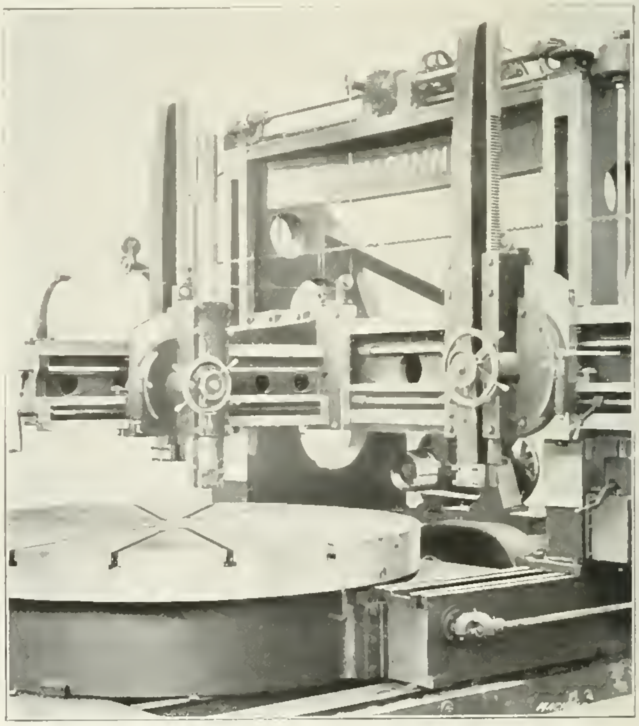


Fig. 3. Extension Arm used when the Housings are moved back

The feed changes on this machine are obtained through

feed boxes, located on the sides of the housings. A separate feed box is attached to each housing near the base, as shown in Fig. 1, thus giving an independent feed for each head in all directions. Power for feeding is taken from the vertical driving pinion shaft which is connected to an intermediate shaft through spur gears, as shown in Fig. 4. This intermediate shaft drives, through spiral gears, a horizontal shaft that extends across the bed and transmits the movement

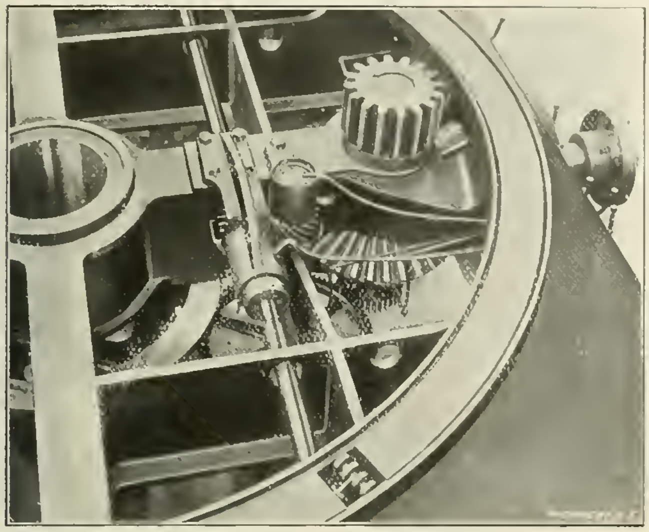


Fig. 4. Drive for Table and Feed Boxes

through bevel gears, to shafts A, Fig. 8, mounted at the sides of the base. Shafts A, in turn, connect with the feed boxes through bevel gears, as the illustration shows. These feed boxes are so located on the housings that the feed-controlling levers are convenient to the operator. Eight different feeds are available, ranging from 1/32 inch to 1 inch per revolution, and the changes are effected by the small pilot wheels or handles B and C. By means of handle B which operates a tumbler gear, four changes are obtained, and this number is doubled

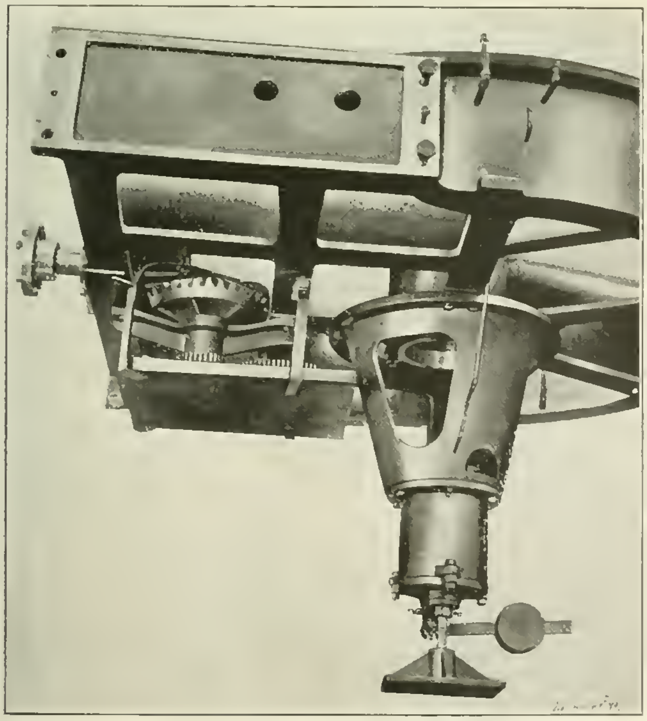


Fig. 6. View showing Cone Brace, Adjustable Bushing for Main Spindle Bearing, and Automatic Adjustable Step Bearing

by handle C which engages a clutch connecting the high or low speeds. A rapid power traverse is provided for moving the heads in any direction to eliminate any unnecessary work in the operation of the machine. These movements may be controlled from the cross-rail or feed boxes, there being four handles for this purpose. Two of these handles are seen projecting from beneath the cross-rail near the ends, and the other two are mounted on the feed boxes. These handles engage or disengage both the power traverse and feed, the operator using the one that is most convenient.

The bed of this machine is of box form throughout, and it has a depth of 21 inches. All parts are thoroughly ribbed and braced, and as the entire mechanism of the mill is supported on the bed, no foundation, except that for the base, is required. The table of this mill is 10 feet in diameter, 10 inches deep on the outside, and it has sixteen deep ribs, ra-

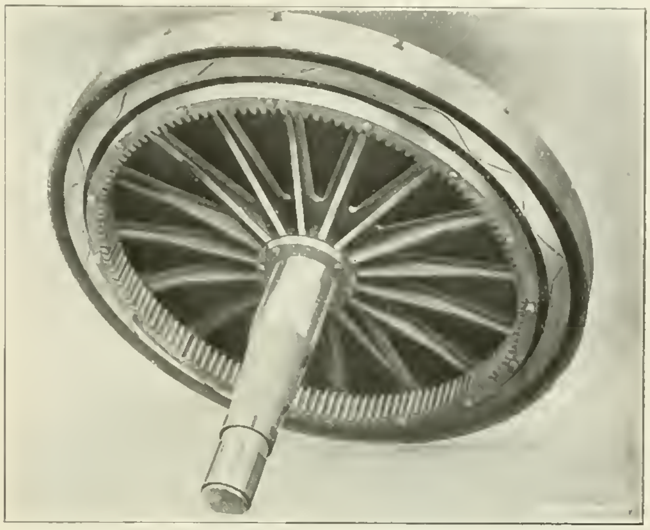


Fig. 5. Table and Spindle

diating from the center to the rim, as shown in Fig. 5, which insure rigidity. Three pockets are cored in the bed to receive automatic oiling devices for lubricating the table and the track. These pockets, one of which is shown in Fig. 4, are filled from the outside and are so arranged that the operator can see the height of the oil in them, thus insuring a proper amount of lubrication. The pockets can be drained and cleaned by inverting the inlet pipe.

The table spindle runs in an oil-filled step bearing, shown

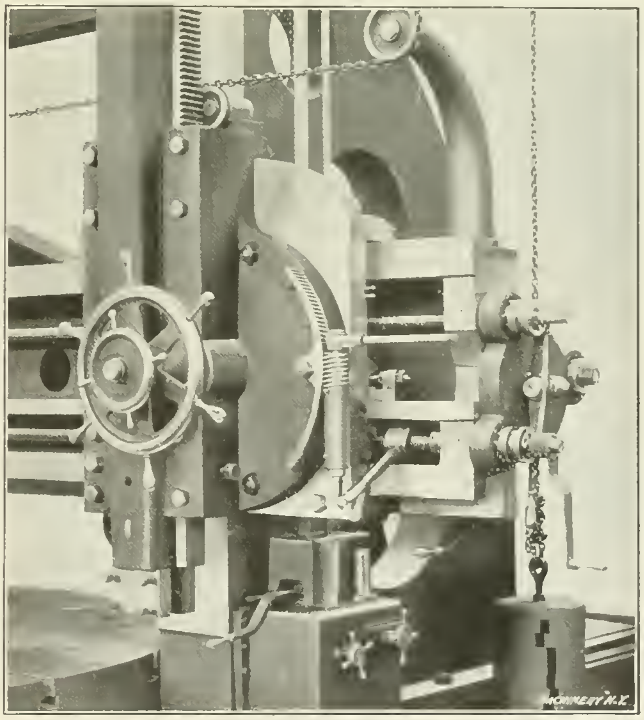


Fig. 7. Detail View showing Head and Controlling Levers for Feed and Rapid Traverse

in detail in Fig. 6. The adjustment for the table is made underneath and when the machine is first set on its foundation, it is aligned by means of this adjustment. After the aligning operation, the weight of the table is properly distributed between the rim and step bearings. The table is allowed to rest permanently on its rim bearing instead of raising it for comparatively high speeds, so that all chance of straining the spindle, especially when machining a heavy

and irregularly shaped piece, is eliminated. It has been found that the weight on the track is comparatively light, the pressure, when turning a piece weighing 5000 pounds, not exceeding 14 pounds per square inch of bearing surface.

The housings are of box form and have broad faces and wide bases; they are tied at the top by a deep three-ribbed arch, and in the back by an X-brace, as shown in Fig. 2. The housing bases are of box form and are secured to the bed by six bolts and two dowel pins. When the housings need to be adjusted on the extension bases, a power traverse is employed, the power being taken from the speed box at the rear which drives a cross-shaft that, in turn, connects with the traversing screws.

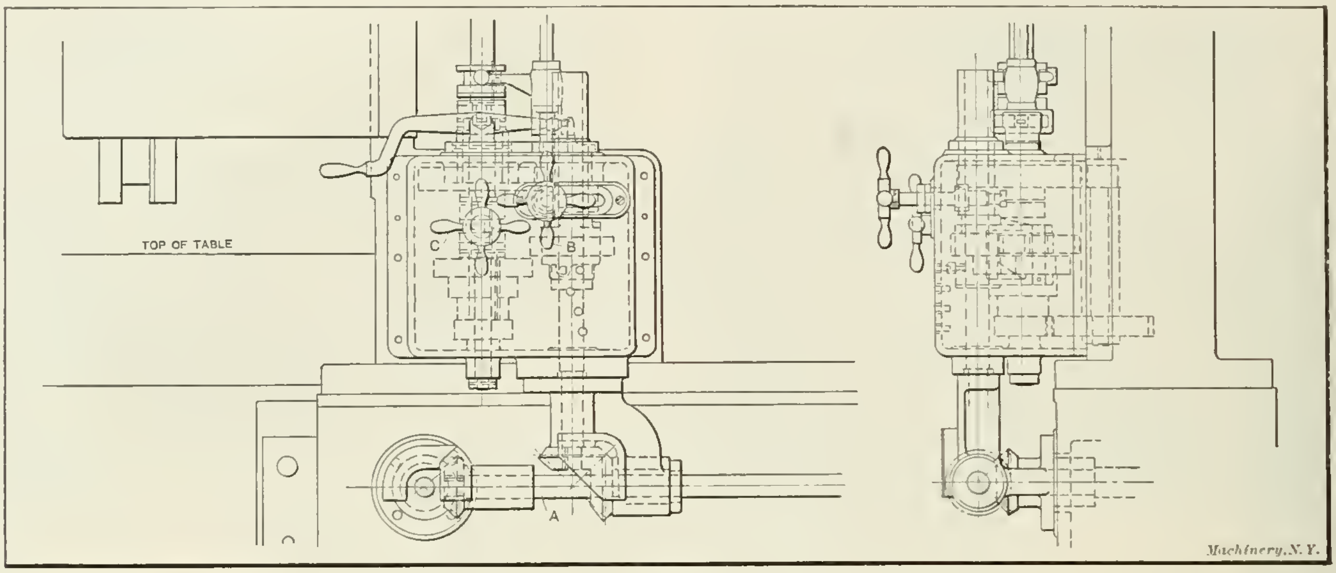


Fig. 8. Detail of Feed Box in which Eight Changes are obtained

The special extension arm that is used when the housings are set back for turning work of large diameter, is shown in place in Fig. 3. This arm is of massive construction and it is provided with an auxiliary swiveling head and a bar 6 inches in diameter, having a stroke of 48 inches. The vertical feed is by hand or power, and the bar has an independent counterbalance. This extension is so arranged that it can be conveniently removed at any time. The cross-rail, which has a depth of 30 inches, has a deep arch on the back so that any deflection due to the weight of the heads or pressure of the cut, is reduced to a minimum. It is secured to the uprights by clamps, both on the outside and inside edges of the housing. The guiding surfaces for the heads of this machine are both on the lower part of the cross-rail, to reduce the cramping or twisting action when the tool bars are extended some distance below the rail. The construction of the head is clearly shown in the enlarged view, Fig. 7. The saddles have three taper gibs that are adjustable for wear, and a sensitive adjustment for each saddle is provided. The tool bars are made from steel castings of large box section, and they have a travel of 48 inches. Each bar is independently counterweighted, and it has a rapid traverse by hand through a rack-and-pinion movement.

All the shafts used in this machine are of high carbon steel and accurately ground. The bearings are all bushed with bronze and have large oil chambers. The oil pipes leading to the main bearings all radiate from a central point, which adds to the convenience. The bevel gears are all accurately planed, and all sliding surfaces, such as those on the rail, housing faces, tool bars, etc., are carefully scraped to accurate surface-plates. The alignment of all parts is insured by special equipment.

BERGSTROM EXPANSION MANDREL

The Roren Drop Forging Co., Inc., 258 Broadway, New York, has placed on the market the expanding lathe and grinding mandrel, illustrated in Fig. 1. This mandrel, which is a Norwegian product, is composed of three pieces: the main mandrel, a sleeve and a nut. The sleeve is slotted as the engravings show, to give the necessary expansion, and the main mandrel over which it fits is tapering and has, in addition, four cam surfaces of spiral form. These cams or spirals are shown on a somewhat exaggerated scale in the sectional end view of Fig. 2. With this construction, any tendency of the sleeve to rotate with relation to the main mandrel, when a heavy cut is being taken, will cause it to be expanded more tightly against the work by the spiral cam surface; in other words, the work is automatically held more securely as the pressure of the cut increases.

Before placing a piece of work on this mandrel, the split sleeve should be placed so that a zero mark on it coincides with a similar mark on the main mandrel; this locates the sleeve in

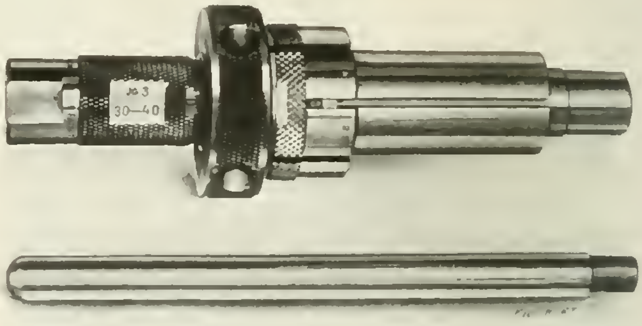


Fig. 1. Bergstrom Expansion Mandrel

correct relation with the spiral surfaces. When the work is inserted, the sleeve is twisted by hand, and a surprisingly strong grip may be obtained in this way. After a cut is started, the part being machined is automatically tightened by any retardation due to the cut. When a finished piece is to be removed, the serrated nut to the left of the sleeve is used to

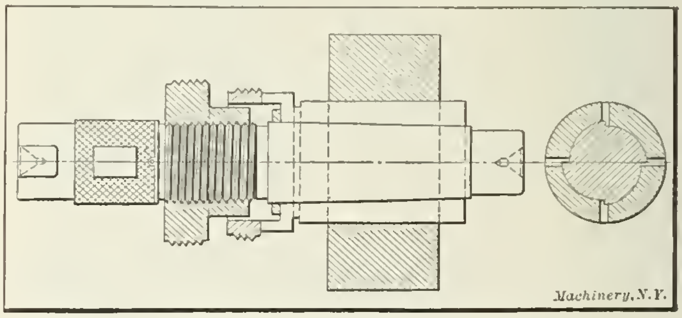


Fig. 2. Sectional View of Bergstrom Expansion Mandrel

force the latter off the main mandrel. If this nut cannot be turned by hand, a bar similar to the one shown in Fig. 1 is used, there being holes in the nut for the reception of the bar. This mandrel is made in eight different sizes.

PRATT & WHITNEY THREAD AND SPIRAL GEAR MILLING MACHINES

An attachment which has recently been developed by the Pratt & Whitney Co., of Hartford, Conn. for the milling of internal threads, is shown applied to the Pratt & Whitney thread milling machine in Fig. 1. This attachment is rigidly constructed, and it forms a complete unit so that it may be readily accommodated to the regular carriage.

The proper relation between the carriage and attachment is maintained by means of long dovetail bearings and a taper gib which may be readily adjusted for wear. The cutter head is so mounted that the necessary swiveling action for setting the cutter to different angles, when cutting threads of different lead, is obtained without disturbing the central relation between the cutter and the work. The cutter may be accurately set to any angle within the capacity of the head by suitable graduations. When the cutter head is properly located, it is securely clamped to its seat by means of bolts. The cutter spindle is made of tool steel and is hardened, ground and lapped. A taper hole is provided for the reception of cutter arbors, and there is a draw-back bolt for holding the arbors in place. The bronze sleeve or box in which the spindle runs, is

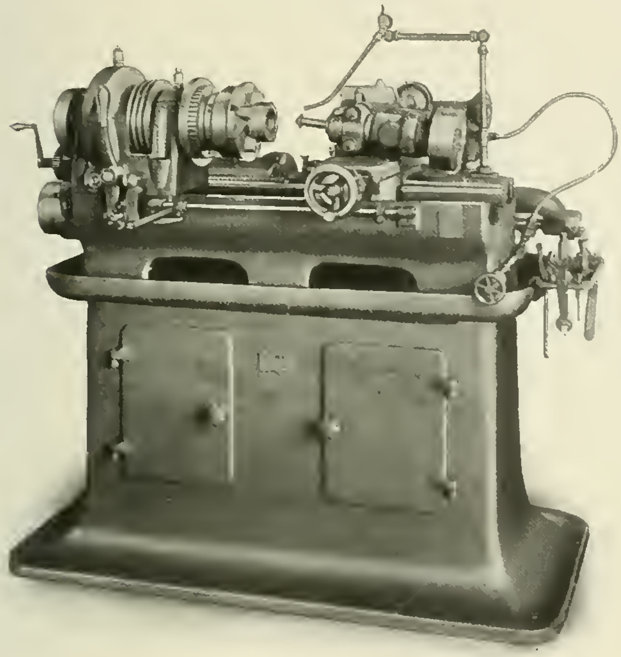


Fig. 1. Pratt & Whitney Thread Milling Machine with Internal Milling Attachment

mounted in the head in such a way as to permit the spindle to be adjusted longitudinally, which is very convenient when resetting the cutter to a previously cut thread. The drive for the cutter spindle is taken direct from the main driving shaft in the rear through gearing. Any tendency on the part of the cutter to chatter, owing to backlash in the driving gears, has been eliminated by the introduction of a flywheel. This flywheel which may be seen to the right of the carriage in Fig. 1, is mounted in bearings that are independent of the spindle. The cutter head has a very accurate and positive control, laterally, by means of a micrometer dial and positive adjustable stop. The latter enables the cutter to be withdrawn from the work and accurately returned for taking a cut of the same depth.

The necessary variations in the speed of the work spindle are obtained by means of a gear box at the rear of the machine. Eighteen speed changes, ranging in geometrical progression, are obtained by means of this gear box for each of the three driving pulley speeds, thus giving a total of fifty-four changes. Variations in the carriage travel for threads of different lead are obtained by change gears at the left end of the machine.

This machine has a compound spindle, consisting of an outer hollow spindle, which carries the driving mechanism and the spindle gear, and an inner hollow spindle containing the nosepiece and collet and also a notched index ring as shown. The two spindles are normally locked together by a pawl on the outer spindle, so that indexing, when cutting a multiple thread, is accomplished by simply releasing the pawl and turning the inner spindle one-half, one-third, or one-fourth of a revolution, etc., depending upon whether a double, triple, or quadruple thread is being cut. Both the cutter head and work spindle are driven by one belt, operating on a three-step cone pulley that is mounted on the left end of a splined driving

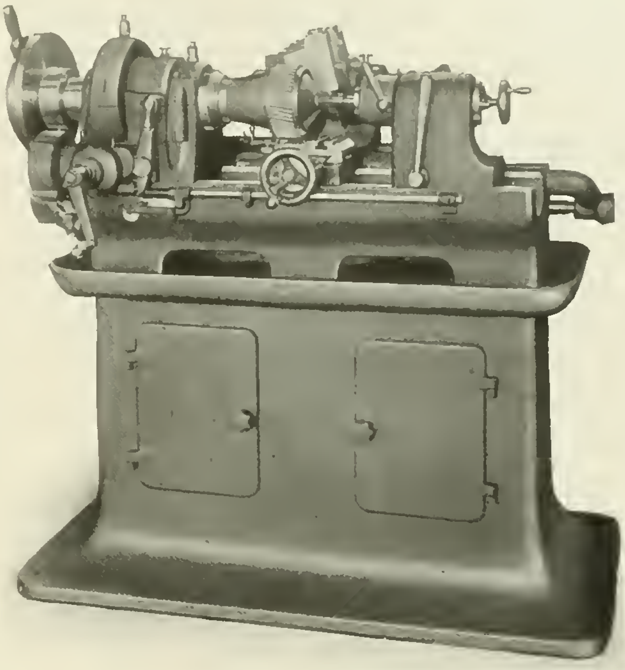


Fig. 2. Pratt & Whitney Spiral Gear Milling Machine

shaft at the rear. This splined shaft drives the cutter through gearing as stated, and the work spindle through the various ratios of gearing in the feed box.

In Fig. 2 a machine is shown that has been especially designed for milling spiral gears. The work is held on an arbor that grips the rim of a gear blank, so that it is well supported. As the engraving shows, the cutter is mounted in an adjustable head at the rear. Variations in the lead spiral are obtained through change gears, as with the thread milling machine. Three cutter speeds are provided and there are eighteen carriage feeds for each cutter speed, obtained by means of a geared feed box at the rear. The indexing mechanism may be quickly operated, and it is built on the same principle as that used on the Pratt & Whitney rifling machines. The indexing plates are very accurately made, and are much larger

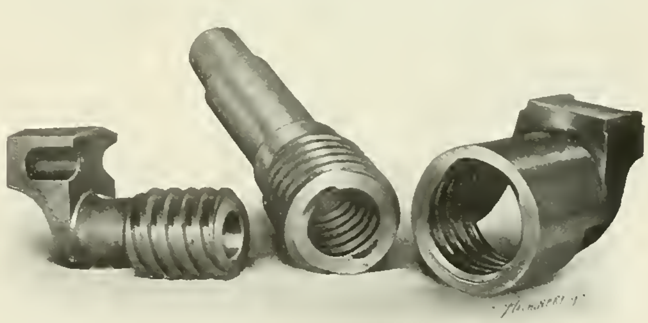


Fig. 3. Examples of Internal and External Thread Milling

in diameter than the gears, thus insuring accuracy. The longitudinal feeding movement of the carriage is controlled by the vertical lever seen in front of the headstock, and the feed may be automatically tripped at any predetermined point by an adjustable dog on the trip-rod at the front. The cross-slide is provided with a positive stop and a micrometer dial for setting the cutter to depth, and the carriage may be rapidly returned for a new cut by the crank on the left side of the machine.

In the operation of this machine, the cutter, which should be on the right side of the work, is fed in to the correct depth as

determined by the stop. The carriage is then traversed by hand until the cutter is almost in contact with the work, after which the power feed is engaged. After the cutter has fed across the face of the gears, the feed is disengaged by the automatic stop; the cutter is then moved back to clear the work and the carriage is rapidly returned by hand. After the work has been indexed for a new cut by means of the lever on the left end of the spindle, the cutter is again fed in to depth, and the feed engaged. From the foregoing it will be seen that the operating requirements of this machine are very simple.

ALL-GEARED MULTI-SPINDLE DRILLING MACHINE

In drilling operations where a number of holes of about the same diameter are required, the multi-spindle drilling machine has been of great value to the manufacturer, owing to the short time in which any number of holes within the range of a machine of this type, can be drilled. An interesting design of multi-spindle machine that has been placed on the market by The Walter H. Foster Co., 50 Church St., New York City, is shown in Fig. 1 of the accompanying illustrations. This machine has been designed to get efficient service from high-speed drills when operating on the tough alloy steels which are now used quite extensively, particularly in the construction of automobiles.

The distinctive feature in the construction of this machine is the drive, which is an all-geared type, and has been adopted as a means of transmitting sufficient power to the drill points to meet modern requirements, without undue strain or wear on the adjustable and moving parts. In addition to the substitution of gears for universal joints, other important features in the construction are, the introduction of steel, where cast iron was formerly used, and the improved method of adjusting the spindles, either horizontally or vertically, to any desired position, within their range.

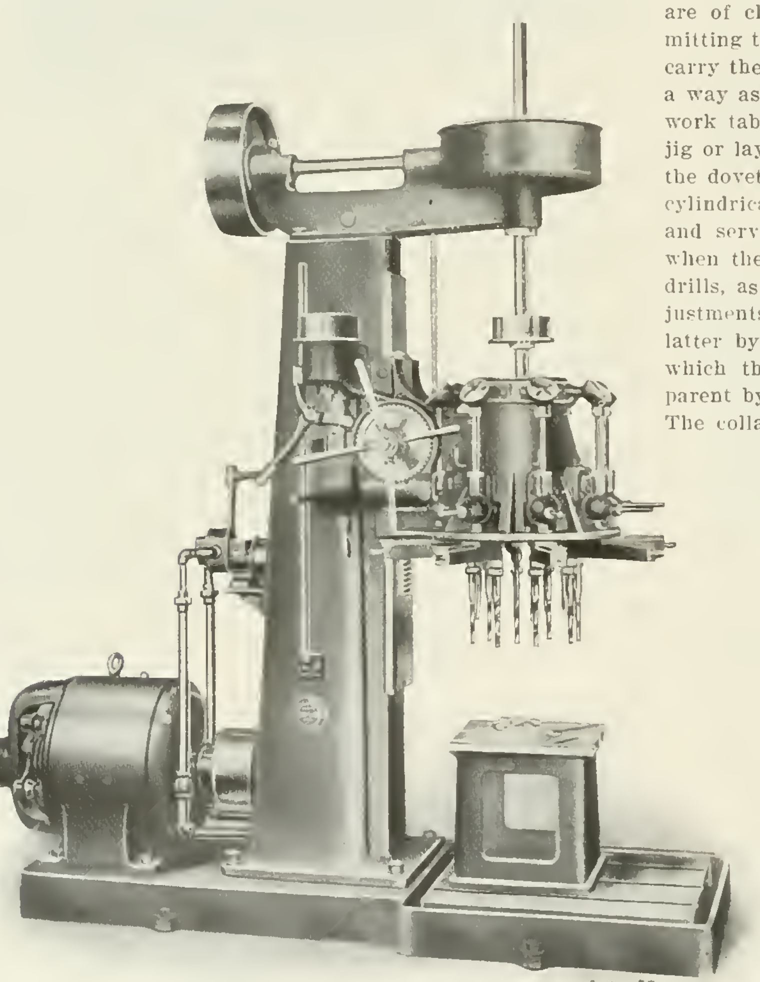


Fig. 1. Multi-spindle Drilling Machine, the Spindles of which are driven by Bevel Gears

The spindle or drill head is of conical box pattern, braced to insure rigidity. This head is so designed that the spindles can be set to drill any layout, whether circular, square, or in a straight line, as shown by the diagrams, Fig. 2. The machine is driven by a 2 to 1 variable speed motor, which is connected by a 4-inch belt to a 16-inch pulley on the horizontal shaft at the top of the column. The method of transmitting power from the central driving spindle, by bevel gears instead of universal joints, is clearly indicated in the sectional view, Fig. 4. The small bevel gears employed in this drive are of chrome-nickel steel, hardened and encased, thus permitting them to run in lubricant. The adjustable arms which carry the drill spindles are attached to the drill head in such a way as to always maintain the drills at right angles to the work table—a feature which facilitates setting the drills to a jig or layout. The arm, which is of cast steel, is mounted in the dovetail ways of a machinery steel saddle *A* which has a cylindrical projection or pintle that fits into the head casting and serves to maintain the vertical position of the spindle when the nut *B* is loosened for making an adjustment. The drills, as before stated, have both horizontal and vertical adjustments, the former being obtained by a screw *C*, and the latter by turning the knurled collar or nut *D*. The way in which the vertical adjustment is effected, will be more apparent by referring to the enlarged view of the spindle at *E*. The collar *D* fits over a threaded part of the spindle and it has an annular groove which engages a pin that passes through the drill socket and extends on either side as shown. By this simple means, the drill socket may be moved up or down to any position within the length of the spindle slot which contains the cross pins. This vertical adjustment is of special value, as it enables the operator to start all the drills cutting at the same time, and it also provides for a considerable range of stepped drilling. As each spindle has a maximum movement of 1½ inch, surfaces lying in planes 3 inches apart can be drilled.

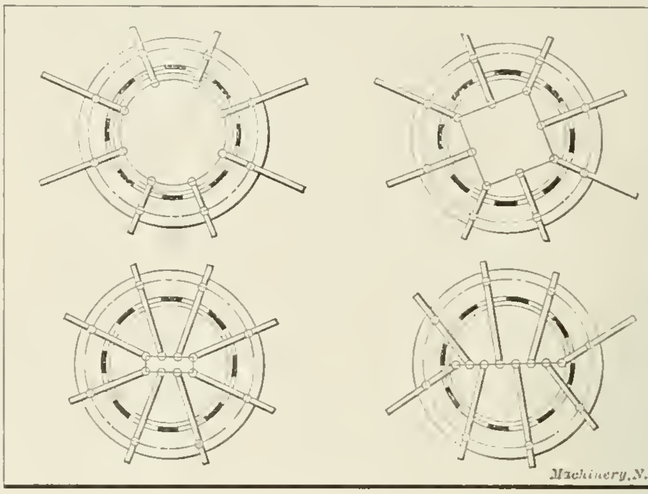


Fig 2. Diagrammatic View showing a Few of the Layouts to which the Spindles may be set

The spindle head has a bearing surface on the column of 20 by 9 inches and it is properly gibbed to compensate for wear. The column is of heavy box section and it contains the counterbalance for the drill head. The base has a working surface of 30 by 28 inches, and the box table is 16 inches square by 16 inches high. The working surface of the base is surrounded by an oil groove which is connected with the main oil reservoir that is cast integral with the base. The oil pump for supplying lubricant to the drills, is located on the rear of the column and is belted direct to the motor, or to a countershaft when a belt drive is employed. The lubricant is pumped to an auxiliary reservoir in the head, whence it is conveyed to each drill through a spiral flexible hose, as shown in Fig. 4, the supply being controlled by valves *F*.

Power feed is imparted to the drill head through a geared feed box, a sectional view of which is shown in Fig. 3. This feed box gives three changes that are obtained by manipulating lever *L* which operates a diving key. The feeding movement is transmitted to the head through a hardened steel worm which meshes with a large bronze worm-wheel *W* connected with pinion shaft *S* by a clutch on the pilot wheel *D*. The pinion and shaft *S* are integral and the former engages a wide steel rack secured to the column. The feed may be thrown in or out by hand lever *L*, and it may be automatically tripped at any point by the adjustable dog *E*. The drill head may be quickly traversed in either direction by pilot wheel *D*, after disengaging the clutch on its hub with a corresponding clutch on the worm-wheel.

All the spindles are driving shafts used in the construction of this machine run in bronze bushings, and all bearings are provided with ample and accessible lubricating facilities. The gears are made either of steel or bronze and they are properly guarded and hardened where necessary. The drill spindles have Hess-Bright radial and thrust ball bearings, and the feed worm also has a thrust ball bearing.

The machine illustrated has a capacity for high-speed drills, ranging from 1/4 to 1/2 inch in size, and holes may be drilled outside a 4 1/2-inch, and within a 12-inch circle. The minimum center-to-center distance between the spindles is 1 3/4 inch. Other standard sizes are equipped with four, six, eight, ten, and twelve spindles, suitable for drilling 1-inch holes within a circle having a maximum diameter of 24 inches and outside a circle having a minimum diameter of 9 inches. Standard heads can also be furnished having a capacity for twelve and sixteen 1/2-inch holes within a rectangular surface measuring 16 by 20 inches.

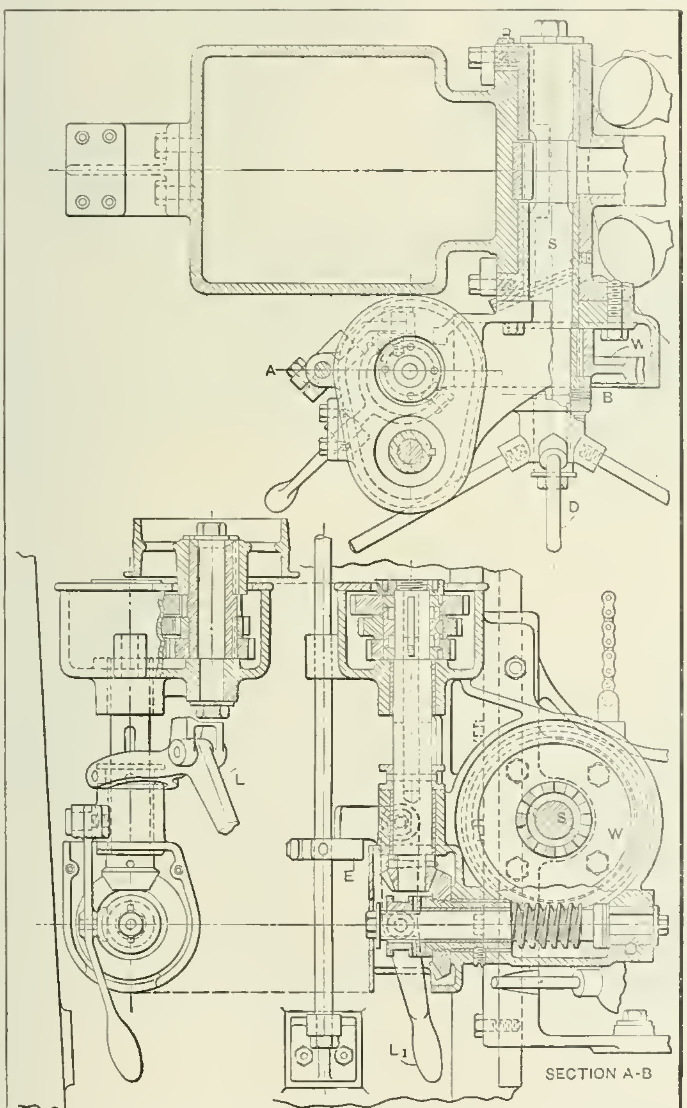


Fig. 3. Sectional View of Feeding Mechanism

TWENTIETH CENTURY STOCK RACK

The metal stock rack illustrated herewith is a recent product of the Manufacturing Equipment and Engineering Co., of Boston, Mass. The uprights of this rack are composed of a central sheet of light gage, bound on each edge by a heavy gaged sheet formed into a triple V and forced onto the central sheet. These stiffening strips have a series of holes punched at intervals of three inches throughout their length, for carrying the truss bars that support the shelves. When these holes are punched, a burr is carried down through all the sheets, thereby securing the central sheet to the stiffening edges on both sides. It will be seen that these edges form a direct support for load, as the truss bars are bolted into the punched holes. The partitions of this rack are usually located 18, 24, 30, or 36 inches apart, though any desired width can be furnished. The truss bars are made of tubing and have angular braces or knees riveted on each end, by which they are bolted in place. This construction enables the shelves, which are carried directly upon these bars, to be placed at any desired distance apart. The shelves are made of a gage suitable for the load. They are flanged

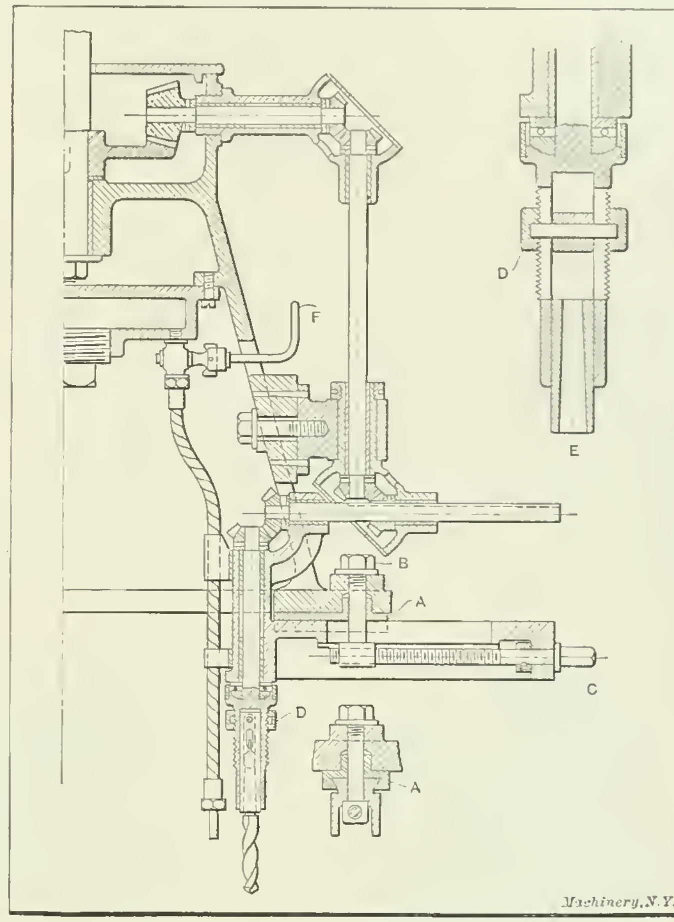


Fig. 4. Section of the Head showing All-geared Spindle Drive

Metal Stock Rack with Adjustable Shelves

and trussed on the front and back edges, and there are also flanges on the ends, thus enabling a light sheet to carry a heavy load. The shelves are pierced to take a card-holder on the front and dividing partitions. The bin fronts are formed to hook under the shelves, and they can readily be swung up into place. They are flanged on the ends and are held in place by bolts passing through the flanges and uprights. The top edge is trussed and left broad to permit the use of the fronts as a ladder. These fronts can be made for any desired height of bin and they are readily removed or put in place. The shelves are punched to admit intermediate partitions, either crosswise or lengthwise. Backs can be supplied when desired. They are formed on either edge and are pierced so that they can be bolted to the back of the shelves.

UNIVERSAL WOOD GEAR CUTTING MACHINE

The Newark Gear Cutting Machine Co., 66 Union St., Newark, N. J., has brought out a new machine that is used for cutting the teeth of wood gears for patterns, and it is especially adapted to spiral or helical gear work. There is a wide field in which heavy cast-tooth "herringbone" or double helical gears are required, and such gears can be cast solid from patterns cut on this machine. A pattern for gears of this type is made in two pieces, having right- and left-hand spirals, but the casting is, of course, solid.

This machine, which is illustrated in Figs. 1 and 2, has a capacity for spur gear patterns up to 8 feet in diameter by 24 inches face, and it will take helical or spiral gear patterns as large as 7 feet in diameter by 24 inches face width. Worms of any lead or angle and with any number of threads, may be cut, as well as helical gears of any lead or angle. Blocks of wood for use in gear-tooth molding machines may also be cut on this machine. The range of pitches which it is capable of cutting is, of course, very large. By using fly cutters, all pitches ranging from 1 inch circular up to 7 inches circular, can be easily taken care of, and heavier pitches can also be cut if necessary. The finer pitches, when required, are cut by using regular rotary gear cutters.

Owing to the nature of the material which this machine handles, there are several features in its construction which differ from those found on a standard metal gear cutting machine. The feed is obtained by means of a handwheel which operates a screw equipped with ball thrust collars. This hand feed is used so that the operator can vary the feed to suit conditions. A fast feed would be employed during a full cut, though a reduction might be necessary, owing to changes in the grain of the wood. A comparatively slow feed would also be necessary when the end of the cut was reached, or when the cutter encountered a knot. After each tooth is cut, the cutter slide, the weight of which is equalized by a counterbalance, is returned for a new cut which is taken after the blank is indexed by a hand crank. The indexing is obtained by means of change gears, thus avoiding the use of dials and the chance of spoiling work because of mistakes in using the dials. With this machine the operator makes one or more even turns of the crank, according to the index required. All numbers of teeth up to 100 can be cut, and all numbers from 100 to 450, excepting prime numbers, above 100. A wide range of numbers above 450 can also be cut. When any unusual number is required, this can be arranged for by means of extra change gears.

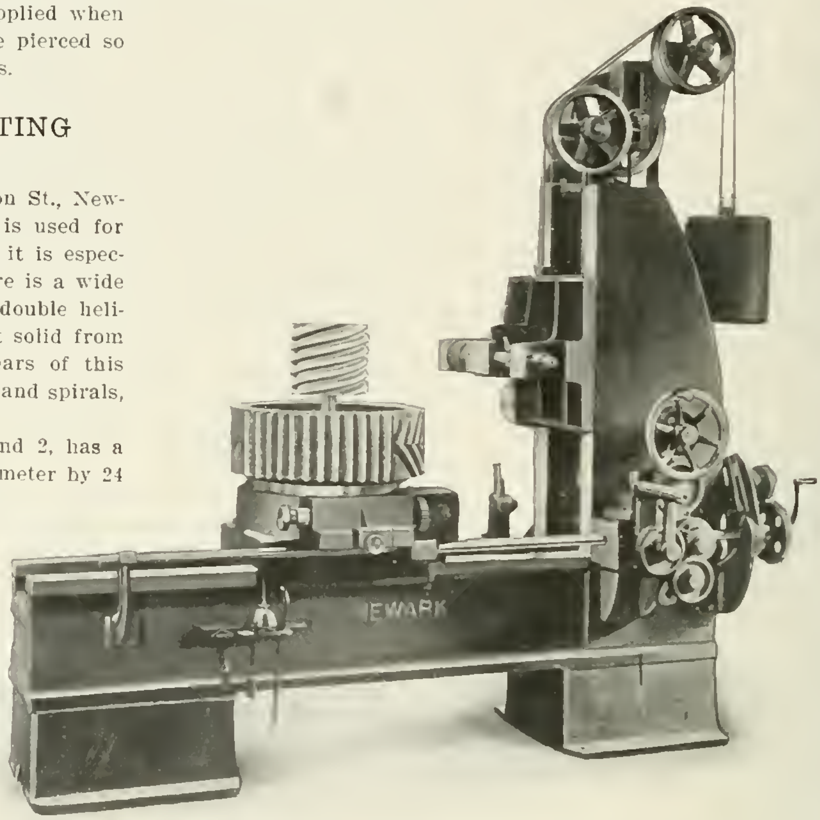


Fig. 1. Machine for Cutting Wood Gear Patterns—Examples of Work on Machine

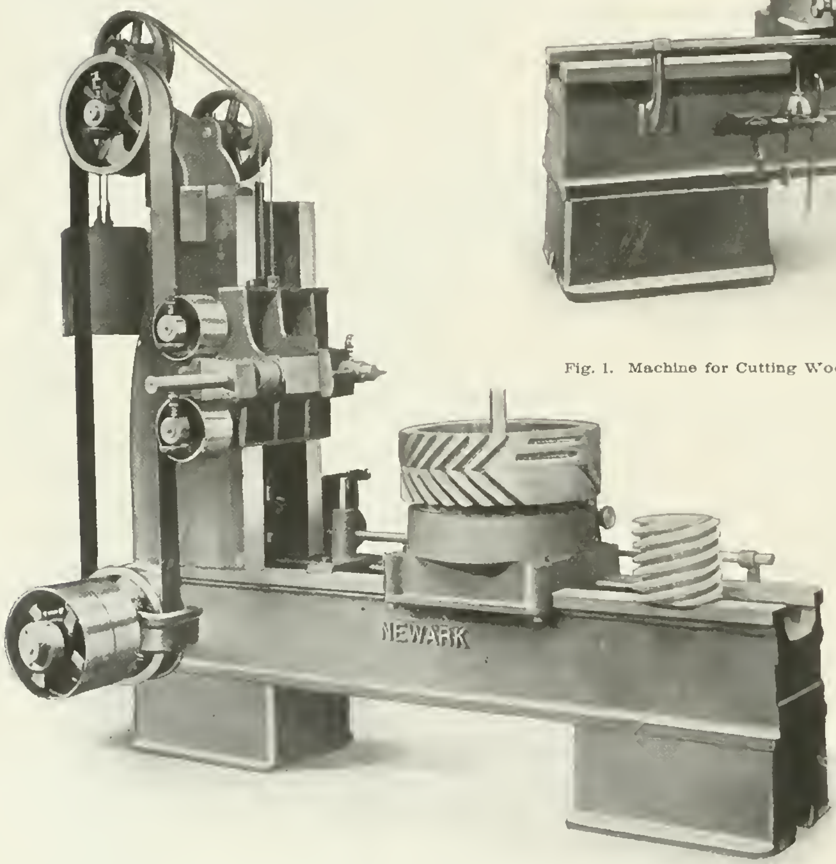


Fig. 2. View of Wood Gear Cutting Machine showing Drive to Spindle

In operation, the wooden pattern blank is mounted upon the work arbor, or directly upon the faceplate. A rim support is provided for taking the thrust of the cut on large gears. The faceplate is integral with the dividing worm-wheel which is made in two sections and generated in place to secure accuracy. The dividing worm may be disengaged from the wheel to permit the blank to be rotated by hand. This worm is provided with an adjustment for use in resetting, or when taking side cuts. A complete guard protects the worm and wheel from dust and dirt. The work head may be adjusted longitudinally on the bed to take care of patterns of various diameters, by means of a screw having a dial graduated to thousandths of an inch.

The simple method of driving the cutter spindle is shown in Fig. 2. An endless belt is employed which passes around an idler pulley at the top and a small pulley on the cutter spindle to which it is guided by idlers on the slide. The drive to the machine itself is to a tight and loose pulley arrangement, as the engraving indicates. These pulleys are mounted upon a rigid sleeve, and not upon the shaft, thus relieving the latter of all strain from the belt pull.

The form of cutters used on this machine for heavy pitches, are shown in the illustrations. When cutting spur gear patterns, a formed fly-cutter is used, which is mounted upon the spindle as shown in Fig. 1. This spindle makes 3200 revolutions per minute. When cutting helical gears or worms, an end mill form of fly-cutter is used, which is mounted upon the end-mill attachment shown in Fig. 2, through which the cutter is driven at the rate of 4200 revolutions per minute. These cutter spindles are of high carbon steel, accurately ground, and run in phosphor-bronze bearings.

Although this machine has been designed for cutting wood, the construction shows a careful distribution of the metal to insure rigidity. The bed has a deep section and the box form of construction is used, which eliminates the tendency of vibration that would otherwise result with this class of work. As an illustration of the rapidity with which work can be done in this machine, the makers state that a wooden spur-gear pattern having 40 teeth of 3-inch circular pitch and an 8-inch face width was cut in thirty minutes' actual cutting time. As the driving pulley of this machine runs at a constant speed, a motor drive can readily be employed if desired.

MORRIS 20-INCH CONE-HEAD LATHE

A design of 20-inch cone-head lathe now being manufactured by the John B. Morris Machine Tool Co., of Cincinnati, Ohio, is shown in Fig. 1. The headstock of this machine is long and massive and entirely encloses the face gear. It is equipped with a three-step cone pulley and double back-gears, giving ratios of 4.4 to 1 and 18 to 1, with speeds arranged in geometrical progression.

A general idea of the construction of the headstock may be obtained by referring to the sectional plan view, Fig. 2, which shows the arrangement of the gearing, spindle bearings, etc.

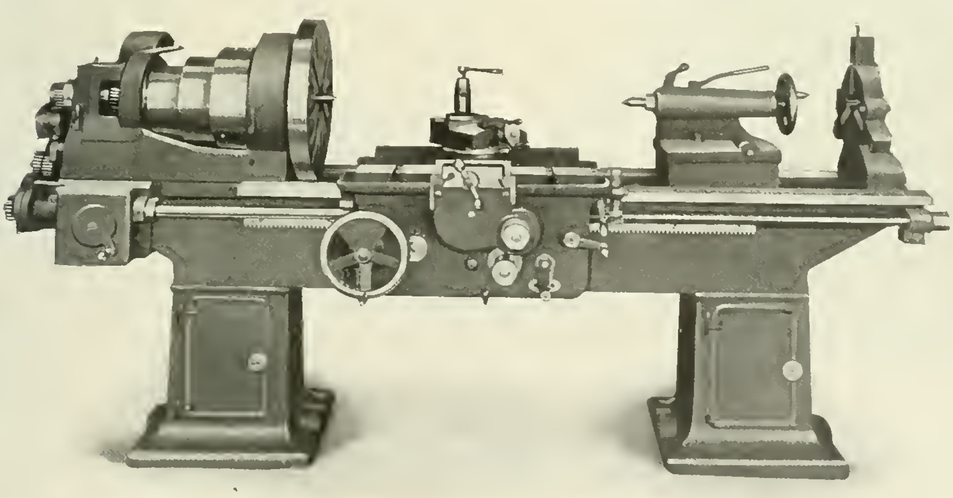


Fig. 1. Twenty-inch Cone-head Lathe built by the John B. Morris Machine Tool Co.

The cone pulley has a double gear keyed to it which meshes with the sliding gears N on the back-gear quill, and the pinion O of this quill meshes with the face gear, which is keyed to a flange on the spindle outside of the front spindle bearing. This method of driving makes it impossible to lock the cone pulley to the spindle in the usual manner, and to accomplish this a plate A having a number of holes drilled in it, is keyed to the spindle. This plate is engaged for a direct drive by the spring seated plunger B, which has a knurled knob C on its left end and a retainer pin D to keep B out of engagement with the holes of plate A, when the back-gears are in use. The knob C is operated by hand through the opening in the gear cover, seen in Fig. 1.

It will be noticed that the headstock bearings both in the front and back, are tapered and ring oiled. The headstock boxes are not capped, but are solid bearings, bored the same size front and back. The bronze sleeve E is fitted into the front bearing a light driving fit, and its bore corresponds to the spindle taper. It is keyed to prevent rotation, and a left-hand thread is chased on its inner end to receive the adjusting nut F, which has a right-hand thread on its hub to fit into

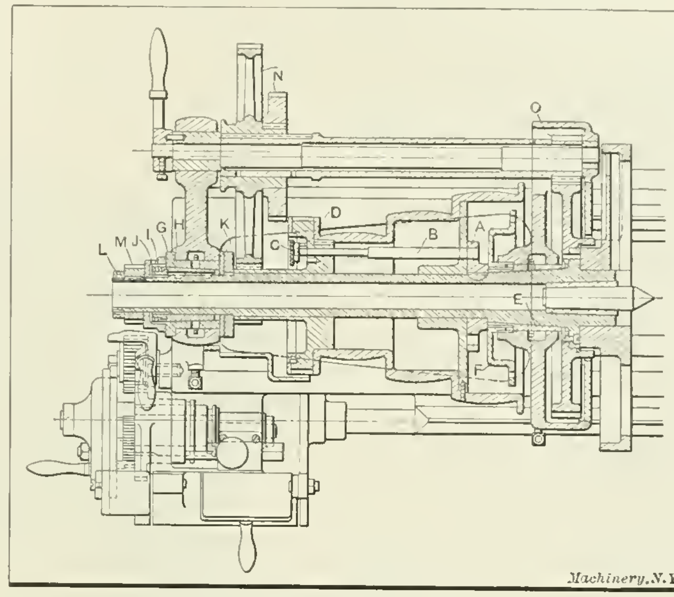


Fig. 2. Sectional View of the Headstock

the headstock. The nut F has a large flange, drilled to receive the pins of a face spanner wrench, which is supplied for making adjustments. A small cover shown in the enlarged portion of the headstock to the right of the cone pulley, Fig. 1, may be removed for adjusting this nut or to inspect the front bearing. The rear bearing of the spindle has a bushing G that is driven into the headstock, and this bushing is bored tapering to receive a sleeve H keyed to slide on the spindle. This sleeve is moved longitudinally by adjusting nut I, operated by a spanner, engaging the slots in thrust cup casting J. The thrust of the lathe spindle is opposed by the hardened tool steel washer K, and the spindle is confined longitudinally by the nut L on its outer end and the feed gear M which bears against the cup J, which in turn rests against box G.

The spindle is made of high-grade crucible steel and it has a 1⅝-inch hole extending through it. The nose of the spindle is 3½ inches in diameter, and it serves as a pilot for the faceplate or chuck plates, which screw directly into the face gear. The apron of this machine is double webbed, and all shafts which are subjected to severe strain are given double support. By means of a lever on the apron, a positive feed may be engaged for rough-chasing all threads with the ordinary rack feed to preserve the lead-screw for finishing. Provision is made for keeping the rack and screw feeds out of engagement at the same time, and also for reversing the cross and longitudinal feeds of the apron. The thread-cutting capacity ranges from 2 to 72 threads per inch, including 11½ pipe thread, and a chasing dial is provided for "catching" the threads without stopping or reversing the lathe. The semi-quick-change box gives three changes of feed for every change of gears, and the variations, which range from 0.005 inch to ½ inch per revolution of the spindle, are obtained by the movement of a lever. The compound rest has a long traverse and is accurately grad-

uated on the entire circumference. The countershaft has double 14 by 4 inch friction pulleys, and both belts may run forward, as no backing belt is necessary.

This lathe swings $20\frac{3}{4}$ inches over the ways and $12\frac{1}{2}$ inches over the carriage. When the tailstock is flush with the rear end of the bed, the 8-foot machine will turn 4 feet 5 inches between the centers, and an extra length of 5 inches may be obtained when the tailstock is overhung. The 8-foot lathe weighs approximately 3700 pounds.

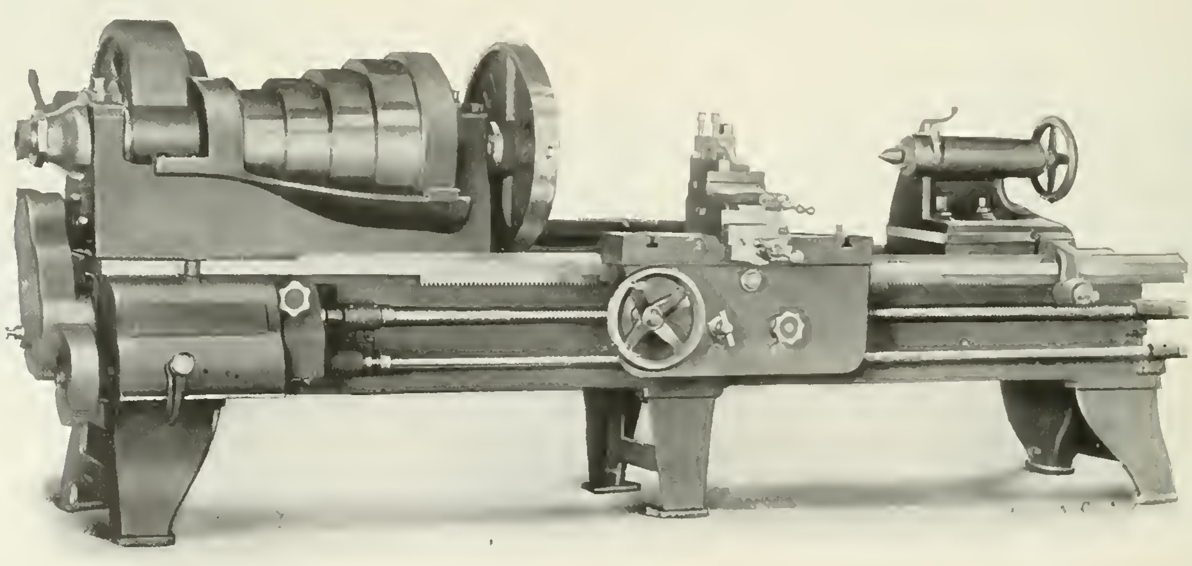
REED HEAVY-DUTY LATHES

A new line of heavy-duty lathes of the double back-geared type, has been brought out by the F. E. Reed Co., Worcester, Mass. These machines range in size from 18 to 30 inches, and a general idea of the design may be obtained from the accompanying halftone, which shows a 24-inch size.

All parts, such as the bed, headstock, tailstock, carriage and apron, have been made extra heavy to enable these machines to handle the class of work for which they are designed. On the 24-, 27- and 30-inch lathes, the headstocks are equipped with four-stepped cone pulleys, while the 18-, 20- and 22-inch sizes have three-step cones.

These lathes have a quick-change gear mechanism by means of which sixty changes for both the lead-screw and feed-rod are obtained. Thirty of these changes are effected by the manipulation of a lever at the top of the box in conjunction with the tumbler gear bracket shown, and this number is doubled by a sliding gear at the end of the lathe. Connection is made with either the lead-screw or feed-rod by the star knob, shown to the right of the gear box, and the arrangement is such that the lead-screw and feed rod cannot be connected at the same time. A detailed description, accompanied by a phantom illustration showing the interior mechanism of this gear box, was published in the department of New Machinery and Tools, May, 1910. All the gears in the front case are of steel and have teeth of coarse pitch.

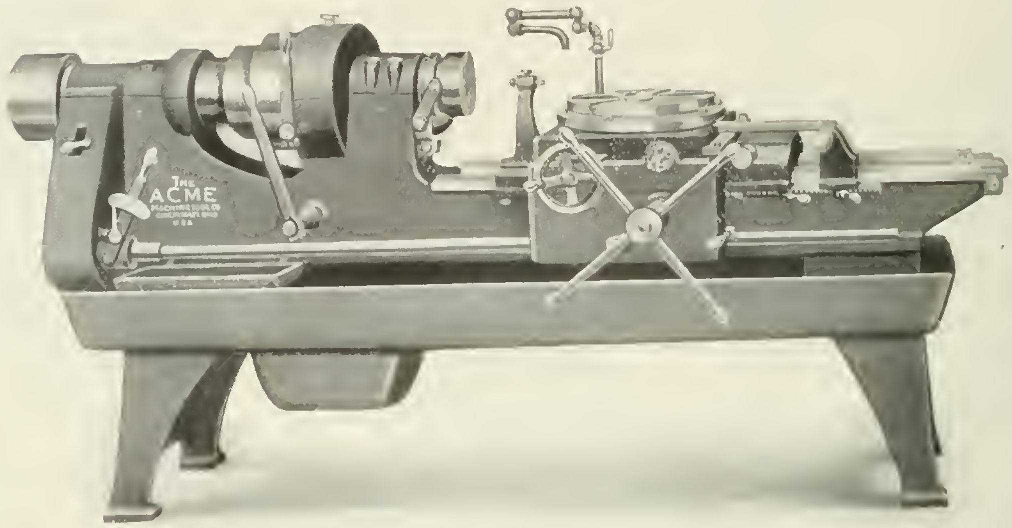
The lead-screws are equipped with thread-cutting indexes. The apron feed works are driven by worm and worm-gears, and there are double frictions for longitudinal and cross feeds. The tool-rests are made in both the compound and plain types, and a taper attachment can be supplied with either style of rest. The countershaft is of the two-speed friction type, and the hangers are equipped with self-oiling boxes. This line of lathes is particularly adapted for railroad work and all kinds of heavy turning.



F. E. Reed Co.'s 24-inch Double Back-geared Lathe

ACME COMBINATION TURRET LATHE

A combination turret lathe has been designed by the Acme Machine Tool Co., Cincinnati, Ohio, to meet the demand for a first-class machine adapted to the production of parts from bar stock, and also to the machining of forgings and castings, with the use of simple tools. This machine, which we illustrate herewith, handles bar work up to $2\frac{1}{4}$ inches in diameter and 26 inches long, with the bar outfit of tools; and forgings or castings up to 14 inches in diameter may be machined with the chucking outfit. The machine will swing diameters up to 19 inches.



Acme 2 1-4- by 26-inch Combination Turret Lathe

The head is cast solid with the bed, thus insuring rigidity, and it is provided with friction back-gears and a three-step cone taking a $3\frac{1}{2}$-inch belt. The spindle is of high-carbon, hammered, crucible steel and it is provided with ring oiling babbitted bearings. The bed rests on three points in order to avoid all twisting action. The chuck is especially designed to insure holding the work accurately, and it has great gripping power. It is opened and closed, while the machine is running, by means of the long lever shown at the front of the head; this lever also operates the roller feed. With this chuck the work does not have an "end motion" when the chuck is closed, so that second operation work requiring

exact shoulder lengths may be handled, and the jaws do not overhang, allowing short work to be gripped without tilting them. The jaws are easily removed and inserted without dismantling the chuck.

A roller feed of improved design is used for feeding the stock, in which the centering jaws and rolls are operated together automatically. When setting the roller feed for any size stock, an adjustment is made by turning a spanner wrench until the jaws grip the stock; they are then loosened a trifle, after which the rolls are under the proper tension for feeding. Bars of any section, whether round, square, or hexagonal, can be handled.

The turret consists of a circular plate having radial locating slots for the tools and also bolt holes for clamping the tools. The locking bolt for the turret is placed at the front end of the slide directly under the cutting tool, and works in hardened and ground taper bushings set into the solid turret. An oil hole is provided under each tool space for use with oil tube drills, etc., in addition to the regular oil pipe. A swinging stock-stop is attached to the front of the saddle.

The cross-slide, which is of generous proportions, moves on a narrow dovetail guide having a gib for taking up wear. It has hand and power cross-feeds in both directions, and a large micrometer dial giving direct measurements. Independent adjustable cross-stops are provided for each tool on the turret. These stops are convenient to the operator, and the combination can be varied as desired. A very rigid stop is used to locate the turret in its central position, all movements of the cross-slide being from the center outward.

The carriage has a full length bearing on the V's which are of large proportions, and it is securely held by gibs at the front and rear ends. Automatic adjustable stops are provided for each station of the turret and there are four auxiliary stops which may be used in any combination desired; these are controlled by the knob seen at the right end of the carriage. All these stops trip the automatic feed.

Power feed is provided for both the cross and longitudinal movements of the turret. This feed is of the geared type and gives four changes which may be quickly obtained by moving the lever shown at the front of the head. Both feeds are reversible by means of the lever at the front of the feed box.

An ample supply of oil is provided by a pump which operates with the machine running in either direction. The oil tank is cast solid with the large chip pan, and it is provided with a perforated cover which strains the oil. All the working parts of this machine are carefully protected from dirt and chips, thus insuring accuracy. An improved stock-supporting stand and a triple friction countershaft with ring oiling boxes is furnished with each machine. A motor drive can be supplied upon special order.

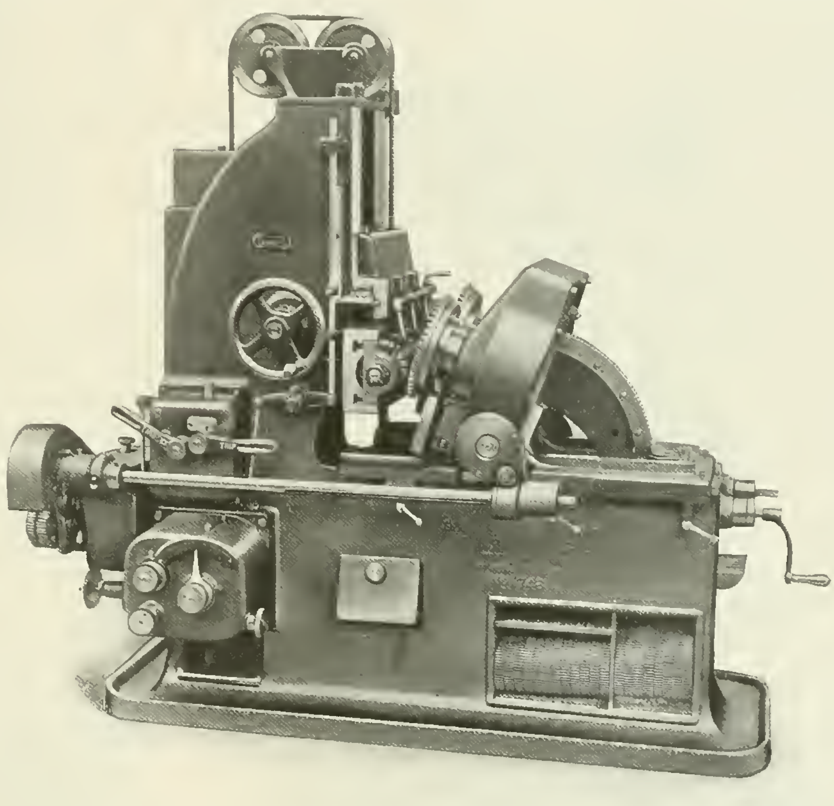
GOULD & EBERHARDT MULTIPLE-SPINDLE AUTOMATIC GEAR-CUTTING MACHINE

A multiple-spindle automatic gear-cutting machine for spur and bevel gears, worm-wheels and clutches, is now being manufactured by Gould & Eberhardt, of Newark, N. J. This machine, which is illustrated herewith, is a "manufacturing tool" that is capable of cutting one, two, or three spur or bevel gears, worm-wheels or clutches, simultaneously—thus materially reducing the time per piece—and it is especially adapted for roughing out bevel gears preparatory to finishing them on a bevel gear planer.

The illustration shows a 24 by 8 inch machine, equipped with two spindles on which are mounted two 49-tooth, 5-pitch steel gears having a face width of 1 5/16 inch. The time required for roughing out two of these gears is 36 minutes, or 18 minutes each, this being the actual cutting time. This machine is practically the same as the Gould & Eberhardt machine illustrated in the department of New Machinery and Tools for January, the chief difference being in the special cutter and work slides.

The cutter slide is arranged to accommodate one, two, or three cutters, and the cutter spindle bearings are so located that each cutter has a bearing close to it on both sides, so that a rigid support is secured. The slide is actuated on the draw-cut principle; that is, the feed-screw is anchored in the base of the stanchion so that it is under a tensile strain which overcomes the vibration that would take place if the screw were placed under compression by being anchored at the top part of the stanchion. The strains from the thrust of the cut are also transmitted to the base of the machine, when the feed-screw is anchored at its lower end.

The cutter, feeding and indexing mechanism of this machine are driven in a direct manner, and ball bearings are provided to take care of thrusts, where needed. The feed and return



Gould & Eberhardt Gear-cutting Machine, especially adapted for Roughing Bevel Gears

of the cutter slide, and the indexing, are controlled by only two levers that enable the operator to return the cutter slide by power without the necessity of unlocking the indexing mechanism. This mechanism also provides for a safety device that holds the cutter slide from feeding while indexing of the work is taking place, it being impossible for the feed to start until after the indexing operation is completed.

The work slide is provided with three work spindles which are controlled by a positive indexing mechanism. The spindles are indexed in unison by means of helical gears located directly under the blanks being cut. When all the spindles are in use, which enables three gears to be cut simultaneously, bevel gears up to $5\frac{1}{8}$ inches in diameter can be machined. When only the two outer spindles are used, bevel gears up to $10\frac{1}{4}$ inches in diameter can be machined, while the use of only one spindle enables a gear of 24 inches in diameter to be cut, which size represents the maximum capacity of the machine.

In addition to the regular segment support to the table, the angular position of which is controlled by a worm and worm-wheel sector centrally located and securely held by an extra clamping device, there is a special adjustable brace which supports the periphery and also the back of each blank being cut, at a point opposite the cutters. This brace also acts as a chip

chute and directs the chips and oil into a pocket located in the base of the machine, where the oil is strained and thus separated from the chips before it again reaches the oil pump. This combination of supports gives a rigid and solid construction, which is, of course, very essential to rapid production. This machine weighs approximately 3500 pounds, and as the illustration shows, it is equipped with guards that entirely cover every running gear.

SUPERIOR UPRIGHT DRILLING MACHINES

The Superior Machine Tool Co., of Kokomo, Ind., is now manufacturing a new line of upright drilling machines, similar to the design illustrated in Fig. 1. These machines are built in sizes ranging from 21 to 36 inches. The geared type of feeding mechanism is employed, and the feed box, the worm box, and the head are all cast in one piece. The gear box provides four changes of feed, any one of which may be obtained while the machine is in operation. The feed variations

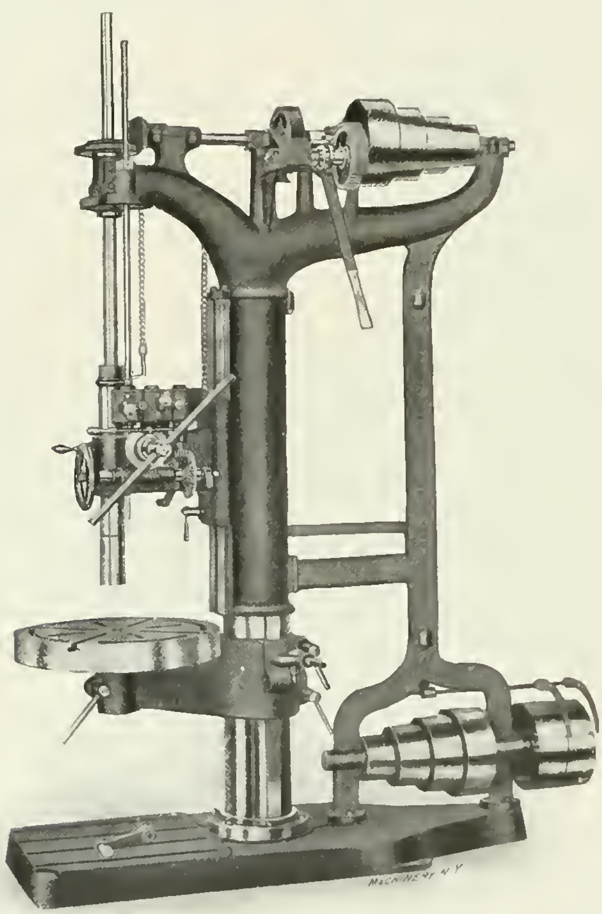


Fig. 1. Drilling Machine built by the Superior Machine Tool Co.

are controlled by two handles located on the side of the feed box as shown. These handles control the position of clutches C and C_1 shown in the sectional view of the feed box, Fig. 2. As the engraving indicates, these clutches may be brought into engagement with either of two clutch gears, mounted above and below them, thus giving the four changes. The method of transmitting power through the bevel gears and worm gearing to the pinion feeding shaft is clearly shown. The change gears are made from 3½ per cent nickle steel, heat treated. The spindles are forged from high-carbon steel and ground to size; in fact all spindles, sleeves, shafts and tight and loose pulleys are ground. The base and table are extra heavy and strongly built. The table arm and the head are provided with long bearing surfaces on the column, and the spindle and head are counterbalanced to insure easy operation. Three-step cone pulleys are used on the 21-inch machine, and four step pulleys on the larger sizes. These pulleys have extra wide and heavily-crowned faces. The patent tapping attachment made by this company can be applied to these machines if desired. All the principal parts of these machines are thoroughly tested with special micrometer testing machines, thus insuring perfect alignment and accuracy.

ROBBINS 16-INCH PATTERNMAKERS' LATHE

The Robbins Machine Co., Worcester, Mass., is now manufacturing the design of 16-inch patternmakers' lathe, shown in the accompanying illustration. This machine is rigidly built, the weight with a 6 foot bed being 1100 pounds. The head-

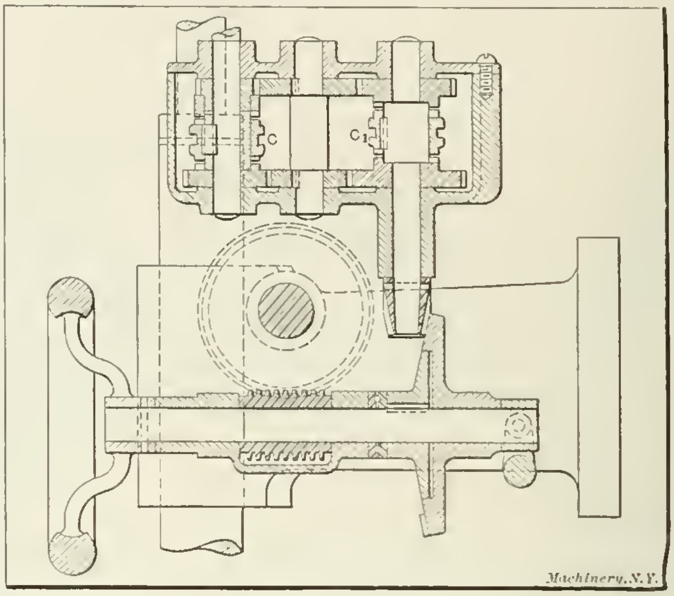
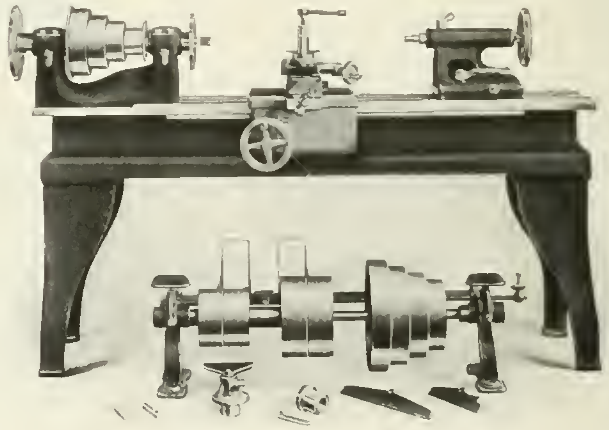


Fig. 2. Geared Feed Box of Superior Drilling Machine

stock spindle is of crucible steel, and runs in dust-proof ring-oiled bearings of phosphor-bronze, having large oil reservoirs. The spindle extends beyond the headstock on the left side, and is provided with a large faceplate for turning work that cannot be swung over the ways. The tailstock is of the cut away type, and the tail spindle is also of crucible steel, and has a long travel. The carriage has a hand feed, though a power feed can be supplied at extra cost, if desired. The compound slide has a graduated swivel, and the transverse adjustment is obtained by means of a screw of coarse pitch. If desired, the



Robbins 16-inch Patternmakers' Lathe

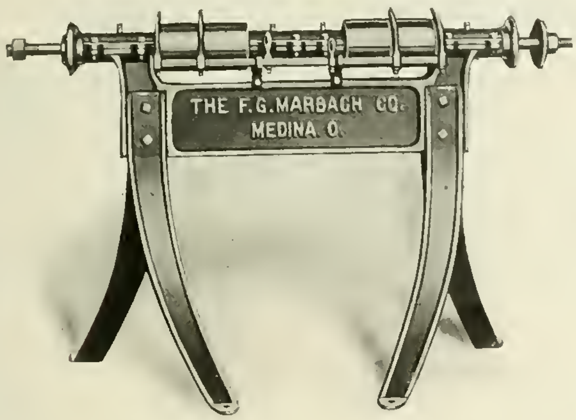
compound slide can be quickly detached and replaced with a swiveling holder carrying a tool rest for hand turning. The countershaft is provided with self-oiling hanger boxes, and two pairs of tight and loose pulleys of different diameters, for doubling the number of speeds obtained through the step cone pulleys. The countershaft has a patent belt shifter which requires but one handle for the operation of both belts.

This machine is built in 16-, 20- and 24-inch sizes. The 16-inch machine, illustrated herewith, swings over the bed 18¼ inches; over the carriage 13¾ inches; and it has a maximum distance between the centers on a 6-foot bed, of 39 inches. Each lathe is provided with a tripod rest; three hand tool

rests; one pair of wood centers; one pair of pointed centers; two faceplates; one screw plate, and the necessary wrenches. The workmanship is high-grade throughout, and each lathe is thoroughly tested at the speed at which it is intended to run.

MARBACH GRINDING OR POLISHING MACHINE

A grinding or polishing machine that is now being built by the F. G. Marbach Co., Medina, Ohio, is shown herewith. This machine is of the double-spindle type, and each spindle has an independent control. The spindle bearings and also those for the loose pulleys, are equipped with Randall's graphite sheet lubricator. The shifters are placed in a convenient position, so that the operator can start or stop either end of the machine instantly. As the engraving shows, the front legs are

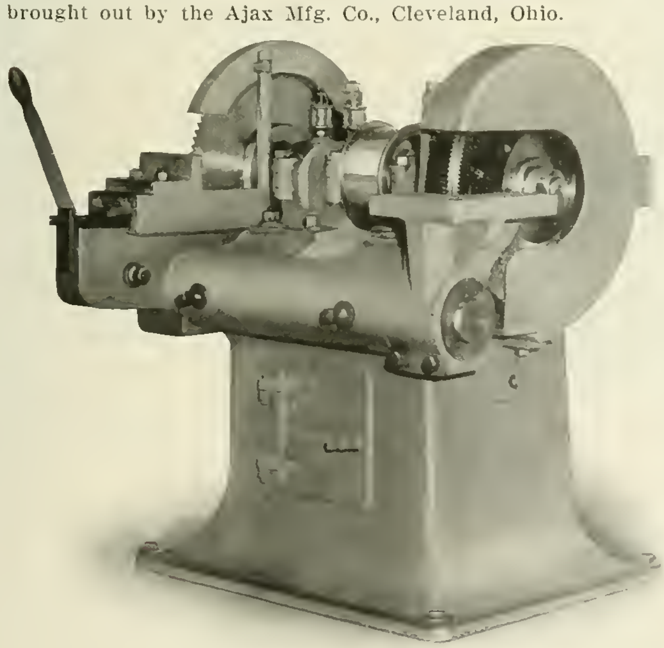


Grinding or Polishing Machine built by F. G. Marbach Co.

curved inward to give the workman plenty of standing room. The principal dimensions of this machine are as follows: Distance between the wheels, 48 inches; length of the bearings, 8 inches; diameter of the spindle in the bearings, 1⅜ inch; length of the shaft over-all, 62 inches; diameter of the wheel flanges, 5⅜ inches; height from the floor to the center of the spindle, 36 inches; diameter and width of pulleys, 5¼ and 4¾ inches, respectively; weight, 340 pounds.

AJAX HOT SAW AND BURRING MACHINE

A hot saw and burring machine that should be a valuable addition to the equipment of a forging shop, has been recently brought out by the Ajax Mfg. Co., Cleveland, Ohio.

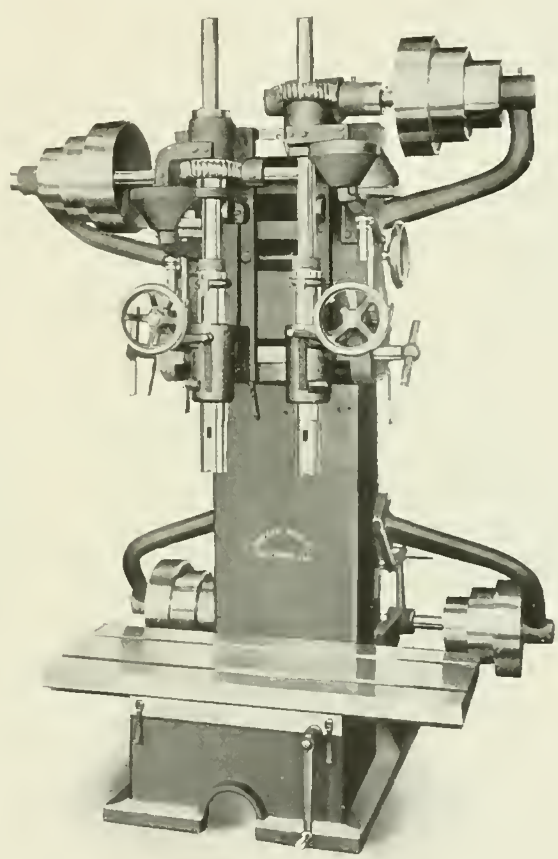


Combination Hot Saw and Burring Machine

This machine, which is shown in the accompanying halftone, is intended primarily for service in connection with an upsetting forging machine, and it was designed with the idea of further economizing in the production of machine-made forgings. By the use of this machine a headed forging may be sawed from the bar immediately after it is upset, thus leaving a clean square end. The burrs or fins which are formed after a set of dies has been used, can also be rapidly removed. The general design of this machine is similar to that of a double-ended grinder or emery wheel stand. One end of the shaft or spindle carries a head that is fitted with a milled band on the periphery and a milled disk face on the side, as the engraving shows; this end is used for removing the fins or burrs from a forging which has been upset. The opposite end of the spindle carries a hot saw for cutting off the forgings from the bar. These machines are built in three sizes having saws and burring heads, 14, 20 and 30 inches in diameter. They operate at a high rate of speed, and, consequently, are built rigidly and equipped with large bearings and ample provision for lubrication. The utility of such a machine will be fully appreciated by the users of upsetting forging machinery.

HOEFER TWO-SPINDLE BORING MACHINE

A design of vertical, two-spindle drilling and boring machine, now being built by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill., is shown in the accompanying view. As this machine is intended for boring operations requiring heavy cuts and



Hoefer Two-spindle Drilling and Boring Machine

rapid feeds, particular attention has been given in the design to the support of the tools and the provision against heavy strains. The design is self contained in that the countershaft is attached directly to the machine. This feature enables the speed changes for the spindles to be easily and rapidly made.

The heads which carry the spindles and the driving and feeding mechanism, are securely gibbed to a wide cross-rail, which, in turn, is bolted and doweled to the column. The spindles are of hammered crucible steel, and are large in diameter, to rigidly support the boring tools. They are ground, and run in interchangeable bronze bushings. The nose of each spindle is provided with a No. 5 Morse taper and a driving slot for the tools. The right-hand spindle head is stationary, being bolted and doweled to the rail, while the head

to the left is adjustable, so that the center-to-center distance between the spindles can be varied. This adjustment is effected by means of a handwheel shown at the right of the machine. Each head has its own driving belt and independent geared power feed, and is therefore self contained. The final drive to the spindle is through a worm and worm-gear of large pitch, which gives ample power to the spindle. The worms have ball thrust bearings, which are contained in the heads, thus eliminating any tendency, during a heavy boring operation, of pushing the heads out of alignment.

This machine is equipped with a gear feed mechanism, controlled by levers that are convenient to the operator. The feed variations range from 0.008 to 0.0625 inch per revolution of the spindle. These are the standard feeds regularly employed, but the feed variations can be arranged to meet individual requirements. To enable the machine to handle a wide variety of work, the table, which has a working surface of 18 by 48 inches, is given a longitudinal adjustment; this is effected by the crank shown, which operates through a rack and pinion movement. This adjustment enables the workman to set up a job at one end of the table, while the two spindles are at work on the other end. This feature adapts the machine to a wide range of work without sacrificing the accuracy or rapidity of the output.

Some of the dimensions of this machine are as follows: Minimum distance from the spindles to the table, 12 inches; maximum distance, 28 inches; minimum center-to-center distance between the spindles, $4\frac{5}{8}$ inches; maximum distance, 12 inches; distance from the column to the center of the spindles, 12 inches; vertical feed of the spindles, 16 inches; greatest height from the floor to the top of the machine, 81 inches; net weight, 4800 pounds; and floor space required, 30 by 45 inches.

MILLED SCREW AND MACHINE CO.'S THREAD MILLING MACHINES

The Milled Screw and Machine Co., Sayre, Pa., is now building the heavy type of universal, automatic thread milling machines shown in the accompanying illustrations. These machines are rigidly built and particularly adapted for such work as steering-gear worms, heavy elevator worms, jack screws, roller mill, boring mill, planer and lead-screws, requiring accuracy.

The machine shown in Fig. 1 has a maximum capacity for work 6 inches in diameter and 24 inches in length, and the size shown in Fig. 2 takes work 6 inches in diameter by 48 inches in length. These machines are quite different in their construction from those built by the same company, which were illustrated in the department of New Machinery and Tools for March, 1910, though the principle of operation and general arrangement of the parts is practically the same.

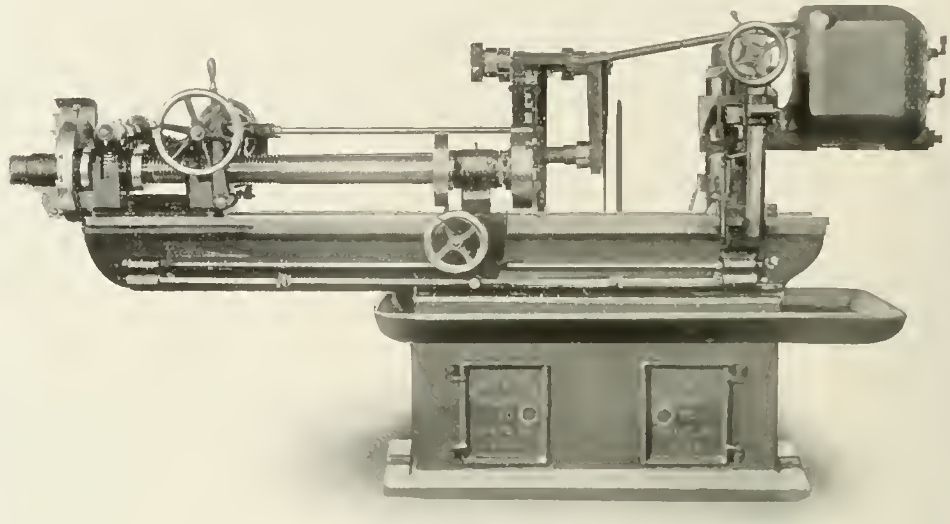


Fig. 2. Six- by Forty-eight-inch Automatic Thread Milling Machine

In brief, the machine consists of a bed upon which is mounted a work carrying lead screw with mechanism for imparting to it, rotary and longitudinal movements, and a spindle-driving mechanism and cutter so mounted that the latter can be set to the angular position required by the helix angle of the thread. The lead screw is of large diameter to resist torsional strains, and it is mounted directly over the center of the bed, while the blank to be threaded is gripped in a chuck that is carried on the end of the lead-screw. This lead screw is splined its entire length, and it is provided with a double worm drive which gives it a steady, direct and powerful simultaneous rotary and longitudinal motion. One of these worm-wheels is splined to the lead-screw and simply gives it a rotary movement. The second worm-wheel drives a split feed nut, seen to the extreme left in the illustrations, which imparts a longitudinal movement to the lead-screw in either direction, as desired.

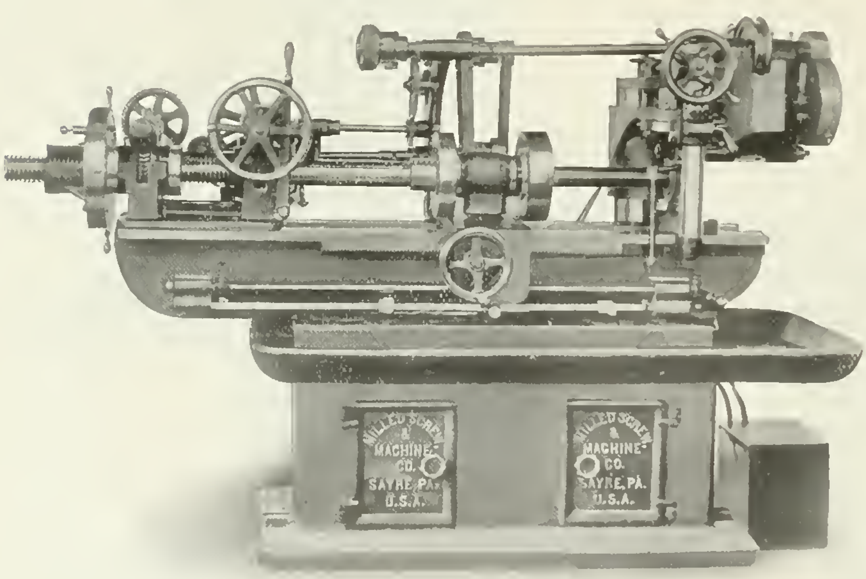


Fig. 1. Six- by Twenty-four-inch Automatic Thread Milling Machine

Suitable change gears are interposed between the two worm shafts for changing the relative speeds of the longitudinal and rotary motions of the lead-screw, and in this way provision is made for cutting threads of different lead. The drive for the lead-screw is obtained from the main driving shaft, which is connected to a worm-shaft at the rear by a belt operating on cone pulleys, thus enabling the speed of rotation to be varied to suit the work being performed.

The machine is driven from a countershaft, or other source of power, by a belt operating on a grooved pulley, from which the power is transmitted to the cutter spindle through driving gears, as illustrated in Fig. 3, which is a detail view of the spindle head with the casing removed to show its construction. If desired, a direct motor drive can be employed. The blank to be threaded is gripped on the outside by chuck jaws at one end, and it is supported directly under the cutter while the thread is being milled, by a circular bushing bored to the exact size of the blank, so that the threaded portion is free from all strain after passing the cutter. This arrangement avoids any bending of the blank because of side pressure from

the cutter, and any tendency towards buckling because of heating is also eliminated, as there is unlimited room for longitudinal expansion. In Fig. 4 is shown a worm having a diameter of 5 inches, and a pitch of 1¾ inch, which was machined in one cut, the depth of the cut being 1 3/16 inch. By means of the coupling seen to the left of the sliding head which supports the outer end of the lead-screw, multiple threads may be cut, as this coupling enables the chuck and

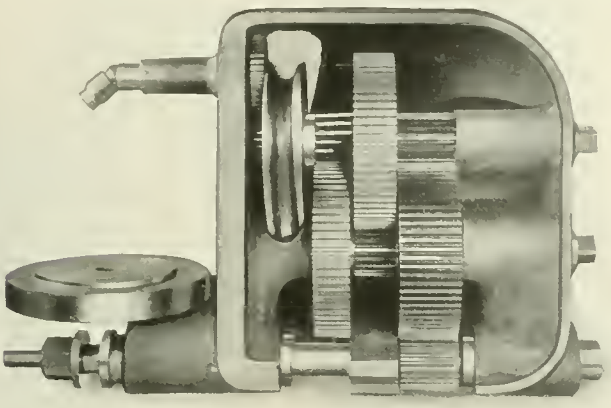


Fig. 3. Cutter-spindle Driving Mechanism

work to be accurately rotated or indexed with reference to the lead-screw.

These machines are automatic in their operation, there being positive knock-outs that may be adjusted to automatically stop the work at any predetermined point. Because of this feature, the operating requirements are very simple and the number of machines that one man can handle is only limited

Fig. 4. Worm Machined in One Cut in an Automatic Thread Milling Machine—Diameter 5 inches

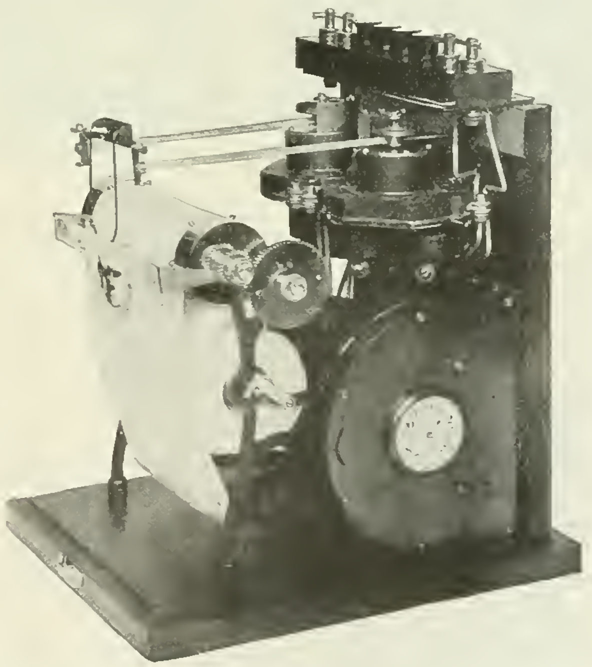
by the number of blanks he can gage and look after. In case the main belt should break, the entire machine would stop; similarly if the small belt for driving the lead-screw mechanism should break, the feed would stop, and in any event, the construction is such that there would be no damage to the work. By means of a simple attachment that can be furnished extra, if required, keyways may be cut on these machines.

PORTABLE GRAPHIC RECORDING METER

A portable type of recording meter for showing graphically on a chart the exact performance of machines in electrically-driven plants, has been developed by Messrs. R. C. Lanphier and H. W. Young of the Sangamo Electric Co., Springfield, Ill. This meter has been specially designed to withstand the rough treatment to which portable meters are usually subjected, and to give complete, accurate records which will enable the load factor and efficiency of motor-driven machines to be determined.

The measuring mechanism of this meter consists of two mercury-floated motor elements, so located as to actuate a common indicator to which is attached a recording pen that traces a line or curve on the moving chart. These measuring elements may be separately energized as in polyphase wattmeters with three-wire direct or single-phase alternating current, or they may be connected in series or parallel for use on two-wire direct-current or single-phase alternating current. The moving element is a simple metal disk or sector rigidly attached to a shaft carrying the recording pen-mounting and control springs. The disk is floated in a mercury chamber which not only serves as a conducting medium for the current to be measured, but also by the damping action of the disk passing through the mercury renders the meter indications highly dead beat. This is a very important and desirable feature when meters are measuring fluctuating loads, as it insures a true record free from false indications or "overshooting." Surrounding the moving disk there is a magnetic field having such a position, relative to the moving system or armature, that it cuts or passes through the armature field and tends to rotate the moving system. This rotative movement causes the recording pen to move across the chart against the restraining force of the control springs which tend to return the pen to the zero position. The turning force of the mercury-floated moving element is thus balanced against the restraining or coercive force of the control springs, and their point of balance, or equilibrium, is a measure of the current flowing in the measuring coils.

The record is made on a paper chart ruled with rectangular coordinates and driven by clockwork mechanism. The movement of the recording pen across the chart is proportional to the quantity measured, and the speed of the record chart is controlled by a driving clock. The recording pen is so formed as to provide an ink reservoir of sufficient capacity for several days' use. The pen point is composed of a special metal alloy insuring a clear-cut line without blurs or blots. The clock is a standard, accurate time-piece, the function of which is to drive the record paper under the recording pen at a uniform predetermined rate, synchronous with the time markings on the paper. The eight-day hand-wound type has been adopted as a standard, and the driving springs are of such size and strength that the mechanism is under a strong uniform force, giving a powerful torque and insuring a positive feed to the record paper. The driving force of the clock is transmitted to the paper roll through a suitable gear and pinion. Three inches per hour has been adopted as the standard rate of feed, but other speeds may easily be obtained by substituting gears



Graphic Recording Meter with Cover Removed to show Mechanism

and pinions having different ratios of teeth. These changes may be readily made, thus enabling the meter to be employed for special tests.

The record paper is graduated longitudinally in a set of parallel lines representing the meter calibration, the spacing being uniform with the various capacities, but of different values. At right angles to the calibration lines are parallel lines representing hours, varying in distance from each other with the particular rate of speed for which the record paper is marked. The rectangular coordinates permit of a record being easily interpolated, and the record can readily be totalized in wattmeters, by means of a planimeter.

The use of mercury suspension in a non-spillable chamber has the advantage of enabling meters to be shipped and installed without the necessity of making complicated or difficult adjustments, as it is simply necessary to fill the pen and start the driving clock. As the meters are of the direct deflection type, the use of relays, control magnets, contacts, etc., is entirely avoided. The construction adopted is also unique in that it secures a high torque or turning moment, which, in conjunction with the minimum friction value of the mercury-floated moving element, gives a ratio of "torque to weight and friction" of such value that errors due to pen friction on the chart are entirely eliminated.

Another important feature is that the moving element of the measuring system is inherently damped or rendered highly aperiodic by the dash pot action of the copper vane traveling through the mercury chamber. This very desirable and essential quality is thus secured without employing the usual auxiliary means for damping. The area of the moving system is so proportioned to the mercury-chamber area that the recording pen will not overshoot or under-register, thus insuring an accurate record on the most rapid load fluctuation.

GENERAL ELECTRIC REGULATING RHEOSTATS

Controlling devices of exceptionally rugged construction are necessary for the control of series, shunt or compound wound direct-current motors for use in machine shops or other establishments where the nature of the work is such that, ordinarily, a constant torque must be developed by the motor, the motor requiring the same current at half speed as at full speed. The regulating rheostats illustrated herewith, are designed for this service, and embody features which add to the convenience and reliability of their operation. These rheostats are the product of the General Electric Co., Schenectady, N. Y.

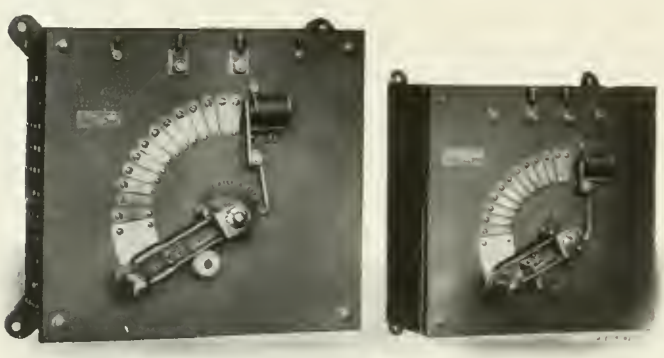


Fig. 1. Rheostats with Renewable Segments

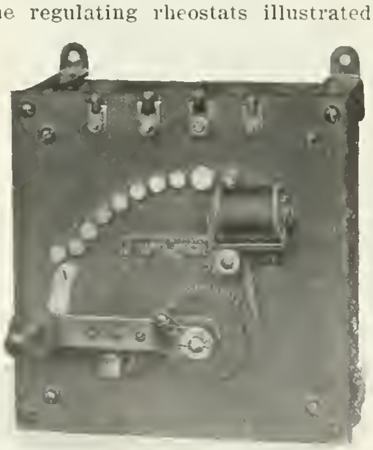


Fig. 2. Regulating Rheostat with Permanent Segments

The type illustrated in Fig. 1 is equipped with contact segments that may be easily and quickly removed. For protection against failure of voltage and the consequent danger of its immediate return, these rheostats are provided with an attachment which holds the switch arm in the running position under normal conditions of operation. If the power fails, the attachment releases the switch arm and a spring instantly returns it to the off position; the motor is then disconnected from the power circuit, and it cannot be started except in the correct way. This device is connected directly across the line in series with a resistance, and is thus independent of the current of the motor field, which varies in different motors, and it will protect any motor with which the rheostats may be used. The resistance units are of an improved design, so constructed as to be non-fragile, and thoroughly ventilated. These rheostats are designated as the CR-151.

When additional protection is required, the type known as CR-155 should be used. They have all the features common to the type previously referred to, and in addition they are provided with a device which protects the motor in case it is too heavily loaded. For installations where the service is not so severe, the CR-152 rheostats, one of which is illustrated in Fig. 2, are used. These are similar to those illustrated in Fig. 1, with the exception that they do not have renewable segments. In the larger sizes, the circuit is made and broken on an auxiliary button, which is so designed that it can be easily renewed.

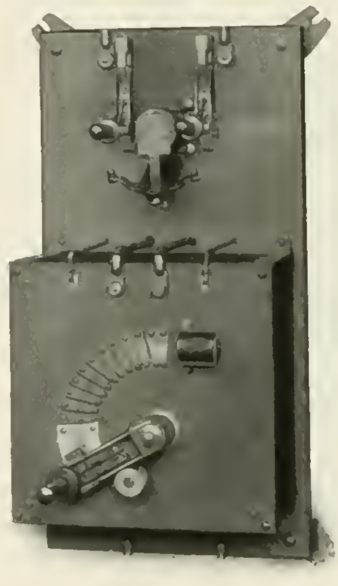


Fig. 3. Regulating Panel of the Wall Type

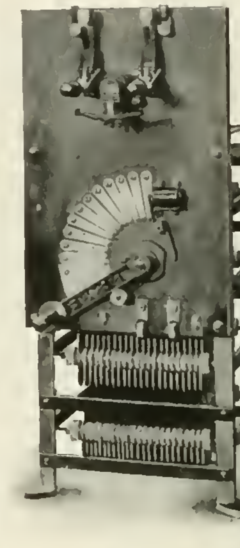


Fig. 4. Regulating Panel of the Floor Type

In Figs. 3 and 4, regulating panels of the wall and floor types are shown. The controllers are mounted on a slate base in connection with a double-pole circuit breaker, thus forming a very compact equipment, which may be easily installed.

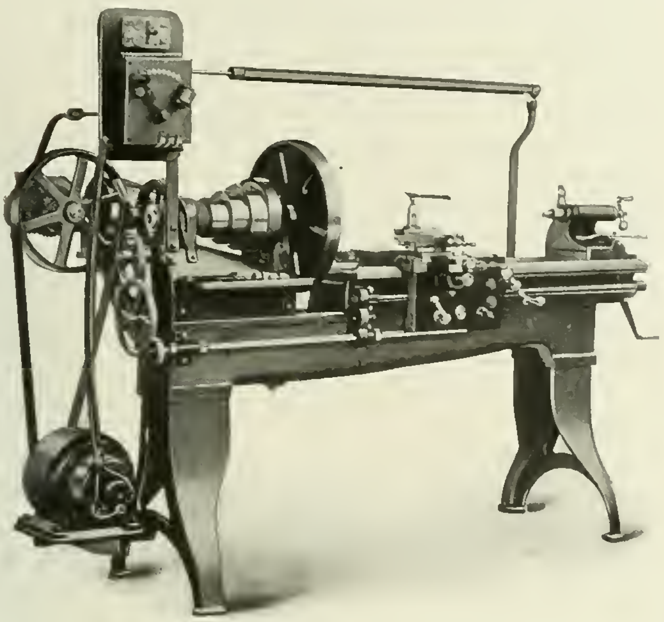
MOTOR DRIVE FOR BARNES SLIDING EXTENSION GAP LATHE

The method of applying a self-contained motor drive to the 12-22-inch sliding-extension gap-lathe built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is illustrated herewith. This type of lathe is particularly adapted to the work of garages and general repair shops, owing to the wide range of work which it is capable of handling; and the self-contained drive adds to the convenience of the equipment where electric current is available.

Any constant-speed motor for either direct or alternating current may be used for driving, and when this type of motor is employed, eight changes of spindle speed are available. A variable-speed motor can, however, be used if desired, to increase the number of spindle speeds. The motor is belted to the driving shaft pulley as shown. On this shaft there are two reversing friction clutch gears which give both forward and reverse speeds. These gears are practically the same as those on the all-geared tapping machine built by this company, which was described in the department of New Machinery and Tools for July, 1910. As the illustration shows, power is transmitted from the driving cone at the rear to the spindle cone by means of a belt. This belt is 2 inches in width, and provision is made for keeping it to the required tension.

The starting, stopping, and reverse motion of the lathe spindle is controlled by the horizontal shifting bar shown above the lathe, which is within convenient reach. Moving this bar

to the left gives a forward motion; a movement to the right reverses the lathe; and it can be stopped by placing the bar in a central or neutral position. The reverse speed is in the ratio of 1¾ to 1. The starting rheostat is mounted on a bracket above the headstock, as shown, and the outfit is fur-



Barnes Sliding Extension Gap Lathe with Motor Drive

nished, wired, belted and ready to run as soon as the feed wires are connected.

This machine has power feeds for both longitudinal and cross movements, and the necessary change gears are furnished for cutting either right- or left-hand threads, ranging consecutively from 2 to 18 (including 11½ pipe thread) and by two's from 18 to 36 and by four's from 36 to 48. The bed of this machine is broad, deep, and well braced. The main and top beds are fitted together by a dovetailed construction which permits the latter to be firmly held at any point by means of clamp-bolts placed transversely through the main bed. For extending the gap, the top bed is drawn back by means of a screw and crank at the rear end. The maximum swing over the bed is 13 inches and over the carriage 8½ inches. The swing through the gap is 22½ inches. The lengths of the beds regularly furnished are 5½ and 7 ½ feet. The maximum dis-

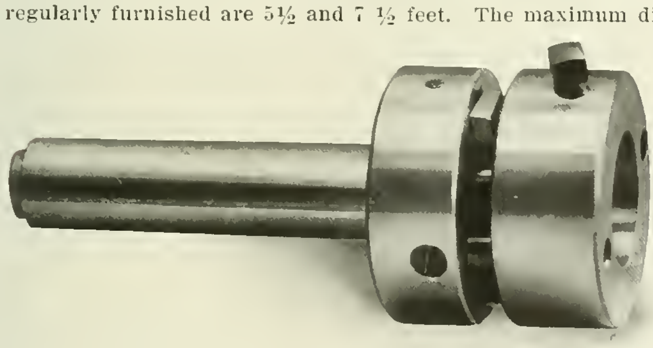


Fig. 1. Cleveland "Silent" Die-holder for Right- or Left-hand Threads

tance between the centers with beds of this length, when closed, is, respectively, 36 and 60 inches. With the top bed extended, the maximum distance between the centers is 54 and 96 inches for the 5½- and 7½-foot beds, respectively.

CLEVELAND "SILENT" DIE-HOLDER

An ingenious design of die-holder that has recently been brought out by the Cleveland Automatic Machine Co., Cleveland, Ohio, is illustrated in Figs. 1 and 2. This is known as the "silent" die holder, owing to the fact that the driving members do not strike or pound against each other after disengagement at the forward end of the turret travel. With some makes, the drivers strike more or less, provided the turret does not recede instantly, thereby damaging the die-holder and making an unpleasant noise. This holder can also be used for right- or left-hand threads by making a few simple changes.

As shown in the sectional view, Fig. 2, the holder has a sleeve which is gripped in the turret and a stem which fits in the sleeve. In the driving mechanism there are two pieces *A*, of the same shape, which are held in position by screws *B*. The driving pins *E*, which come in contact with parts *A* when threading, are plain pins having heads which are somewhat larger than the body and flattened on the sides. Parts *A* and *E* are held in their correct positions by a weak, piano-wire coiled spring *I*, which is just strong enough to keep the two large members of the die-holder together. After the turret has advanced to the end of its travel, and the driving points *A* and *E* are disengaged, the small springs *G* swing parts *A*, which are pivoted on screws *B*, back so that their angular ends are nearly in a straight position, or in a plane at right angles to the axis of the holder. By this movement, the ends of driving pins *E* and parts *A* clear one another, regardless of how long the turret remains in the advanced position, thereby eliminating any pounding and damaging of the parts which carry the die or tap forward. The pieces *C* have no duty to perform when the die-holder is on the threading operation, but when the spindle reverses, parts *C* drop into the slots *H* and hold the die-holder rigid while the turret recedes. These pieces are constantly held in their position, whether in the slots or otherwise, by springs *K*. The slots *H*, into which pieces *C* fit, are milled on a fairly large diameter, and this part of the mechanism is designed to last indefinitely.

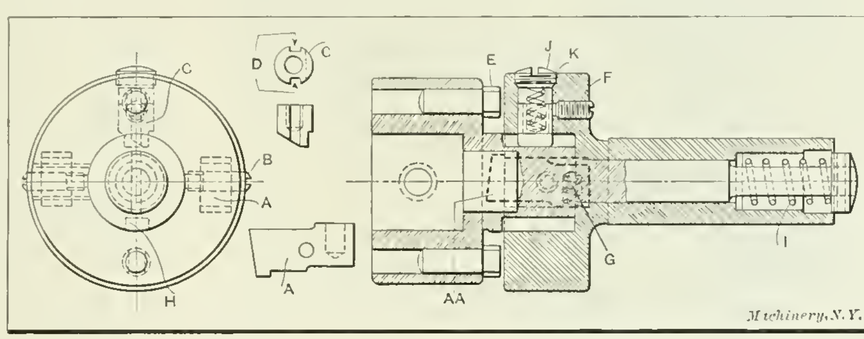


Fig. 2. Sectional View of Cleveland Die-holder

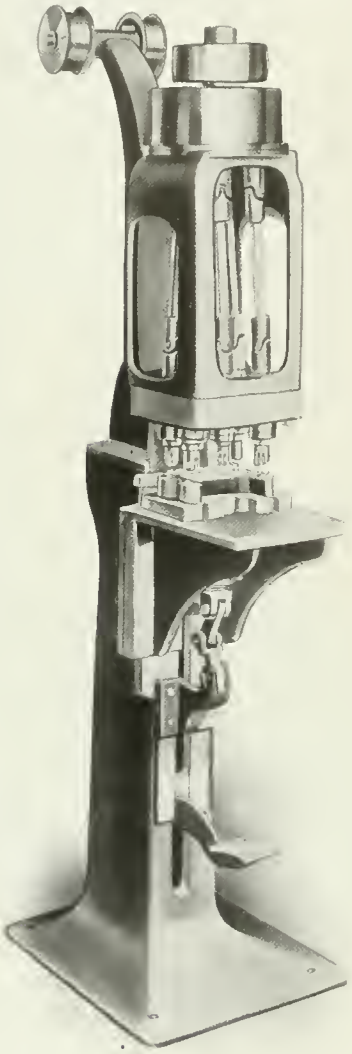
When changing the die-holder for cutting left-hand threads, the screws *B* are removed and the parts *A* are turned over so that the straight driving side is in the opposite direction in both cases. The screws *J* and *F* are also removed so that pieces *C* can be turned around to reverse the position of the driving sides. The small screws *F* fit into slots *E* and simply hold the pieces *C* in their proper position. From the foregoing, it will be seen that the necessary changes for cutting a thread of opposite hand, take but a few moments. After a long series of tests made by the company, the mechanism of this die-holder showed no perceptible wear, which speaks well for its durability.

GRANT FIVE-SPINDLE ROTATING-ROLL RIVET SPINNING MACHINES

The machine illustrated herewith is a special five-spindle noiseless, rotating-roll, rivet-spinning machine, recently brought out by the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This riveting machine differs materially from the regular line of single-spindle riveters built by this company. The table is arranged to move up and down thus bringing the work in contact with the spinning rolls through the medium of a toggle leverage arrangement. The spindles are also individually adjusted vertically to accommodate varying heights of work to be riveted.

The method of revolving the spindles from one common pulley is practically the same as that used in multiple-spindle

drills. The spiral gears which operate the spindles are enclosed in a cast-iron case and are partially immersed in oil. The gears are so arranged that a pumping action takes place while they are in motion, which draws the oil from the bottom up around the sleeve gear bearing; it is then thrown out at the top of the gears, due to the centrifugal force, and returns to the bottom of the gear case, thus lubricating all of the upper working parts in a thorough manner.



Rotating-roll Rivet-spinning Machine

It will be noted that the roll-holders and the lower part of the spindles are mounted in a solid casting which is attached to the main frame of the machine. The spindles are so located in this casting that they exactly match the location of the posts which are to be riveted, it being intended to use several of the roll-holder spindle-locating plates or castings to accommodate work of varying center distances and shapes. The plates all being interchangeable with the frame, can be quickly removed and replaced by others, owing to the fact that the lower part of the universal-joint connecting the lower part of the spindle with the upper, has a square hole in it matching the short spindle which is attached to the plate casting. This permits of its being removed and another plate and its spindles inserted which will exactly match the work it is intended for, without adjustment, in a very few minutes.

This machine was designed particularly for riveting five posts into clock frames or plates. The machine is, however, readily adapted to quite a variety of work where the parts to be riveted are not too close together as it is necessary to have the riveting spindles of sufficient size to insure ample strength.

NEW MACHINERY AND TOOLS NOTES

Mandrel: Jaeger & Sword Mfg. Co., Millbrook, N. Y. Mandrel equipped with a roller grip which holds the work in a positive manner. This mandrel is particularly adapted for such work as gear blanks, collars, bushings, etc.

Tool-room Forge: C. U. Scott, Davenport, Iowa. Forge especially designed for high heats. It is claimed for this furnace that extremely high heats can be taken on finished tools without scaling or blistering them. The size of the heating chamber is 4½ by 9 inches, and the opening measures 5 by 3 inches.

Combined Punch and Shear: Henry Pels & Co., 90 West St., New York City. Combined universal punch, splitting shear, angle and bar cutter adapted to the work of shipyards, boiler, bridge or structural shops. This machine is built in seven sizes, and it will be made to conform to any specifications which may be furnished.

Tool and Surface Grinder: Burke Machinery Co., Conneaut, Ohio. The tool and surface grinder formerly built by the XXth Century Tool Co., is now being manufactured by the Burke Machinery Co. This machine is adapted to the grinding of form and cutting-off tools for hand or automatic screw machines, and is also useful for general tool and surface grinding.

Press: Ferracute Machine Co., Bridgeton, N. J. Press particularly adapted for such work as notched armature disks. The distance between the columns is 40 inches, and the machine is equipped with a circular die-bed. The drive is sufficiently powerful to enable the use of dies having flat cutting surfaces, rather than the sheared type, as those without shear have been found preferable for armature disks.

Electric Hand Drill: United States Electrical Tool Co., 1938 West 8th St., Cincinnati, Ohio. Electric hand drill that is exceptionally light and convenient to handle, its complete weight being only 9 pounds. The motor is of the self starting induction type and is designed for a 110- or 220-volt, 60-cycle, single-phase alternating current. The casing for the motor is made of aluminum to reduce the weight as much as possible.

Drill Press Milling Attachment: Ritter Machine Co., Sedalia, Mo. Attachment that may be applied to a drill press for cutting keyways or for end milling operations. The frame of the attachment is clamped to the spindle quill, and a bevel gear attached to the end of the spindle drives the cutter arbor through a train of gearing. The work is attached to an auxiliary table or slide that is mounted on the regular drill press table.

Recording Instrument: General Electric Co., Schenectady, N. Y. Recording instrument for obtaining information on motor-driven machines, such as the number of hours the machine has been operated, both running light and loaded, the time required for removing a finished piece of work and starting another, etc. This instrument is well designed, both electrically and mechanically, and it is adapted to permanent or temporary installation.

Tumbling Barrel: J. M. Betton, 178 Washington St., New York. Tumbling barrel in which the castings are cleaned by the action of a sand blast which is conveyed to the barrel through two pipes having nozzles which are moved mechanically across the barrels so as to cover all the articles to be cleaned. It is said that from 250 to 350 pounds of brass castings may be cleaned in this barrel in ten minutes and without defacing the surfaces of the work in any way.

Spark Plug Wrench: J. H. Williams & Co., 150 Hamilton Ave., Brooklyn, N. Y. Drop forged, steel spark plug wrench having a box end adapted for ⅞-inch spark plugs, and an open end fitting a tire lug, a ⅜-inch United States Standard cap-screw, a ⅜-inch A. L. A. M. standard nut and cap-screw, and a 9/16-inch setscrew. This wrench has been designed to meet the demand for a convenient and reliable tool, around automobiles, motor boats, gasoline engines, etc.

Combined Punch and Shear: Slater, Marsden & Whittemore Co., Beloit, Wis. Combined power punch and shear built in four different sizes. The body is a single piece casting and the eccentric is cast integral with its shaft. The operating clutch is an improved positive, four-jaw type controlled by a foot lever. This tool is equipped with knives for cutting both round and flat stock, in addition to a punch and die and adjustable gage. Angle shearing attachments, and other special equipment can also be supplied.

Tool-Holder: Universal Tool Co., Jamestown, N. Y. Tool-holder especially designed for planer, shaper and boring-mill work. The body of the holder is enlarged at the working end which contains a swiveling part through which the cutter passes. This swivel may be clamped in any position, which enables the cutter to be used for either vertical or horizontal planing. A self-tightening feature causes the cutter to be held more firmly, as the pressure of the cut increases. As the cutter is located back of the holder far enough to be in line with the pin in the clapper-box, chatter is eliminated.

Reducing Presses: Standard Machinery Co., 7 Beverly St., Providence, R. I. A line of reducing presses used for drawing, broaching and reducing metal. These machines may be equipped with dial feeds, or with an automatic cam knock-out for sheet work. They have extra long ways, long bearings for the slides and ball-and-socket connections. The crank-shaft is of heavy drop-forged steel. The driving power is taken direct on the clutch and pulley, so that the balance wheel is without a belt. The equipment regularly furnished with these presses includes all the accessories ordinarily supplied with a tool of this character.

Power Presses: Leader Foundry & Machine Co., Quincy, Ill. Line of inclinable open-back power presses. The frame of the press proper is mounted in a cradle or base and it may be inclined by means of a screw and swiveling device. The frame is reinforced by tie-rods at the front, which are used only for heavy forming and embossing work. A safety clutch is provided so that the dies may be set while the flywheel is in motion. The automatic knock-out attachment is positive and does not depend upon springs for its action. The cap

grip is designed for holding either round or square shanks rigidly and without marring them.

Automatic Shears: Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y. Automatic shears equipped with straightener for straightening and cutting automatically strips of any desired length from sheet-metal coils. The coil, mounted on a reel, is placed in front of the machine, and the material is drawn between the straightening rolls and then cut into strips, the length of which depends upon the position of an adjustable gage which the stock strikes, thus tripping the machine and setting the shears in motion. This machine has a capacity for stock ranging in widths from 3 or 4 inches to 15 inches and with thicknesses varying from 1/8 to 5/16 inch. It can be furnished for lighter or heavier and wider work and, if desired, it can be arranged for straightening shapes other than sheets or flat stock.

Horizontal Boring, Milling, and Drilling Machine: Cleveland Machine Tool Works, Cleveland, Ohio. Horizontal boring, milling, and drilling machine driven by a three-horsepower constant-speed motor, operating at a speed of 1135 revolutions per minute. The motor is attached to the rear of the bed, and it is protected from chips and dirt by a hood. The machine has 12 speed changes, in geometrical progression; six of these are direct, while the remainder are obtained by the back gears. There are also 16 head, platen, and bar feeds obtained through positive gearing, and varying from 0.005 inch to 0.3 inch per revolution of the spindle. All feeds are reversible and a complete change in either speed or feed can be made by the manipulation of a single handle. These changes can also be made while the machine is running, without interference. Attachments, such as a revolving table, auxiliary table, boring-bars and star-feed facing-head can be supplied.

Pneumatic Grinder: Cleveland Pneumatic Tool Co., Cleveland, Ohio. Portable pneumatic grinder and casting cleaner. This grinder is controlled by twisting one of the handles, a turn to the right or left serving to start or stop the machine. The emery wheel arbor is equipped with ball bearings, and it is connected by a key directly to the main crankshaft, which is operated by four single-acting pistons that are connected in pairs to opposed throws of a double crankshaft. This grinder will drive wheels up to 6 inches in diameter with a 1½-inch face. It is adapted to grinding off fins and risers from iron and steel castings, trimming weld seams, etc. When clamped in a vise, it may be used for edging small tools. The emery wheel can be replaced by a multiple disk scaling wheel for removing rust or scale. A wire wheel brush can also be employed for cleaning castings, and buffing or polishing may be done by the use of a felt wheel.

Rifling Machine: Pratt & Whitney Co., Hartford, Conn. Piston rifling machine that will accommodate pistol barrels of any style up to 10 inches in length. Two barrels may be rifled simultaneously, and the machine is entirely automatic in its operation. The two spindles which carry the rifling rods are mounted in a head which travels longitudinally on the bed. The rotating action of the spindles, by means of which the rifling groove is given the required lead, is governed by a taper bar, the angular position of which is varied for different leads. The indexing mechanism is made to index for either 4, 5 or 6 grooves as desired, and it is entirely automatic. The rifling tools are of the hook cutter type, and they are automatically fed and withdrawn for each succeeding cut until the required depth is reached, when the feed is stopped automatically. Each machine is equipped with an oil pump for conveying the lubricant to the cutters.

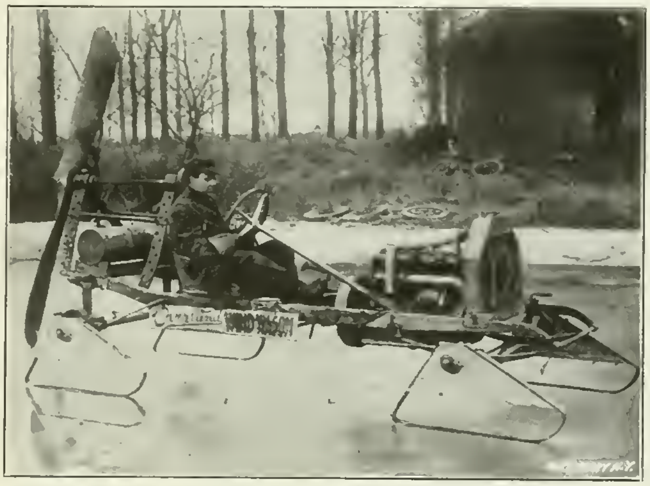
Internal Grinder: The Garvin Machine Co., Spring & Varick Sts., New York City. Hole grinder designed to give a maximum production of high-grade work. Particular attention has been given to the reduction of time required for centering and clamping work in position. By means of special jaws, bevel and spur gears may be accurately located by the pitch line. The master collet type of chuck, and a magnetic chuck with a centering plug for rapidly centering work which cannot be advantageously held in a chuck or collet, can be furnished, as well as slotted faceplates. The work-head of this machine is heavily constructed and it can be swiveled to an angle of 15 degrees for grinding taper work. This head has a cross feed of 2 3/16 inches and it is operated by a handwheel having micrometer graduations, thus enabling accurate adjustment. An adjustable diamond truing attachment is mounted on the rear of the bed, which, when not in use, may be swung back out of the way. This machine has a capacity for holes ranging in diameter from ⅞ inch to 4 inches, and for lengths up to 4 inches. Its net weight is 1200 pounds.

400-Ton Press: A. Garrison Foundry Co., Pittsburg, Pa. 400-ton double-acting drawing press, weighing about 175,000 pounds. One of the novel features of this press is the mechanism by which the blank-holding device is operated. The blank-holder is given an unusually long movement, the lift being 20 inches while the stroke of the ram is 28 inches. This gives a long interval and considerable room, for the insertion of the blank. Another advantage of the construction is that the dwell of the blank-holder is absolute; not only does all action cease but the crankshafts which lift the blank-holder, are held rigidly, being clamped in a vertical position by a latch and arm. The length of the dwell of the blank-holder is also independent of the stroke of the ram. The blank-holder carries two rods which pass down through the frames, and these rods have a cross arm through which the knockout bar passes. This arrangement for ejecting the blanks is said to be very efficient on heavy work, where blanks of unusual thickness have to be forced upward through large dies. The stroke of the knockout rod is adjustable from 20 inches down to as little as desired. The ram is raised and lowered by a small motor, mounted on it. About 100 horsepower is required for driving this machine when doing its heaviest work.

* * *

WIND WAGON ON SKATES

What is known as a "wind wagon" was first introduced to the public at the Indianapolis Motor Speedway last summer, when it raced with a Wright aeroplane driven by Walter Brookins. This machine is a stock Overland car and is driven entirely by a rapidly revolving propeller in the rear. This



"Wind Wagon," with Wheels replaced by Runners

propeller is of the aeroplane type and is eight feet in diameter. The differential is not connected with the transmission in any way, the motor being connected by a chain drive with the propeller. This machine is now equipped with runners, as shown in the accompanying illustration, and it has been driven at a high rate of speed over the snow-covered roads and ice around Indianapolis.

* * *

The formation of the Machine Tool and Engineering Association in Great Britain was referred to in the January number of MACHINERY. The organization has rapidly become a factor in the machine tool business in Great Britain, and embraces now practically all the leading machine tool builders of the United Kingdom. One of the objects of the organization is to regulate the matter of exhibitions of machinery, and the machine tool makers have decided that henceforth they will determine for themselves how, when, and where exhibitions shall be held, rather than to feel under obligations to partake in exhibitions arranged by other promoters. It has been decided to hold a large exhibition of machine tools in 1912 at Olympia. This exhibition will not, however, be confined to machine tools, but the association has decided to widen its scope so as to include every phase of engineering.

* * *

Wonderful feats in flying are becoming so common that little attention seems to be paid to even rather remarkable achievements. It seems, however, that rather too little attention has been given to the flight of Wynmalen, who, carrying a passenger, flew from Paris to Brussels and back—a total distance of nearly 350 miles—in less than 30 hours, on October 16 and 17. This flight won for the aeronaut a $20,000 prize offered by the French Automobile Club, the requirement being that the flight should be completed in less than 36 hours. The flight in one direction—Paris-Brussels—was completed in 5 hours 20 minutes.

DON'TS FOR MACHINISTS*

By H. E. WOOD†

Don't forget that a good pin gage is a very desirable and reliable tool.

Don't use a fine file for filing babbitt metal, lead, or any soft material.

Don't use a V-thread tool to cut a U. S. standard thread; they are not alike.

Don't force a drill that does not cut freely on account of incorrect grinding.

Don't hammer an unplaned steel or rough cast-iron piece down onto parallels.

Don't try to ream out much more than 1/64 inch of stock with a hand reamer.

Don't try to ream out much less than 1/32 inch of stock with a "rose reamer."

Don't hold your hand on the longitudinal carriage handle when cutting threads.

Don't spring a model, or templet out of shape when using it to lay out work from.

Don't hit the contact points of firm joint calipers on hard surfaces to adjust them.

Don't lubricate the packing of a gasoline pump with oil; common hard soap is better.

Don't fail to provide a way to get dowel pins out of work before you drive the pins in.

Don't try to cut threads on steel or wrought iron dry; use lard oil or a cutting compound.

Don't forget that a die will usually shrink more lengthwise than sidewise, in hardening.

Don't waste time trying to file with a dull file; new files are cheaper than a man's time.

Don't be reluctant about using a bastard file when possible; you can finish with a finer one.

Don't forget that gasoline is an efficient but dangerous servant for cleaning dirty parts.

Don't attempt to take a final cut on a job of threading, without a keen free cutting tool.

Don't do all the peening in one or two places if you have occasion to peen out a piston ring.

Don't think because some men call a mill file a "lathe file." that you can't do bench filing with it.

Don't forget that the side grain of a piece of sheet steel will dull tools less than the end grain.

Don't put more than two end thrusts collars on a line-shaft; under ordinary conditions, two will be sufficient.

Don't connect the ends of belts and leave the hooks poorly clinched, as the projecting ends will tear the hands.

Don't put packing under a die, or bushings in a die, and forget to provide a hole for the scrap to fall through.

Don't forget that a tank of hot soda water is a fine thing to clean dirty work with; ask for it and get it if you can.

Don't use rubber in any place on a machine where oil will get at it; the oil will soon eat the life out of the rubber.

Don't let brass or copper be exposed to ammonia in an ice machine, for the ammonia will eat it as acid eats zinc.

Don't neglect for a minute reporting the line-shaft in case you notice a coupling working loose, or a key working out.

Don't put up cord belt shifters and leave the ends hanging near belts, without having weights on the end of the cord.

Don't forget that you should have a rack in front of your vise to keep your files in, for it ruins them to hit together.

Don't run a chuck or faceplate up to the shoulder suddenly; it strains the spindle and threads and makes removal difficult.

Don't forget that it saves time and worry to have the tool-room checks stamped with the numbers on both sides of them.

Don't continue using a lathe in which the tail-center does not eject itself; if it is too short, insert a pin into the back end.

Don't forget that a crossed belt may be made to run to one side, or to the center of the pulleys, by crossing it different ways.

* For Don'ts previously published in MACHINERY, see "Don'ts for Electricians," October, 1910, and accompanying references.
† Address: 182 N. 4th St., Newark, N. J.

Don't forget that common hard soap makes a splendid thing to temper a scratch awl in; it needs no drawing after this plunge.

Don't screw your lathe centers up too tight on any kind of work, as it is sufficient to have the slack all taken up, and no more.

Don't loosen the screws too much, at the time you raise or lower the shaper knee; it allows a chance for chips to get behind it.

Don't clean out a tapped hole in a hardened piece of work by running a tap into it, even if you can scratch the piece with a file.

Don't throw a file-cleaning brush in among heavy pieces of scrap, etc.; the wire bristles need protection just as much as the file beard does.

Don't fail to put a little bees-wax, or Albany grease, or some other heavy grease on the bench draw-slides; it saves both money and energy.

Don't forget that in an emergency (when you have no nut arbor) you can screw two nuts on a tap and put them in a lathe and face them.

Don't slide sheets of copper, brass, aluminum, or any soft material along on a pile of the same material without placing a board under them.

Don't forget that the reason pulleys are made larger in the center of the face than at the edge is because the belt runs to the highest point.

Don't be in too much of a rush or nervous when callpering a piece of work, as that is one job at which you must be deliberate to insure accuracy.

Don't fail to pick up all washers, nuts, odd bolts, straps, scrap pieces of brass, etc., and put them where they can be found when wanted for use.

Don't caliper a piece of work in a grinding machine when the emery wheels are running, as even the slightest vibration destroys the sense of touch.

Don't forget that if your largest lathe dog has too small a mouth to bite the job, you can grip it by using two straps, of most any kind, bolted together.

Don't leave defective goods lying around the shop, in windows, in corners and nooks, or on ledges; it is better to consign them at once to the scrap heap.

Don't screw a tool-post screw any tighter than is absolutely necessary; many mechanics have a false idea as to how tight a lathe tool should be to do its work.

Don't throw odd-sized bolts into a bin among the standard bolts; it is better to have a special bin for all odd bolts and nuts, or to put them in the scrap box.

Don't wear overalls with rags on them; if you can't afford to buy new ones have the old ones patched; patches are no disgrace, but rags are dangerous in many ways.

Don't forget that if you tell the emery wheel or carborundum wheel manufacturers what class of work you are to do, they will advise you rightly about what wheels to use.

Don't use a large tap wrench on small taps or reamers, even if you can screw the jaw down so that the hole fits the shank, as the slender tools are liable to be broken.

Don't use a lathe carriage any length of time in one place and then start and run it a long distance, without cleaning off the shears and adding a little oil before you start on the trip.

Don't attempt to cut a T-slot on a shaper or planer without raising your tool up over the work on each return stroke, unless the clapper-block is bolted down so that the tool cannot rise.

Don't expose the fine or delicate cutting edge of any tool to the hottest place in the fire; you should heat the heavy parts first if possible and let the heat run out to the thin or cutting edges.

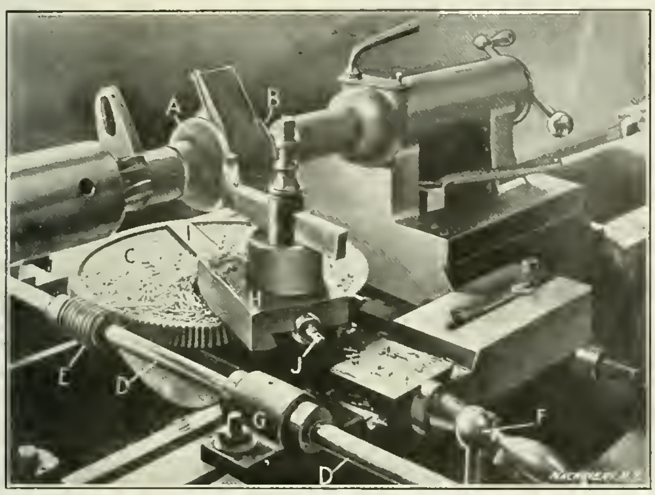
Don't plane down the side of a piece of work on a planer or shaper without shifting the clapper-block over to one side, thus causing the tool to swing away from the surface you are cutting, and not ride over it.

Don't grow envious and start "knocking" a man when you know he is getting more wages than you are; rather try to make yourself as valuable to the company as he is and thus get an increase in your own wages.

LATHE ATTACHMENT FOR TURNING SPHERICAL SEGMENTS

By ETHAN VIALL*

The turning of the small balls on the ends of ball-cranks, or other similar jobs, is comparatively easy and may be done in several ways with nothing more than forming tools of either circular or tube-like cutting section, but when it comes to doing spherical turning on large pieces of work where the cut is interrupted in the manner shown in the accompanying engraving and in which considerable tough metal has to be removed, a simple forming tool is not practicable for a number of reasons; and a specially designed fixture is best if more than a few are to be machined. The piece shown being turned is part of the ball-and-socket section of a case for the shaft drive on an automobile made by the Nordyke & Marmon Co., Indianapolis, Ind., and it is turned spherical only on the surfaces indicated by the points *A* and *B*. As the engraving plainly shows, the fixture used is attached to the regular tool carriage of the lathe, only the cross-slide being removed. Circular motion is imparted to the large worm gear *C*, through the shaft and worm *D* and *E*, by



Ball-cutting Attachment for a Lathe

turning the hand crank at *F*. The shaft *D* is attached to the tool carriage by two easily removed brackets or boxes which are bolted to the T-slots at the front and rear, one bracket being shown at *G*. Adjustment of the cutting tool is made possible by having the toolpost and block *H*, set on a cross-slide *I* and moved in or out by the screw *J*, though similar results to a limited extent may be obtained by setting the tool so as to project from the toolpost to a greater or less degree as desired.

The applicability of this form of attachment to various spherical turning jobs of all kinds and sizes will be at once grasped by those having such work to do.

* * *

A copy of a monthly magazine published eleven years ago containing a leading article that recorded American progress in automobiles to date, was lately brought to our attention. It was illustrated with several halftones showing the prevalent types of self-propelled vehicles of the period. The change that has taken place since is astounishing. The bicycle-type wheel has disappeared; the short body and the other buggy or horse-drawn vehicle characteristics also. The automobile was in a most unsatisfactory state so long as it followed the conventional lines of its progenitor—the horse-drawn vehicle. The logical position of the engine was found by the French designers to be directly in front where it is get-at-able, where the radiator is most advantageously located and where the engine hood gives a characteristic to the lines of the machine as a whole quite in keeping with its purpose. Moreover the forward position of the power plant made necessary the long wheel base which is advantageous in many ways. American inventors had located the engine in almost every other position, but with poor success.

* Address: 131 Mills Ave., Hartwell, Ohio.

EDWARD DANIEL MEIER

Edward Daniel Meier, who was elected president of the American Society of Mechanical Engineers at the December meeting, was born of German parentage in St. Louis, May 30, 1841. After a preliminary education in the country schools, he entered the Washington University of St. Louis, where he spent the years from 1856 to 1858. During the four following years, he was educated at the Royal Polytechnic College, Hanover, Germany, and returned to the United States in 1862, beginning his engineering career at the Mason Locomotive Works at Taunton, Mass. In the following year, however, he left the employ of this firm to enlist as a volunteer in the Union Army, and remained in service until the close of the war in 1865. After the war he immediately turned his attention to peaceful pursuits, but the military spirit continued active in him, for in 1877 he organized the first company of emergency militia in St. Louis, and he became afterwards a colonel, and was finally put in command of the entire state militia. The appointment of brigadier general was offered to him, but he declined it, and soon afterwards resigned from active service. His civil career has been no less distinguished than his military achievements. Immediately after the war he spent a year as machinist and draftsman in the Rogers Locomotive Works, at Paterson, N. J., and from 1867 to 1870 he was assistant general superintendent, and later superintendent of machinery for the Kansas Pacific Railway. In the '70's he was engaged as consulting mechanical engineer in the designing and building of machinery of various kinds. In 1882, Col. Meier began developing the well-known Heine type of water-tube boilers, and from 1885 to the present time he has been president and chief engineer of the Heine Safety Boiler Co. Practically all the advances and improvements that have been made in the past twenty years in the legal requirements of boiler material have been made through the suggestions and under the advice of Col. Meier and his associates. He has also been interested in several other mechanical devices which he has designed or perfected. His association with the American Society of Mechanical Engineers dates back to the first years of the existence of the Society, and he has served in an official capacity in that body since 1895, when for three years he was one of the managers. He was also vice-president from 1898 to 1900, and from 1909 to 1910.

* * *

In the article entitled "A Micrometer Stop for the Lathe Carriage," published in the January issue of MACHINERY, it was stated that the scale *H* shown in the illustration accompanying that article is graduated into one-hundredths of an inch. Instead it should have read that the scale is divided into twentieths of an inch.

PERSONALS

Foster Bartlett has been appointed foreman of the foundry of the New Home Sewing Machine Co., at Orange, Mass.

Walter Leonard of Athol, Mass., has taken the position of master mechanic for the Union Mfg. & Drop Forge Co., Providence, R. I.

Ethan Viall has resigned as associate editor of MACHINERY and is now connected with the *American Machinist* in a similar capacity.

J. F. Barr, formerly Detroit manager for Manning, Maxwell & Moore, Inc., has joined forces with the Gear Grinding Machine Co., Detroit, Mich.

F. P. Huston, sales manager of the Kempsmith Mfg. Co., Milwaukee, Wis., sailed in December for an extended trip abroad in the interests of his company.

William H. Hooper, for the past nine years foundry superintendent for the New Home Sewing Machine Co., Orange, Mass., has resigned his position.

William Hadley, for the past four years general foreman of the machine department of the Hendee Mfg. Co., Springfield, Mass., has resigned his position.

George W. McIntyre, representing the Monarch Valve Co., Springfield, Mass., is taking a six weeks' trip through France, looking after the interests of the company in that territory.

E. F. Lake, for a number of years associate editor of the *American Machinist*, has resigned, and will, for a time, contribute articles on metallurgical subjects to the technical press generally.

H. B. Layman, formerly with the Packard Co., and for the past year president and general manager of the Brightwood Motor Mfg. Co., Springfield, Mass., has withdrawn from that company.

W. L. Schellenbach, formerly with the John B. Morris Machine Tool Co., Cincinnati, Ohio, has taken the position of chief engineer with the Lodge & Shipley Machine Tool Co., of Cincinnati.

Cecil H. Taylor, formerly chief engineer of the Hudson Motor Car Co., Detroit, Mich., has taken a position in the engineering department of the Everett-Metzger-Flanders Co., in the same city.

E. J. Stone, Springfield, Mass., has resigned as chief draftsman and mechanical engineer of the Chapman Valve Mfg. Co. to take the position of general manager for the Brightwood Motor Mfg. Co., of Springfield.

W. A. Davidson, for the past six months draftsman for the Parker Transmission & Appliance Co., Springfield, Mass., has resigned and will return to his former position with the Colburn Automobile Co., Denver, Colo., as designing and head draftsman.

Walter Loring Webb and James M. Kennedy, well-known in the engineering world, have been added to the organization of the engineering firm of Dodge, Day & Zimmerman of Philadelphia, Pa. Mr. Webb has a reputation as the author of several engineering text-books.

E. C. Hosmer, for the past three years employed by the Crucible Steel Co. of America, has resigned and taken a position with Denman & Davies, steel and iron merchants, New York. Mr. Hosmer will cover the Connecticut and Massachusetts territory, his headquarters being at Springfield, Mass.

F. O. Hoagland, who was recently appointed acting works manager of the Remington Arms Co., Ilion, N. Y., at the time when C. C. Tyler, formerly works manager, was appointed general manager of works for the Remington Arms Co., Ilion, N. Y., and the Union Metallic Cartridge Co., Bridgeport, Conn., has now been appointed works manager of the Union Metallic Cartridge Co.

W. S. Chase and P. E. Ryan of the National-Acme Mfg. Co., Cleveland, Ohio, sailed for England January 14, for the purpose of establishing a sales branch in Great Britain. This branch will handle not only the regular Acme automatic multiple-spindle machines, but special machinery for second operation work, etc., as well. Messrs. Chase and Ryan will also spend some time traveling on the Continent in the interests of their company.

* * *

The latest Government report of the number of railroad employes puts the total number for the country at 1,672,074. Of this number approximately 665,000, or 40 per cent., are employed on railroads which have inaugurated pension systems. The leading railroads having inaugurated pension systems are the New York Central, the Rock Island, the Pennsylvania, the Buffalo, Rochester & Pittsburg, the Chicago & Northwestern, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific, the Lackawanna, the Baltimore & Ohio, the Atlantic Coast Line, the Reading, and the Jersey Central.

Charles Hill Morgan

OBITUARIES

Clayton S. Mattison, treasurer and superintendent of the Eagle Square Co., South Shaftsbury, Vt., died in January, aged forty-one years.

Charles Nicholson, salesman for the Carborundum Co., Niagara Falls, N. Y., died at his home in Philadelphia, December 18, aged fifty-nine years.

Jay E. Spaulding, president and treasurer of the New England Pin Co., Winsted, Conn., died at his home on January 6, aged sixty-four years.

Alpheus W. Rice, for the past forty-five years an employe at the Smith & Wesson Works in Springfield, Mass., died at his home in that city December 3, aged seventy years.

Henry Grant Thompson, secretary and treasurer of the Henry G. Thompson & Son Co., New Haven, Conn., died recently at Paris, France, after an operation for appendicitis, aged fifty-seven years.

Fred B. Childs of Spokane, Wash., who was master mechanic of the Northern Pacific Railroad Co.'s shops, was last month stricken with apoplexy and died while on board a train in Montana. He was forty-eight years of age.

James Sadler, one of the first steel makers in the United States, and for many years in charge of the Farist & Windsor Steel Co. at Windsor Locks, Conn., which company furnished much steel for the government during the Civil War, died at Springfield, Mass., January 4, aged seventy six years.

CHARLES HILL MORGAN

On January 10, Charles Hill Morgan, president of the Morgan Spring Co. and the Morgan Construction Co., of Worcester, Mass., died at his home at 28 Catharine St., of that city. Mr. Morgan was born January 8, 1831, and was thus eighty years old at the time of his death. At the age of fifteen he entered the machine shop of his uncle, Mr. J. B. Parker, of Clinton, Mass., as an apprentice; during this time he also studied mechanical drawing at night, after twelve hours' work in the shop. When twenty-one he was put in charge of the Clinton mills dye house, and devoted himself with great zeal to the study of chemistry. He was then for some time draftsman for the Lawrence Machine Co., and from 1855 to 1860 was employed in the same capacity by the well-known inventor and manufacturer, Erastus B. Bigelow. In 1860 Mr. Morgan formed a partnership with his brother, Francis H. Morgan, and was for some years engaged in the manufacture of paper bags in Philadelphia. He at this time developed machinery which put paper-bag making in the United States on a commercial basis. In 1864 he entered into the employ of the Washburn & Moen Mfg. Co., of Worcester, Mass., as general superintendent—a position which he held for twenty-three years. In this capacity he traveled extensively in Europe for the purpose of studying wire manufacture abroad. For eleven years he was one of the directors of the company. Mr. Morgan has been prominently identified with the development of the continuous rolling mill and with spring making. In 1881 he founded the Morgan Spring Co. for the manufacture of springs, and was a pioneer in this line of business. In 1891 the Morgan Construction Co., which devoted itself to the making of rolling mills and wire drawing machinery, was founded. In 1852 Mr. Morgan married Harriet T. Plympton of Shrewsbury, Mass., who died a few years later leaving a son. In 1863 he married Rebecca A. Beagary who, with two sons and two daughters, survives him.

COMING EVENTS

January 28-February 11.—Tenth Annual National Automobile Show under the auspices of the National Association of Automobile Manufacturers, Inc., in the Coliseum and Coliseum Annex, Chicago. S. A. Mills, manager, New Southern Hotel, Chicago.

February 9.—Monthly meeting of the Institute of Operating Engineers, in the Engineering Societies Bldg., 29 W. 39th St., New York City.

June 14-16.—Annual Convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics', and Master Car Builders' Associations, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

SOCIETIES AND COLLEGES

American Society of Engineer Draftsmen, 116 Nassau St., New York. Prospectus of the aim and scope of this new national organization for draftsmen.

New York Electrical Credit Association, 80 Wall St., at its meeting in December elected W. B. Wallace to succeed P. M. Haight as president, and U. S. Kolby and F. A. Wurzbach as the new directors. The hold-over directors are: John H. Dale, W. H. Roberts, W. C. Hall, B. H. Ellis, and W. B. Wallace. A. L. Miller was re-elected representative on the board of managers. The following concerns were also elected members of the association: Hunter Fan & Motor Co., Fulton, N. Y.; New England Electric Supply Co., Hartford, Conn.; Westinghouse Electric & Mfg. Co., Pittsburg, Pa.; Penn Yan Flexible Conduit Co., Penn Yan, N. Y.; and Richard W. Osland, New York City.

Sheffield Scientific School, Yale University, New Haven, Conn., is having a new mechanical engineering laboratory built, the funds for which were supplied to the Sheffield trustees by two graduates, G. G. and W. S. Mason. Work on the building is progressing, and it should be completed early this summer. The building, which has three floors above the basement, will be 85 feet wide by 200 feet long, especially adapted for its purpose. In the building no provision has been made for recitation or drawing-rooms, the entire space being devoted to instruction and experimental work for undergraduates and for research work along engineering lines for graduate students and special investigators. The main floor of the laboratory will contain the larger pieces of the equipment, and will be served by a 40-foot electric crane traveling its full length.

NEW BOOKS AND PAMPHLETS

Annual Report of the International Association of Municipal Electricians. 170 pages, 6 x 9 inches. C. R. George, secretary, Houston, Texas.

Annual Report of the Statistics of Express Companies in the United States. 82 pages, 8 x 10½ inches. Prepared by the Bureau of Statistics and Accounts, Washington, D. C.

Proceedings of the Thirtieth Annual Convention of the American Water Works Association, held at New Orleans, April 26-30, 1910. 292 pages, 6 x 9 inches. John M. Diven, secretary, Charleston, S. C.

Washing and Coking Tests of Coal. By A. W. Belden, G. R. Delamater, J. W. Groves, and K. M. Way. 62 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 5.

North Dakota Lignite as a Fuel for Power-Plant Boilers. By D. T. Randall and Henry Kreisinger. 42 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 2.

Test of an "E2a" Locomotive on the Pennsylvania Railroad Company's Test Plant, Bulletin No. 5. 115 pages, 6 x 9 inches. Published by the Pennsylvania Railroad Co., Altoona, Pa.

This bulletin contains detailed information of the tests on a class "E2a" locomotive of the two-cylinder simple Atlantic type, performed at the locomotive testing plant at Altoona, Pa. It had been purposed to make this test at the plant when installed at St. Louis, but lack of time prevented this from being done. This bulletin is to be considered supplementary to the publication issued after the close of the Louisiana Purchase Exposition, and gives the means of comparing the performance of the simple-cylinder locomotive with that of the four-cylinder compound locomotive, the latter of which was tested at that time.

Freight Train Resistance. By Edward C. Schmidt. 152 pages, 6 x 9 inches. 50 illustrations, 69 tables. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 43.

This bulletin presents the results of tests upon thirty-two freight trains in regular service, in order to determine their train resistance. These tests were undertaken to study the effects upon train resistance of both speed, and the average weight of cars composing the trains. The results show the usually-accepted influence of speed upon resistance, and they reveal a still greater influence of average car weight in affecting changes in resistance. For trains composed of cars weighing 15 tons on the average, the resistance is shown to vary from 7½ pounds per ton at 5 miles per hour to 13½ pounds per ton at 40 miles per hour; while for trains composed of cars weighing 75 tons, the resistance is found to vary from 3 pounds per ton at 5 miles per hour to 5½ pounds per ton at 40 miles per hour. The whole treatment of the subject is taken up in a masterful way, and represents a tremendous amount of work on the part of the experimenters.

Securing Efficiency in Railroad Work. By Harrington Emerson. 38 pages, 5 x 8 inches. Published by The Emerson Co., 30 Church St., New York. Price, 25 cents.

This booklet is a reprint of a lecture delivered before the Graduate School of Business Administration of Howard University, November 16, 1910, and in brief form gives the substance of the efficiency theories being advanced by Mr. Emerson. In support of these theories the brochure goes on to explain the wonderful savings effected on the Santa Fe, by the application of the principles laid down by Mr. Emerson. From data given, marked advances were made in every direction by this road on the introduction of this new system. Particular emphasis is given throughout the book to the geometrically increasing efficiency due to arithmetical improvements in each of several dependent departments. On this basis, some wonderful inferences are drawn. Another striking feature of the book, is the prominence given to the bonus system of remuneration. Mr. Emerson has great faith in its efficiency in solving the labor problem.

Practical Alloying. By John F. Buchanan. 205 pages. Illustrated. Published by The Penton Publishing Co., Cleveland, Ohio. Price, $2.50.

This book, by the well-known writer in foundry papers, has just made its appearance from the press. Mr. Buchanan has a high reputation as an authority on all kinds of alloys, with particular reference to their practical working. Without doubt this is one of the most complete and comprehensive treatises on alloying that has ever been published. The treatment of the subject is extremely interesting, the development of the casting industry being followed from the earliest times—Aaron's golden calf—culminating in a full, clear exposition of present-day practice. One of the strong features of the book is the number of practical tables contained, of which there are some thirty-three in the text, and in addition a number more in a concluding appendix. This feature, in itself, makes the book of high value. The chapters are as follows: Metal Refining—Ancient and Modern; History and Peculiarities of Alloys; Properties of Alloys; Some Difficulties of Alloying; Method of Making Alloys; Color of Alloys; Notation of Alloys; Standard Alloys, Foundry Mixtures; White Metals; Solders, Novelty Metals, etc.; Fluxes for Alloys; Gates and Risers for Alloys; About Crucibles and Testing Alloys.

The Slide Rule. By Frank C. Hinckley and William W. Ramsay. 104 pages, 4¼ x 6¾ inches. Published by the Engineering Text-Book Co., Boston, Mass. Price: cloth, $1.25; flexible leather, $1.75.

This book is primarily written for men of limited mathematical training, with special reference to the needs of boiler inspectors, engineers and mechanics. It contains some illustrative examples showing the adaptability of the slide rule to problems in steam engineering. The book is the outcome of the experience of the authors and their friends, who encountered numerous difficulties in the mastering of the slide rule from the usual instruction book, and who therefore realized that a text-book written in plain English would tend to raise the veil of mystery and render its use possible to other than higher mathematicians. Contrary to customary methods, the book is unillustrated, it being believed that the only satisfactory method of instruction is by the use of the actual instrument. Chapters are as follows: The Rule; Finding Numbers on the Slide Rule; Multiplication; Division; Decimal Equivalents; Circumferences of Circles; Upper Scales and Square Roots and Squares; Areas of Circles; Cube Roots and Cubes; Logarithms; Table of Natural Sines; Table of Natural Tangents; Inverted Slide; Millimeter Scale; Position of Decimal Point; Adaptability of the Slide Rule; Principle of the Slide Rule.

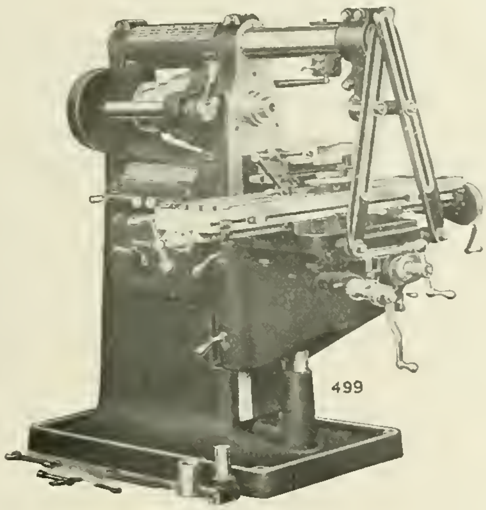
Scientific American Cyclopedia of Formulas. By Albert A. Hopkins. 1077 pages, 6 x 9 inches. Illustrated. Published by Munn & Co., Inc., New York.

Twenty years ago the first volume of this book was published. Since that time, however, the world has rapidly advanced and each year a vast amount of technical literature has accumulated; therefore, instead of attempting to make any drastic revision of this book, it was deemed advisable to recompile and rewrite the entire book. This work required the constant attention of a staff of experts and professional indexers for a period of two years. The old book was thrown out in its entirety, only about 30 per cent of its formulas being retained. The others were derived from entirely new sources, chief among which is the *Scientific American*, followed by the various American and foreign drug and technical journals, of which practically all have been laid under contribution. While the present volume contains about 15,000 formulas, over 150,000 formulas still remain on file, so that only about one in ten of these were used. The twenty-seven chapters are divided as follows: Accidents and Emergencies; Agriculture; Alloys and Amalgams; Art and Artists' Materials; Beverages; Cements, Glues, Pastes, Mucilages; Cleansing, Bleaching, Renovating; Coloring of Metals; Dyeing; Electrometallurgy and Hot and Cold Coating of Metals; Glass; Heat Treatment of Metals, Annealing, Brazing, etc.; Household Formulas; Ice Cream, Confectionery and Chewing Gum; Insecticides and Extermination of Vermin; Lapidary Art, Artificing in Ivory, Bone, etc.; Leather; Lubricants; Paints, Varnishes, Bronzing, Lacquers, etc.; Photography; Preserving and Canning, Condiments, etc.; Rubber; Soap and Candles; Soldering; Toilet Preparations and Perfumes; Waterproofing and Fireproofing; Writing Materials. The index is especially good, great care having been taken in its compilation.

Elements of Electricity for Technical Students. By W. H. Timbie. 556 pages, 5½ x 7½ inches. 415 illustrations. Published by John Wiley & Sons, New York. Price $2, net.

The author, who is instructor in industrial electricity at the School of Science and Technology, Pratt Institute, Brooklyn, N. Y., has primarily intended this book to meet the needs of young men who desire to follow an occupation connected with the electrical industries. He has aimed, in the preparation of the book, to include an adequate amount of information concerning electrical laws; to apply the information contained to actual practice, and not to abstract theories; to provide sufficient practice by a great number of concrete practical examples; and to eliminate history and general theory, and present only those facts and principles which the student needs to know, and to know well, in order to obtain a general conception of the principles and practice of electricity. For this reason the book does not enter into details of construction of a great number of different devices, as matter of this kind quickly becomes obsolete and is of comparatively little value for the student to acquire while at school. Knowledge of this kind is much more quickly and satisfactorily obtained in the actual practice into which he will enter later. In a comparatively short space, however, the general principles of the different phases of electrical engineering are well covered, and a novel departure in technical book-making, consisting of a summary of the contents of each chapter at the end of the chapter, has been introduced. This summary is an excellent idea. It would greatly enhance the value of all engineering textbooks if they were provided with a concluding paragraph to each chapter giving a general idea of the subject matter treated, and the main conclusions. In fact, the summary in the book under review might even have been made somewhat more extensive without fear of repeating too much of what had already been said in the more thorough treatment of the subject in the chapter itself. A great number of numerical examples selected from practice are also included. The book gives evidence of having been carefully prepared, although some inaccuracies seem to be almost unavoidable in engineering book-making. For example, on page 383 it is stated that the efficiency of the Moore tube light compares favorably with that of the best metal filament incandescent lamps. In the summary of the same chapter on page 385 it is stated that the light is of about the efficiency of carbon filament lamps. As the efficiency of carbon filament lamps is only about one-half of that of metallic filament lamps, the student may be somewhat puzzled. We are sure, however, that a book of this type will see a second edition, giving an opportunity for correcting small defects of this kind. The contents by chapters are as follows: Magnets and Magnetism; Electromagnets; Ohm's Law; Power Measurement; Measurement of Resis-

The No. 2 Cone Driven Cincinnati Miller



The No. 2 Plain

Our Cone Type Millers have not been forced off the market by single Pulley Machines. And they will not be. We are making and selling more of them than ever before. We are able to do this because we keep our design ahead of all others.

The illustrations show the No. 2. It has the manufacturers' standard range—

Plain—28″ x 8″ x 19″
Universal—25″ x 8″ x 18″

It can be supplied with power feed in one, two or three directions.

We call especial attention to the following features in its design:

The COLUMN is a complete box of rectangular form.

The FEED MECHANISM is a single unit assembled by men who are specialists on this work.

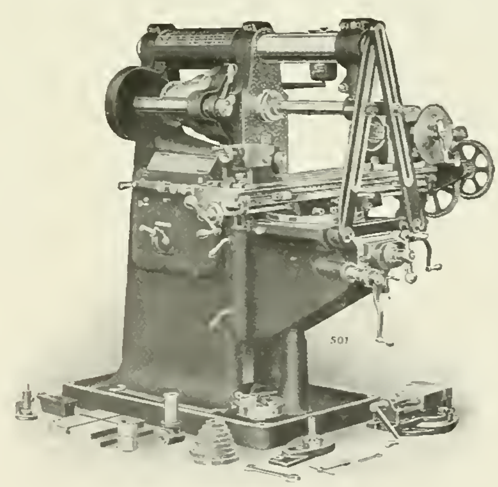
When in place, it is an integral part of the machine.

It is high above the floor. The operator need not stoop to reach the levers.

The feed changes may be made within the practical limits of milling while taking a cut without inconvenience, or injury to the gears, because they are all hardened and run at moderate speeds.

The feed index is direct reading. It is the simplest index used on any machine tool.

All these features, make this type the ideal machine for manufacturing small parts, and for Tool Room use.



The No. 2 Universal

Get our Complete Catalog. Ask for Prices and Delivery.

The Cincinnati Milling Machine Co., Cincinnati, O., U.S.A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.
JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana.
ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

tance; Magnetic Field Due to a Current; The Generator; The Motor; Inductance; Capacity; Electrochemistry; Photometry and Electric Illumination; Electrical Measuring Instruments; and Alternating Currents.

CATALOGUES AND CIRCULARS

Patterson Tool & Supply Co., Dayton, Ohio, and Indianapolis, Ind. Leaflet of emery grinders.

Buffalo Steam Pump Co., Buffalo, N. Y. Illustrated folder of the company's Class B centrifugal pumps.

Walton Co., Hartford, Conn. Small leaflet listing various tap extractors manufactured by this concern.

Keuffel & Esser Co., Hoboken, N. J. A neat New Year's wall hanger representing an engineers' camp in the Klondike.

W. S. Rockwell Co., Hudson Terminal Bldg., New York. Catalogue No. 12 devoted to the Rockwell stationary crucible melting furnace.

Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Copy of the house organ, *The Drill,* published at intervals, and descriptive of the Baush drills.

Winnipeg Development and Industrial Bureau, Winnipeg, Canada. Illustrated book of Winnipeg views with a brief summary of its wonderful growth.

International Machine Tool Co., Indianapolis, Ind. Pasteboard folder containing a graphical comparison between the capacity of a Libby lathe and an ordinary engine lathe.

Kern Machine Tool Co., Cincinnati, Ohio. Leaflet describing this company's 15-inch drilling and tapping machine, containing a brief description with tabulated data of the machine.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue No. 75 listing the company's entire line of wrenches. Practically every type of forged wrench is included in this pamphlet.

Garvin Machine Co., New York. Circulars Nos. 142 and 143, descriptive of the Garvin vertical-spindle milling machines, and the Garvin No. 3 duplex milling machines, respectively.

New York Revolving Portable Elevator Co., Jersey City, N. J. Bulletin No. 10 showing the use of this company's portable elevator truck, called the "Revolvator", emphasizing its tendency to save time, money and space.

Skinner Chuck Co., New Britain, Conn. 1911 price list of this concern. This is a neat little booklet listing the numerous types of chucks manufactured by the company in a convenient form for ready reference.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Treatise on cylinder grinding, by James N. Heald. The advances made from the primitive methods one time employed, are clearly emphasized, and the modern methods of grinding are dealt with in detail.

Warren Webster & Co., Camden, N. J., have issued a reprint of a paper presented by Wm. G. Snow, chief engineer, before the department of Sanitary Science and Public Health of Cornell University, entitled "Ventilation in its Relation to Health."

Societe Anonyme, de Constructions Mecaniques de Longdoz, Liege, Belgium. The latest catalogue of this firm, which is printed in French, is very completely illustrated, and shows practically every type of machine tool. There is but little descriptive matter in it.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 68 describing the Mallet-type articulated locomotives that have been built by this firm from time to time. A number of typical examples are briefly described, and, in addition, an interesting summary of the advantages of this type is included.

National-Acme Mfg. Co., Cleveland, Ohio. The latest production of this firm is a fine example of the printer's art. After a brief summary of the developments that have taken place in the past, a description of the modern automatic machine is given. The title of this booklet is, "The Production of Duplicate Parts."

International Institute of Technical Bibliography, London, England. The first volume of the monthly publications on mechanical engineering abstracts published by this concern. The object of this work is to compile in handy form all articles on engineering subjects, giving the title of the article, by whom, and where it appeared, as well as a very brief abstract of the article.

Ingersoll-Rand Co., 11 Broadway, New York. Form No. 4602 descriptive of Sergeant rock drills. This rock drill is illustrated in a very clear and comprehensive manner with numerous detail views. Form No. 4109 on the Temple-Ingersoll electric-air rock drill describes that machine in use in different mines. Form No. 3007 is devoted to Class P. B. duplex power-driven air compressors.

Bristol Co., Waterbury, Conn. Bulletin No. 130, an illustrated catalogue of this company's electric pyrometer, containing descriptions and lists of both indicating and recording types. A partial list of users is also included. Bulletin No. 152 is a general catalogue of all the different sizes of Bristol's patent belt lacings, containing a number of new illustrations of this style of lacings.

B. F. Sturtevant Co., Hyde Park, Mass. Bulletin No. 187 of the Sturtevant engineering series, entitled "Economical Fire-Room Methods," which is a reprint of an article from *Power and the Engineer* by F. R. Low. In it the power plant of the American Woolen Co.'s wool-mill at Lawrence, Mass., is described. The article has special reference to the fuel economies and the draft system.

Colburn Machine Tool Co., Franklin, Pa. Bulletin No. 43, an illustrated pamphlet, devoted to the Colburn 24-inch heavy-duty drill press. The special detail-features emphasized are the automatic tripping device and the compound table. Bulletin No. 44 from this company gives a description of the Colburn floating reamer holder which is adaptable to all vertical boring and drilling machinery.

W. & L. E. Gurley, Troy, N. Y. This book is the forty-fifth edition of the Gurley Manual of Surveying Instruments, and contains 516 pages, 4½ by 6¾ inches. In general get-up it resembles an engineers' hand-book and might be considered as such, applied to surveying. Almost every kind of surveying instrument is included in this remarkable catalogue. It should be of value to civil engineers and surveyors.

Bantam Anti-Friction Co., Bantam, Conn. Catalogue of ball and roller bearings for all classes of service. The illustrations of the various types of bearings are printed in color, the brass and bronze parts being colored to distinguish the cages and thimbles from the steel ball and roller collars and disks. The dimensions and prices of the various kinds of bearings are concisely given in tabular form. Several new forms of bearings are illustrated.

Hill Clutch Co., Cleveland, Ohio. Catalogue on power transmission machinery, bound in cloth, and illustrating a large variety of power transmitting devices with numerous examples of their application. Accompanying tables make the book valuable, not only as a catalogue, but for a reference text-book. Included in the book is the Hill patented collar-oiling bearing, and Smith-type Hill friction clutches, of which special mention is made.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. The Westinghouse diary for 1911, accompanied by valuable data on air compression; aluminum; carbon incandescent lamps; heating values of coals; water for condensing; table of dimensions, weights, resistances and carrying capacities of copper wires; steam engines; gas engines; hydraulics; electric locomotives; application of motors to machine tools; electric lighting; railway electrical apparatus; steam turbines; stokers; etc. It also contains information regarding cities, hotels, etc., of value to the traveling man.

General Electric Co., Schenectady, N. Y. Bulletin No. 4685, "Belt-driven Alternators"; No. 4784, "Electric Drive in Pulp and Paper Mills"; No. 4785, "Electric Drive in Wood-working Plants"; No. 4793, "Steady vs. Unsteady Voltage"; No. 4798, "General Electric Straight Air Brake Equipments"; No. 4804, "Direct-connected Generating Sets"; No. 4807, "Small Plant Alternating-current Switchboard Panels"; No. 4808, "Washington, Baltimore, and Annapolis 1200-volt D. C. Railway"; No. 4809, "4500-volt Oil-Break Switches; No. 4810, Portable and Stationary Air Compressor Sets."

Hess-Bright Mfg. Co., Philadelphia, Pa. Catalogue No. 580-A describing the developments of the annular type of ball-bearing. Some of the features treated are: Design and material; plain and ball-bearing characteristics; types of ball-bearings; precisions of manufacture; ball-bearings and automobile construction; annular ball-bearings as applied to line-shaftings; electric appliances, and unlimited field of usefulness; the influence of acid and rust on ball-bearings; and the importance of correct mounting. It also includes much interesting data. This book is more of a treatise than a catalogue, for it is one of the most complete publications on the subject. It is a fine example of the printers' art. Accompanying the book is an indexed folder containing a lot of ball-bearing data boiled down, for ready reference.

TRADE NOTES

Ph. Bonvillain & E. Ronceray, Paris, France, were awarded the gold medal, at the Brussels exhibition, which was the highest award for the molding machine department.

Niles-Bement-Pond Co., and Pratt & Whitney Co., announce that W. R. Lathrop is now in charge of their Birmingham, Ala., sales office, in place of N. C. Walpole, resigned.

Baird Machinery Co., Pittsburg, Pa., dealer in machine tools and machinists' supplies, has opened a branch office in the Masonic Temple Building, Erie, Pa. The office will be in charge of Mr. F. J. McCoy.

Rahn-Larmon Co., Cincinnati, Ohio, maker of engine lathes, is the successor (effective January 1) of Rahn-Carpenter Co. The officers are John Rahn, Jr., president and general manager; and A. J. Larmon, secretary and treasurer.

American Pulley Co., Philadelphia, Pa., announces that it is now carrying at 203 Lafayette St., New York, a large stock of its all-steel "American" split pulleys in sizes ranging from 6 to 60 inches diameter, for the convenience of local dealers and users.

Penton Publishing Co., Cleveland, O., has removed the Cincinnati office from 11 Blymyer to 808 Provident Bank Bldg. Louis P. Zimmerman is now in charge as representative for the *Iron Trade Review, The Foundry, The Marine Review,* and *Power Boating.*

Northern Engineering Works, Detroit, Mich., reports having installed the following Northern Cranes: Gregg Co., Newburgh, 8 ton, 60-foot; Anderson Forge Co., two 10-ton; Pierce Phosphate Co., 25-ton, 70-foot; Detroit River Tunnel Co., one 25-ton; Pennsylvania Terminal, one 25-ton; Dodge Bros., 10 ton and 15-ton.

Firth-Sterling Steel Co., McKeesport, Pa., announces that the management of its Pittsburg sales office has been placed in the hands of E. S. Jackman & Co., who have been its agents in all the states west of Pennsylvania for the past ten years. This office is under the charge of D. G. Clark. E. S. Jackman & Co. handle Firth-Sterling's products exclusively.

Cement Age Co., New York, announces that *Concrete Engineering* of Cleveland, and *Cement Age* of New York, which are two of the leading monthly publications in the cement field, have been consolidated. Hereafter the two magazines will be united under the title "*Cement Age* with which is combined *Concrete Engineering.*" The magazine will be slightly enlarged and an innovation made in the form of a two column make-up.

Remington Typewriter Works, Ilion, N. Y., are to be given a largely increased capacity by the erection of a new administration building, which when completed will make all the factory floor space available for manufacturing, and will clear the way for further additions which are being planned. These increases have been occasioned by the pressure of business which has necessitated night work and overtime at the works for some time past.

Cincinnati Bickford Tool Co., Oakley, Cincinnati, O., has just completed the big undertaking of moving both its shops to the new works at Oakley, which has led to some confusion during the moving process. It is claimed that the new works, when completed, will be the largest in the world devoted exclusively to the manufacture of drilling machinery, and an invitation has been extended by the management to all wishing to inspect the plant.

Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield, England, whose chief American office and warehouse is at 434 W. Randolph St., Chicago, announce that agency arrangements have just been completed with the following firms at whose warehouses large and comprehensive stocks of Allen's high-speed and carbon tool steels will be carried: Roehm & Davison, Detroit, Mich.; J. L. Osgood, Erie Co. Bank Bldg., Buffalo, N. Y.; and John J. Greer & Co., Inc., 207 W. Pratt St., Baltimore, Md.

Ludw. Loewe & Co., Ltd., Farringdon Road, Clerkenwell, London, E. C., England, is being voluntarily liquidated. The liquidation in no way affects Ludw. Loewe & Co., Ltd., of Berlin, Germany, the English company being independent. The liquidator is Mr. Geo. W. Goodchild who has been acting for upward of five years as managing director. Mr. Goodchild intends to personally continue the business under his own name, on much the same lines as formerly and at the same address.

Ingersoll-Rand Co., 11 Broadway, New York, has purchased a controlling interest in the A. S. Cameron Steam Pump Works, New York, although the connection cannot be looked upon as a merger. The Cameron works will still continue under the management of

TABLE FOR CALCULATING CIRCULAR FORMING TOOLS—I

Length c on Tool	Number of B. & S. Auto. Screw Machine No. 00	No. 0	No. 2	Length c on Tool	Number of B. & S. Auto. Screw Machine No. 00	No. 0	No. 2
0.001	1.7480	2.2480	2.9980	0.051	1.6491	2.1490	2.8995
0.002	1.7460	2.2460	2.9961	0.052	1.6471	2.1470	2.8975
0.003	1.7441	2.2441	2.9941	0.053	1.6452	2.1451	2.8955
0.004	1.7421	2.2421	2.9921	0.054	1.6432	2.1431	2.8936
0.005	1.7401	2.2401	2.9901	0.055	1.6412	2.1411	2.8916
0.006	1.7381	2.2381	2.9882	0.056	1.6392	2.1391	2.8896
0.007	1.7362	2.2361	2.9862	0.057	1.6373	2.1372	2.8877
0.008	1.7342	2.2341	2.9842	0.058	1.6353	2.1352	2.8857
0.009	1.7322	2.2321	2.9823	0.059	1.6333	2.1332	2.8837
0.010	1.7302	2.2302	2.9803	0.060	1.6313	2.1312	2.8818
0.011	1.7282	2.2282	2.9783	0.061	1.6294	2.1293	2.8798
0.012	1.7263	2.2262	2.9763	0.062	1.6274	2.1273	2.8778
0.013	1.7243	2.2243	2.9744	$\frac{1}{16}$	1.6264	2.1263	2.8768
0.014	1.7223	2.2222	2.9724	0.063	1.6254	2.1253	2.8759
0.015	1.7203	2.2203	2.9704	0.064	1.6234	2.1233	2.8739
$\frac{1}{64}$	1.7191	2.2191	2.9692	0.065	1.6215	2.1213	2.8719
0.016	1.7184	2.2183	2.9685	0.066	1.6195	2.1194	2.8699
0.017	1.7164	2.2163	2.9665	0.067	1.6175	2.1174	2.8680
0.018	1.7144	2.2143	2.9645	0.068	1.6155	2.1154	2.8660
0.019	1.7124	2.2123	2.9625	0.069	1.6136	2.1134	2.8640
0.020	1.7104	2.2004	2.9606	0.070	1.6116	2.1115	2.8621
0.021	1.7085	2.2084	2.9586	0.071	1.6096	2.1095	2.8601
0.022	1.7065	2.2064	2.9566	0.072	1.6076	2.1075	2.8581
0.023	1.7045	2.2045	2.9547	0.073	1.6057	2.1055	2.8561
0.024	1.7025	2.2025	2.9527	0.074	1.6037	2.1035	2.8542
0.025	1.7005	2.2005	2.9507	0.075	1.6017	2.1016	2.8522
0.026	1.6986	2.1985	2.9488	0.076	1.5997	2.0996	2.8503
0.027	1.6966	2.1965	2.9468	0.077	1.5978	2.0976	2.8483
0.028	1.6946	2.1945	2.9448	0.078	1.5958	2.0956	2.8463
0.029	1.6926	2.1925	2.9428	$\frac{5}{64}$	1.5955	2.0954	2.8461
0.030	1.6907	2.1906	2.9409	0.079	1.5938	2.0937	2.8443
0.031	1.6887	2.1886	2.9389	0.080	1.5918	2.0917	2.8424
$\frac{1}{32}$	1.6882	2.1881	2.9384	0.081	1.5899	2.0897	2.8404
0.032	1.6867	2.1866	2.9369	0.082	1.5879	2.0877	2.8384
0.033	1.6847	2.1847	2.9350	0.083	1.5859	2.0857	2.8365
0.034	1.6827	2.1827	2.9330	0.084	1.5839	2.0838	2.8345
0.035	1.6808	2.1807	2.9310	0.085	1.5820	2.0818	2.8325
0.036	1.6788	2.1787	2.9290	0.086	1.5800	2.0798	2.8306
0.037	1.6768	2.1767	2.9271	0.087	1.5780	2.0778	2.8286
0.038	1.6748	2.1747	2.9251	0.088	1.5760	2.0759	2.8266
0.039	1.6729	2.1727	2.9231	0.089	1.5740	2.0739	2.8247
0.040	1.6709	2.1708	2.9211	0.090	1.5721	2.0719	2.8227
0.041	1.6689	2.1688	2.9192	0.091	1.5701	2.0699	2.8207
0.042	1.6669	2.1668	2.9172	0.092	1.5681	2.0679	2.8187
0.043	1.6649	2.1649	2.9152	0.093	1.5661	2.0660	2.8168
0.044	1.6630	2.1629	2.9133	$\frac{3}{32}$	1.5647	2.0645	2.8153
0.045	1.6610	2.1609	2.9113	0.094	1.5642	2.0640	2.8148
0.046	1.6590	2.1580	2.9093	0.095	1.5622	2.0620	2.8128
$\frac{3}{64}$	1.6573	2.1572	2.9076	0.096	1.5602	2.0600	2.8109
0.047	1.6570	2.1569	2.9073	0.097	1.5582	2.0581	2.8089
0.048	1.6550	2.1549	2.9054	0.098	1.5563	2.0561	2.8069
0.049	1.6531	2.1529	2.9034	0.099	1.5543	2.0541	2.8050
0.050	1.6511	2.1510	2.9014	0.100	1.5523	2.0521	2.8030

Contributed by William W. Johnson

TABLE FOR CALCULATING CIRCULAR FORMING TOOLS—II

Length c on Tool	Number of B. & S. Auto. Screw Machine No. 00	No. 0	No. 2	Length c on Tool	Number of B. & S. Auto. Screw Machine No. 00	No. 0	No. 2
0.100	1.5523	2.0521	2.8030	0.151	1.4517	1.9514	2.7027
0.101	1.5503	2.0502	2.8010	0.152	1.4498	1.9494	2.7007
0.102	1.5484	2.0482	2.7991	0.153	1.4478	1.9474	2.6988
0.103	1.5464	2.0462	2.7971	0.154	1.4458	1.9455	2.6968
0.104	1.5444	2.0442	2.7951	0.155	1.4439	1.9435	2.6948
0.105	1.5425	2.0422	2.7932	0.156	1.4419	1.9415	2.6929
0.106	1.5405	2.0403	2.7912	$\frac{5}{32}$	1.4414	1.9410	2.6924
6.107	1.5385	2.0383	2.7892	0.157	1.4399	1.9395	2.6909
0.108	1.5365	2.0363	2.7873	0.158	1.4380	1.9376	2.6889
0.109	1.5346	2.0343	2.7853	0.159	1.4360	1.9356	2.6870
$\frac{7}{64}$	1.5338	2.0336	2.7846	0.160	1.4340	1.9336	2.6850
0.110	1.5326	2.0324	2.7833	0.161	1.4321	1.9317	2.6830
0.111	1.5306	2.0304	2.7814	0.162	1.4301	1.9297	2.6811
0.112	1.5287	2.0284	2.7794	0.163	1.4281	1.9277	2.6791
0.113	1.5267	2.0264	2.7774	0.164	1.4262	1.9257	2.6772
0.114	1.5247	2.0245	2.7755	0.165	1.4242	1.9238	2.6752
0.115	1.5227	2.0225	2.7735	0.166	1.4222	1.9218	2.6732
0.116	1.5208	2.0205	2.7715	0.167	1.4203	1.9198	2.6713
0.117	1.5188	2.0185	2.7696	0.168	1.4183	1.9178	2.6693
0.118	1.5168	2.0166	2.7676	0.169	1.4163	1.9159	2.6673
0.119	1.5148	2.0146	2.7656	0.170	1.4144	1.9139	2.6654
0.120	1.5129	2.0126	2.7637	0.171	1.4124	1.9119	2.6634
0.121	1.5109	2.0106	2.7617	$\frac{11}{64}$	1.4107	1.9103	2.6617
0.122	1.5089	2.0087	2.7597	0.172	1.4104	1.9099	2.6614
0.123	1.5070	2.0067	2.7578	0.173	1.4084	1.9080	2.6595
0.124	1.5050	2.0047	2.7558	0.174	1.4065	1.9060	2.6575
0.125	1.5030	2.0027	2.7538	0.175	1.4045	1.9040	2.6556
0.126	1.5010	2.0008	2.7519	0.176	1.4025	1.9021	2.6536
0.127	1.4991	1.9988	2.7499	0.177	1.4006	1.9001	2.6516
0.128	1.4971	1.9968	2.7479	0.178	1.3986	1.8981	2.6497
0.129	1.4951	1.9948	2.7460	0.179	1.3966	1.8961	2.6477
0.130	1.4932	1.9929	2.7440	0.180	1.3947	1.8942	2.6457
0.131	1.4912	1.9909	2.7420	0.181	1.3927	1.8922	2.6438
0.132	1.4892	1.9889	2.7401	0.182	1.3907	1.8902	2.6418
0.133	1.4872	1.9869	2.7381	0.183	1.3888	1.8882	2.6398
0.134	1.4853	1.9850	2.7361	0.184	1.3868	1.8863	2.6379
0.135	1.4833	1.9830	2.7342	0.185	1.3848	1.8843	2.6359
0.136	1.4813	1.9810	2.7322	0.186	1.3829	1.8823	2.6339
0.137	1.4794	1.9790	2.7302	0.187	1.3809	1.8804	2.6320
0.138	1.4774	1.9771	2.7282	$\frac{3}{16}$	1.3799	1.8794	2.6310
0.139	1.4754	1.9751	2.7263	0.188	1.3789	1.8784	2.6300
0.140	1.4734	1.9731	2.7243	0.189	1.3770	1.8764	2.6281
$\frac{9}{64}$	1.4722	1.9719	2.7231	0.190	1.3750	1.8744	2.6261
0.141	1.4715	1.9711	2.7224	0.191	1.3730	1.8725	2.6241
0.142	1.4695	1.9692	2.7204	0.192	1.3711	1.8705	2.6222
0.143	1.4675	1.9672	2.7184	0.193	1.3691	1.8685	2.6202
0.144	1.4655	1.9652	2.7165	0.191	1.3671	1.8665	2.6182
0.145	1.4636	1.9632	2.7145	0.195	1.3652	1.8646	2.6163
0.146	1.4616	1.9613	2.7125	0.196	1.3632	1.8626	2.6143
0.147	1.4596	1.9593	2.7106	0.197	1.3612	1.8606	2.6123
0.148	1.4577	1.9573	2.7086	0.198	1.3592	1.8587	2.6104
0.149	1.4557	1.9553	2.7066	0.199	1.3573	1.8567	2.6084
0.150	1.4537	1.9534	2.7047	0.200	1.3553	1.8547	2.6064

Contributed by William W. Johnson

TABLE FOR CALCULATING CIRCULAR FORMING TOOLS—III

Length c on Tool	No. of B. & S. Machine No. 0	No. of B. & S. Machine No. 2	Length c on Tool	No. of B. & S. Machine No. 0	No. of B. & S. Machine No. 2	Length c on Tool	No. 2 B. & S. Machine	Length c on Tool	No. 2 B. & S. Machine
0.201	1.8527	2.6045	0.251	1.7543	2.5064	0.301	2.4085	0.351	2.3108
0.202	1.8508	2.6025	0.252	1.7523	2.5045	0.302	2.4066	0.352	2.3088
0.203	1.8488	2.6006	0.253	1.7503	2.5025	0.303	2.4046	0.353	2.3069
13/64	1.8486	2.6003	0.254	1.7484	2.5005	0.304	2.4026	0.354	2.3049
0.204	1.8468	2.5986	0.255	1.7464	2.4986	0.305	2.4007	0.355	2.3030
0.205	1.8449	2.5966	0.256	1.7444	2.4966	0.306	2.3987	0.356	2.3010
0.206	1.8429	2.5947	0.257	1.7425	2.4947	0.307	2.3968	0.357	2.2991
0.207	1.8409	2.5927	0.258	1.7405	2.4927	0.308	2.3948	0.358	2.2971
0.208	1.8390	2.5908	0.259	1.7385	2.4908	0.309	2.3929	0.359	2.2952
0.209	1.8370	2.5888	0.260	1.7366	2.4888	0.310	2.3909	23/64	2.2945
0.210	1.8350	2.5868	0.261	1.7346	2.4868	0.311	2.3890	0.360	2.2932
0.211	1.8330	2.5849	0.262	1.7326	2.4849	0.312	2.3870	0.361	2.2913
0.212	1.8311	2.5829	0.263	1.7306	2.4829	5/16	2.3860	0.362	2.2893
0.213	1.8291	2.5809	0.264	1.7287	2.4810	0.313	2.3851	0.363	2.2874
0.214	1.8271	2.5790	0.265	1.7267	2.4790	0.314	2.3831	0.364	2.2854
0.215	1.8252	2.5770	17/64	1.7255	2.4778	0.315	2.3811	0.365	2.2835
0.216	1.8232	2.5751	0.266	1.7248	2.4770	0.316	2.3792	0.366	2.2815
0.217	1.8212	2.5731	0.267	1.7228	2.4751	0.317	2.3772	0.367	2.2796
0.218	1.8193	2.5711	0.268	1.7208	2.4731	0.318	2.3753	0.368	2.2776
7/32	1.8178	2.5697	0.269	1.7189	2.4712	0.319	2.3733	0.369	2.2757
0.219	1.8173	2.5692	0.270	1.7169	2.4692	0.320	2.3714	0.370	2.2737
0.220	1.8153	2.5672	0.271	1.7149	2.4673	0.321	2.3694	0.371	2.2718
0.221	1.8133	2.5653	0.272	1.7130	2.4653	0.322	2.3675	0.372	2.2698
0.222	1.8114	2.5633	0.273	1.7110	2.4633	0.323	2.3655	0.373	2.2679
0.223	1.8094	2.5613	0.274	1.7090	2.4614	0.324	2.3636	0.374	2.2659
0.224	1.8074	2.5594	0.275	1.7071	2.4594	0.325	2.3616	0.375	2.2640
0.225	1.8055	2.5574	0.276	1.7051	2.4575	0.326	2.3596	0.376	2.2620
0.226	1.8035	2.5555	0.277	1.7031	2.4555	0.327	2.3577	0.377	2.2601
0.227	1.8015	2.5535	0.278	1.7012	2.4535	0.328	2.3557	0.378	2.2581
0.228	1.7996	2.5515	0.279	1.6992	2.4516	21/64	2.3555	0.379	2.2562
0.229	1.7976	2.5496	0.280	1.6972	2.4496	0.329	2.3538	0.380	2.2542
0.230	1.7956	2.5476	0.281	1.6953	2.4477	0.330	2.3518	0.381	2.2523
0.231	1.7936	2.5456	9/32	1.6948	2.4472	0.331	2.3499	0.382	2.2503
0.232	1.7917	2.5437	0.282	1.6933	2.4457	0.332	2.3479	0.383	2.2484
0.233	1.7897	2.5417	0.283	1.6913	2.4438	0.333	2.3460	0.384	2.2464
0.234	1.7877	2.5398	0.284	1.6894	2.4418	0.334	2.3440	0.385	2.2445
15/64	1.7870	2.5390	0.285	1.6874	2.4398	0.335	2.3421	0.386	2.2425
0.235	1.7858	2.5378	0.286	1.6854	2.4378	0.336	2.3401	0.387	2.2406
0.236	1.7838	2.5358	0.287	1.6835	2.4359	0.337	2.3381	0.388	2.2386
0.237	1.7818	2.5339	0.288	1.6815	2.4340	0.338	2.3362	0.389	2.2367
0.238	1.7799	2.5319	0.289	1.6795	2.4320	0.339	2.3342	0.390	2.2347
0.239	1.7779	2.5300	0.290	1.6776	2.4300	0.340	2.3323	25/64	2.2335
0.240	1.7759	2.5280	0.291	1.6756	2.4281	0.341	2.3303	0.391	2.2328
0.241	1.7739	2.5260	0.292	1.6736	2.4261	0.342	2.3284	0.392	2.2308
0.242	1.7720	2.5241	0.293	1.6717	2.4242	0.343	2.3264	0.393	2.2289
0.243	1.7700	2.5221	0.294	1.6697	2.4222	11/32	2.3250	0.394	2.2269
0.244	1.7680	2.5201	0.295	1.6677	2.4203	0.344	2.3245	0.395	2.2250
0.245	1.7661	2.5182	0.296	1.6658	2.4183	0.345	2.3225	0.396	2.2230
0.246	1.7641	2.5162	19/64	1.6641	2.4166	0.346	2.3206	0.397	2.2211
0.247	1.7621	2.5143	0.297	1.6638	2.4163	0.347	2.3186	0.398	2.2191
0.248	1.7602	2.5123	0.298	1.6618	2.4144	0.348	2.3166	0.399	2.2172
0.249	1.7582	2.5104	0.299	1.6599	2.4124	0.349	2.3147	0.400	2.2152
0.250	1.7562	2.5084	0.300	1.6579	2.4105	0.350	2.3127	0.401	2.2183

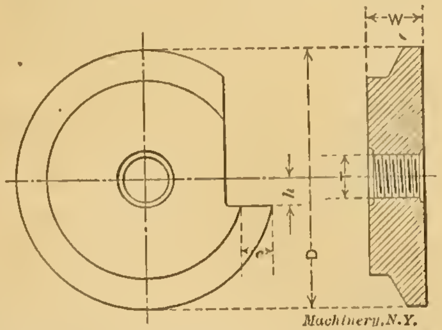
Contributed by William W. Johnson

TABLE FOR CALCULATING CIRCULAR FORMING TOOLS—IV

Length c on Tool	No. 2 B. & S. Machine	Length c on Tool	No. 2 B. & S. Machine	Length c on Tool	No. 2 B. & S. Machine	Length c on Tool	No. 2 B. & S. Machine	Length c on Tool	No. 2 B. & S. Machine
0.402	2.2113	0.422	2.1724	0.443	2.1315	0.464	2.0907	31/64	2.0505
0.403	2.2094	0.423	2.1704	0.444	2.1296	0.465	2.0888	0.485	2.0500
0.404	2.2074	0.424	2.1685	0.445	2.1276	0.466	2.0868	0.486	2.0480
0.405	2.2055	0.425	2.1666	0.446	2.1257	0.467	2.0849	0.487	2.0461
0.406	2.2035	0.426	2.1646	0.447	2.1237	0.468	2.0830	0.488	2.0441
13/32	2.2030	0.427	2.1627	0.448	2.1218	15/32	2.0815	0.489	2.0422
0.407	2.2016	0.428	2.1607	0.449	2.1199	0.469	2.0810	0.490	2.0403
0.408	2.1996	0.429	2.1588	0.450	2.1179	0.470	2.0791	0.491	2.0383
0.409	2.1977	0.430	2.1568	0.451	2.1160	0.471	2.0771	0.492	2.0364
0.410	2.1957	0.431	2.1549	0.452	2.1140	0.472	2.0752	0.493	2.0344
0.411	2.1938	0.432	2.1529	0.453	2.1121	0.473	2.0733	0.494	2.0325
0.412	2.1919	0.433	2.1510	29/64	2.1118	0.474	2.0713	0.495	2.0306
0.413	2.1899	0.434	2.1490	0.454	2.1101	0.475	2.0694	0.496	2.0286
0.414	2.1880	0.435	2.1471	0.455	2.1082	0.476	2.0674	0.497	2.0267
0.415	2.1860	0.436	2.1452	0.456	2.1063	0.477	2.0655	0.498	2.0247
0.416	2.1841	0.437	2.1432	0.457	2.1043	0.478	2.0636	0.499	2.0228
0.417	2.1821	7/16	2.1422	0.458	2.1024	0.479	2.0616	0.500	2.0209
0.418	2.1802	0.438	2.1413	0.459	2.1004	0.480	2.0597	.....	......
0.419	2.1782	0.439	2.1393	0.460	2.0985	0.481	2.0577	....	......
0.420	2.1763	0.440	2.1374	0.461	2.0966	0.482	2.0558	.....	......
0.421	2.1743	0.441	2.1354	0.462	2.0946	0.483	2.0538	.....	......
27/64	2.1726	0.442	2.1335	0.463	2.0927	0.484	2.0519	.....	......

METHOD OF USING TABLES

The accompanying tables have been compiled to facilitate the calculation of circular forming tools for Brown & Sharpe automatic screw machines. The maximum diameter D (see illustration) of forming tools for these machines



Machinery,N.Y.

should be: For No. 00 machine, 1¾ inch; for No. 0 machine, 2¼ inches; for No. 2 machine, 3 inches. To find the other diameters of the tool for any piece to be formed, proceed as follows: Subtract the smallest diameter of the work from that diameter of the work which is to be formed by the required tool-diameter; divide the remainder by 2; locate the quotient obtained in the column headed "Length c on Tool," and opposite the figure thus located and in the column headed by the number of the machine used, read off directly the diameter to which the tool is to be made. (The quotient obtained, and which is located in the column headed "Length c on Tool" is the length c as shown in the illustration).

GENERAL DIMENSIONS OF FORMING TOOLS FOR B. & S. AUTOMATIC SCREW MACHINES
(See illustration for notation.)

Number of Machine	D	h	T Left-hand Thread	W
00	1¾	⅛	⅜—16	⅛
0	2¼	5/32	½—14	3/16
2	3	¼	⅝—12	⅜

Example: A piece of work is to be formed on a No. 0 machine to two diameters, one being ¼ inch and one 0.550 inch; find the diameters of the tool.

The maximum tool diameter is 2¼ inches. This will be the diameter which will cut the ¼ inch diameter of the work. To find the other diameter, proceed according to the rule given.

0.550 — ¼ = 0.300; 0.300 ÷ 2 = 0.150.

In Table II, opposite 0.150, we find that the required tool diameter is 1.9534 inch.

Contributed by William W. Johnson

MACHINERY

March, 1911

CARTRIDGE MAKING*—1

METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO., LTD., IN THE MANUFACTURE OF RIM-FIRE CARTRIDGES

By DOUGLAS T. HAMILTON†

FOR some time past the writer has intended to describe the processes employed in the manufacture of cartridges. An opportunity recently presented itself to him while on a visit to Brownsburg, Province of Quebec, Canada, where the works of the Dominion Cartridge Co. are located. Through the courtesy of Mr. H. W. Brainard, president of the company, this intention materialized, and is here presented with the hope that it may interest the readers of MACHINERY because of the special character of the operations recorded.

The works of the Dominion Cartridge Co. are located in the Laurentian range of mountains, about two miles from the north shore line of the Canadian Pacific Railway. Of late years a branch line has been completed, connecting the Laurentian granite quarry with the main line, and a short line from this branch has been built for the exclusive use of the Dominion Cartridge Co.

A few words regarding the location of the buildings shown in Fig. 1, might here be of interest. The office, explosive works, packing department, loading departments and the building in which the shot shells are manufactured, may be seen in the background of the lower view, while the metallic works are shown in the immediate foreground. All the metallic cartridges are loaded in the explosive works, to which they are conveyed from the metallic works in trucks across a small bridge that spans the river.


Fig. 1. General View of the Dominion Cartridge Co.'s Works, Brownsburg, Quebec—Flume which supplies Water to the Turbine

Previous to the year 1900 the power was supplied to the plant by a water-wheel, a dam being built just above the works. This dam, which was at the foot of a slight fall in the river, gave a good pressure, but was not sufficient for the amount of power required. In order to obtain ample power, the company built a large stone dam about one-quarter of a mile from the works, and put in a barrel flume, shown in the upper view, Fig. 1. This flume supplies power to a turbine, which, in turn, drives an electric generator used in supplying current to the various motors located throughout the works. This turbine also drives a generator which is used in supplying the plant with electric lights.

The Dominion Cartridge Co. was incorporated in the year 1887, the late Mr. Thomas Brainard being made president. At this time the company employed about fifty hands, the number of which has now been increased to over three hundred. Enough has been said, however, in regard to the history of this company, as the chief feature of interest to the mechanic is the methods of manufacture there employed.

This article, which is one of a series to be published in MACHINERY, will deal exclusively with the manufacture of rim-fire cartridges. As the 0.22 long-regular is a well known cartridge of the rim-fire type, it will be taken as an example, and the various methods employed in its manufacture will be described in detail.

Annealing and Washing the Cups

Up to the present time the Dominion Cartridge Co. has not thought it advisable to make its own cups, but buys them in cup form. Before any drawing operations can be performed on the cups, they must be annealed to make them ductile.

*For additional information on the manufacture of cartridges, and kindred subjects, see the following articles previously published in MACHINERY: "High Speeds Touching on the Exterior Ballistics of the Modern High-powered Rifle," August, 1909, engineering edition; "The Drawing of Cartridge Cases for Quick-firing Guns," January, 1906, engineering edition; "Steps and Press Employed in Making Rapid-fire Cartridge Shells," December, 1905, engineering edition.

† Associate Editor of MACHINERY.

The cups are placed in a cylindrical cast-iron drum, shown in Fig. 2, which has holes, smaller in diameter than the smallest cups annealed in it, drilled around its periphery. These holes permit the heat to permeate, thus annealing the cups rapidly.

The cylindrical drum is provided with a slide or door, which is forced in when the cups are inserted. The drum is then rolled into the furnace, where it is rotated by means of a

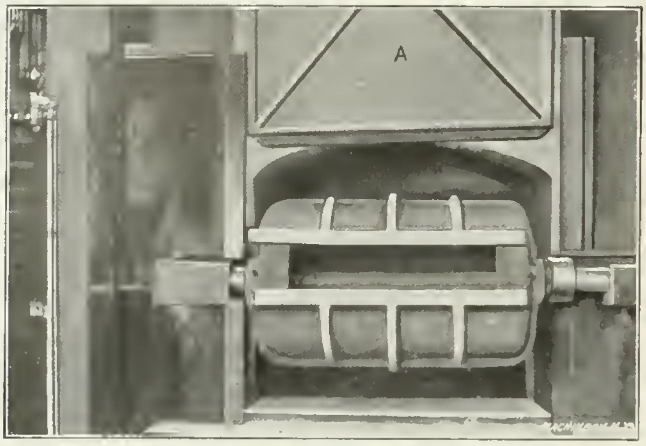


Fig. 2. Cylindrical Drum in which the Cups are annealed

chain and sprocket, driven by an overhead shaft. The door *A*, which is shown in the upper position in Fig. 2, is then brought down. Before the cups are inserted, the drum must be heated to a cherry red. Then the cups are put in and allowed to remain for a period of from thirty to forty minutes. After the cups have remained in the drum the specified time, the front door is raised and the drum rolled out. A truck with a pan located on it is then rolled in front of the annealer, the slide taken out, and the cups dumped into this pan, which is filled with lukewarm water.

Fig. 3. Tubs used in Washing the Cups after Annealing

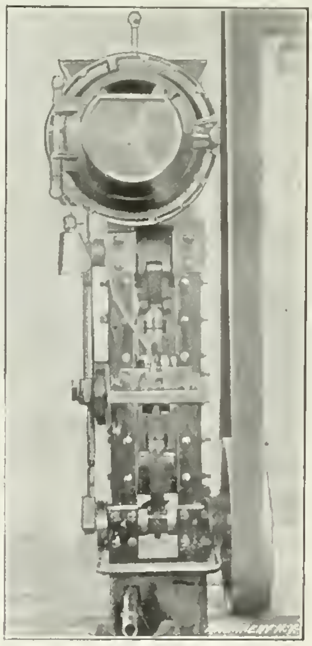


Fig 4. Vertical Header with Automatic Feed

In the annealing process, a scale is formed on the cups, which would be detrimental in drawing; so before any drawing operations can be accomplished, they must be washed. To accomplish this, the cups are dumped into revolving tubs, as shown in Fig. 3. These tubs are driven by a shaft located beneath them, through bevel gears. A clutch is also provided, so that any one of the tubs may be stopped if desired, independently of the others. By rotating these tubs, the cups are made to rub against one another, thus helping to remove the scale. The rotating of the cups and the pouring of water on them is not sufficient to remove the scale, so they are immersed in a solution composed of sulphuric acid and water, mixed together in the following proportions: Water, 48 pints; sulphuric acid, ¼ pint. This solution is used for the first washing and removes the scale. When the cups look quite clean, a plug is removed and the acid solution washed off. Then the plug is inserted and another solution composed of pearlash soda, soft soap and water is mixed together in the following proportions: Water, 48 pints; soft soap, 1 pint; pearlash soda, ¼ pint. The cups are rotated in this solution for about twenty minutes, after which they are rinsed with warm water. A sieve is located over the hole for the plug so that the cups cannot fall out. When the cups have been thoroughly rinsed and the water drained off, they are put in sieves, which, in turn, are placed in a cupboard, where they are held in racks. Steam pipes are located beneath these racks, so that the cups are quickly dried.

Drawing Operations

When dry, the cups are transferred to the drawing department. Here they are put in a pan, from which the operator removes them by means of a vulcanite plate. This plate has

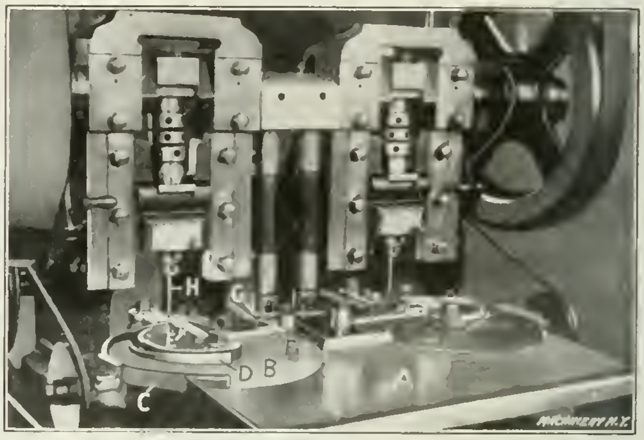


Fig. 5. Double-headed Friction Dial Drawing Press used for the Various Drawing Operations

a series of holes drilled through it, which are bell-mouthed on the top, and are slightly larger in diameter than the cups. A thin sheet-steel plate, bent up on two sides to fit the vulcanite plate, is slipped under it when shaking in the cups. When the cups are shaken into the plate, the operator places it on the table *A* of the double-headed friction-dial drawing press shown in Fig. 5, after which the sheet-steel plate is removed, and the vulcanite plate lifted up, leaving the cups standing on the table *A*. The operator then shoves the cups from the table onto the friction dial *B*, which carries them to the dies. These friction dials are driven through bevel gears by a round belt, which is connected through three grooved pulleys to the main driving pulley. The cups pass between the guard *C* and spring *D*, the latter being vibrated by the action of the revolving dial, which keeps the cups in constant motion, thus arranging them in single file. The guard *C* and the spring *D* approach each other as they near the dies to within a distance equal to the diameter of the cups. The cups are carried from the dial to the dies by a finger *E* con-

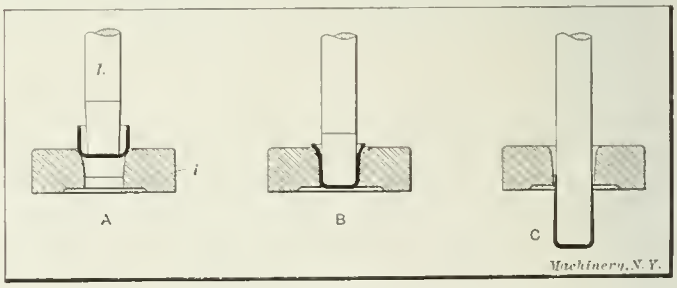


Fig. 6. Diagram showing the Action of Drawing the Cups

nected to the bell-crank *F*, which, in turn, is operated by the cam *G* on the end of a vertical shaft, driven from the crankshaft through bevel gears.

The action of drawing the cups through the dies is clearly shown in Fig. 6. In operation, the cup is carried out by the finger and placed over the die *i*. The punch *h* then descends in it, as shown at *A*, forcing it down into the die, as shown at

B. In the latter position, the shell is given a mushroom shape, and is then forced through the die, as at *C*, reducing it in diameter, increasing its length and decreasing the thickness of its walls. As the cup is forced through the die, it expands slightly away from the punch, and on the upward stroke of the press it catches on the bottom of the die, and is stripped from the punch, dropping into a box placed under the machine. Only one die is shown in the illustration, but in actual practice two drawing dies are used, one on top of the other. The lower die is not bell-mouthed, but is slightly tapered.

In the drawing operations it is necessary to lubricate the cups, so that they will not stick to the die or punch, and for

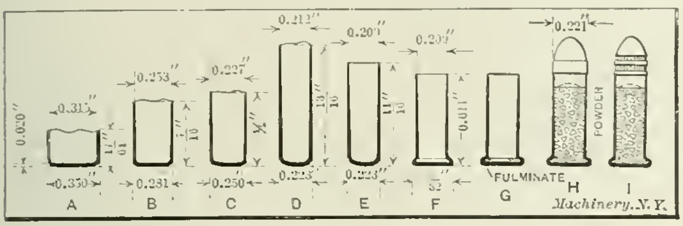


Fig. 7. Illustration showing the Transition from the Cup to the Finished Cartridge

this purpose a lubricant composed of soft soap and water is used. This is placed on the shells while they are located on the dial, by the operator, who spreads the lubricant over them, by means of a small cup fastened to a handle.

The punch for the drawing operations is made slightly tapered, being smaller at the lower end, as shown in Fig. 6. This is necessary, as the explosive material is placed near the head of the shell, thus requiring the walls of the shell to be thicker at this point than near the mouth.

After the first drawing operation, the cups are taken to the annealer, again annealed, washed and dried, in the

Trimming the Shell to Length

In the trimming operation the shells are dumped into the hopper *A*, shown at the top of the machine, Fig. 8, and pass from the latter into the revolving drum *B*, to which segments having pins *C* driven into them, are fastened. These pins, which are smaller in diameter than the inside of the shell, are pointed and set at an angle. As the segments carrying the pins rotate, the shells are agitated and drop onto the pins. The pins now carry the shells to the top of the hopper, and as they approach the perpendicular position, the shells drop off, and fall into the chute *D*, which is connected to the machine by a close-wound spring *E*, and tube *F*.

A better idea of the operation of this trimming machine can be obtained by referring to Fig. 16. Here the shells are shown dropping down the chute. They are held by a finger *a*, which presses against them, allowing only one shell to drop out at a time. In the position at *A*, one shell has dropped into the segment *b*, and the next shell is being held by the finger *a*. This finger is released by a cam, located at the rear of the machine. Attached to the face of the segment *b* is a sheet-steel plate *c*, the function of which is to prevent the shells from dropping out. This sheet-steel plate is held by a dowel pin and two screws as shown. Spiral springs are located under the heads of these screws, thus giving the plate the desired tension on the shell.

After the shells are located in the pocket, the segment is revolved in the direction of the arrow, carrying the shell into the horizontal position as shown at *B*. The punch *d* now advances and carries the shell out of the pocket into the chuck *e*. The chuck begins to close before the punch reaches the end of its travel, so that the punch can force the shell in to the correct depth. The punch *d* is held in a slide, actuated by an eccentric crankshaft which connects the punch-slide *G*

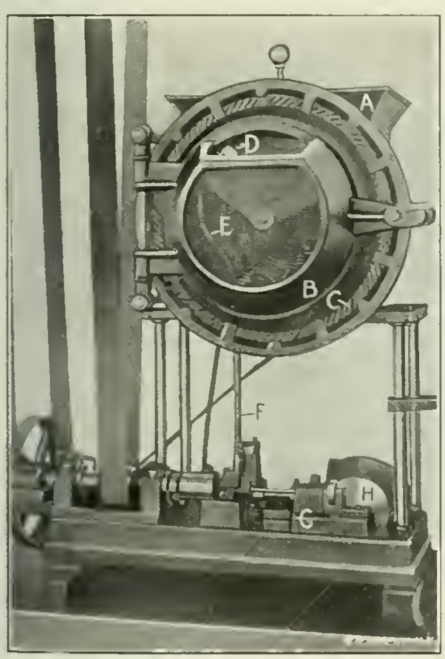


Fig. 8. Automatic Trimming Machine for Trimming the Shells to Length

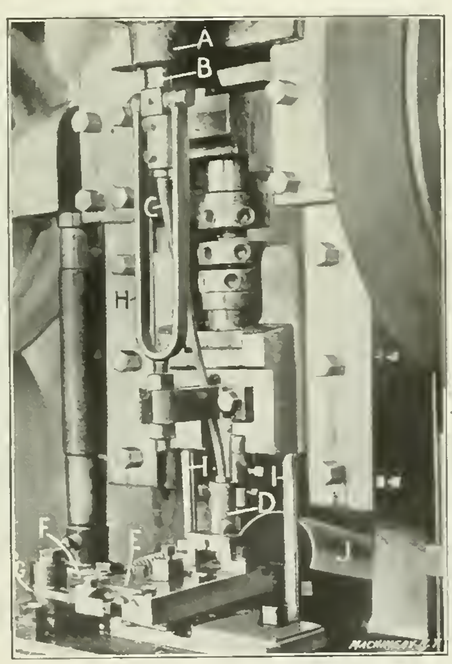


Fig. 9. Automatic Swaging Machine which forms the Slug into a Bullet

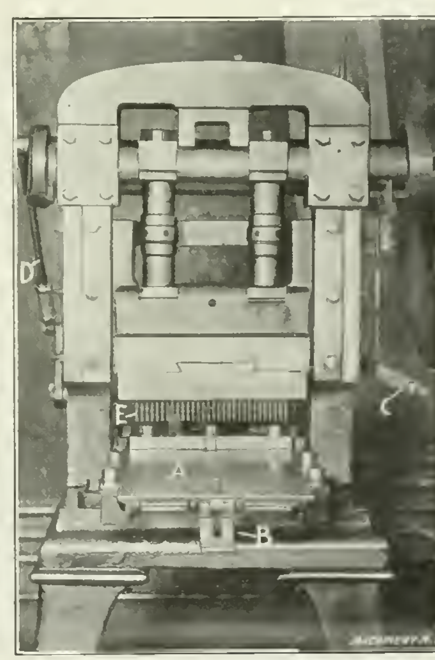


Fig. 10. Semi-automatic Loading Machine for Seating the Bullets in the Shells

manner previously described. They are then brought back to the drawing presses and given a second drawing operation. After this, they again pass through the operations of annealing, washing and drying, after which they are taken to the drawing presses where they are given the third or finish drawing operation.

The transition of the cup *A* to the shell is clearly shown in Fig. 7. Here the three drawing operations are shown at *B*, *C* and *D*, respectively. After the three drawing operations the shells are again washed and dried (not annealed), when they are taken to the trimmers, one of which is shown in Fig. 8. As is shown in Fig. 7, the mouth of the cup is not left perfectly straight after the drawing operations, but has ragged edges. Cracks also sometimes develop in the mouth of the shell, which make it necessary to trim off a certain amount, to obtain a perfect shell.

to the disk *H* (Fig. 8); the latter is driven from the rear shaft through bevel gears.

When the shell is located in the chuck the latter is closed by means of a cam located on the rear shaft of the machine, which operates through a lever forcing the beveled sleeve *f* forward. This beveled sleeve *f* raises the lever *g* to which the roll *h* is attached, and closes the chuck by means of the screw *i* pressing on the outer sleeve *j*. The punch *d* then retreats and the trimming tool *k* advances, trimming the shell to length. The inner face of this tool is slightly offset as shown, so that it will take a light shaving cut after cutting the end off. This makes a good finish and does not throw any burrs into the shell. The segment *b* now rotates back in the direction of the arrow as shown at *B*, into the position as shown at *A*, when the cycle of operations is continued. As one shell is trimmed it is forced by the following one through

the sleeve *l*, which passes through the spindle. The shells pass through this sleeve and drop into a box placed under the machine.

Forming the Head

Now that the shells are trimmed to length, they are ready for the heading operation. This is accomplished in a horizontal header of the semi-automatic feed type as shown in Fig. 14. Here the shells are dumped into the hopper *A*, from which they are taken by the operator, who, by means of a shaker, transfers them to the slide *B*. The shells are placed in this slide with the mouth facing the punch-head *C*. As the shells come down the slide *B* they rest in a pocket, from

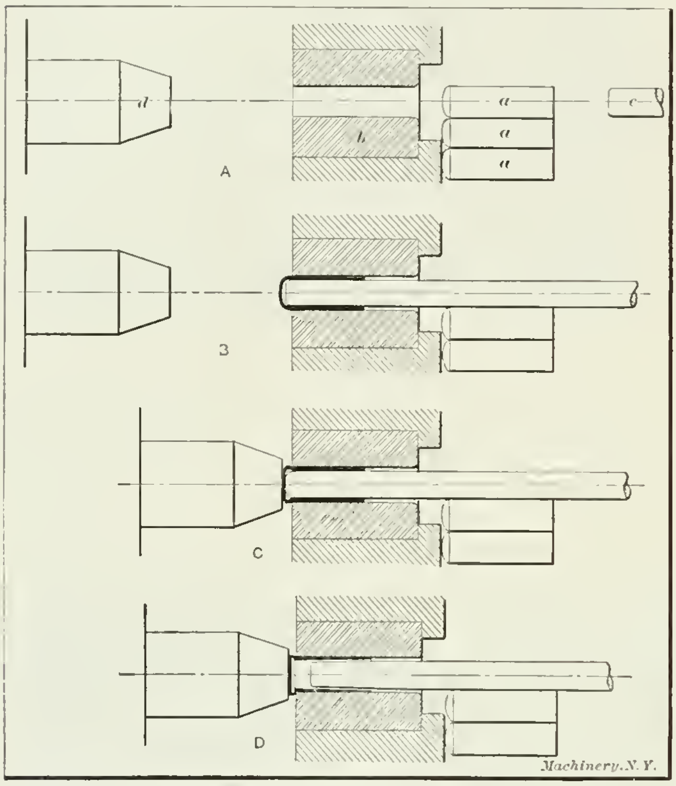


Fig. 11. Diagram showing the Action of Forming the Head on the Shell

which they are carried by the punch into the die, where they are headed by the bunter, held in the head *D*.

This heading operation is interesting, and is clearly illustrated in Fig. 11. At *A* are shown the shells *a* located in the pocket in front of the heading die *b*. The heading punch *c* and the bunter *d* are also shown back, out of operation. At *B*

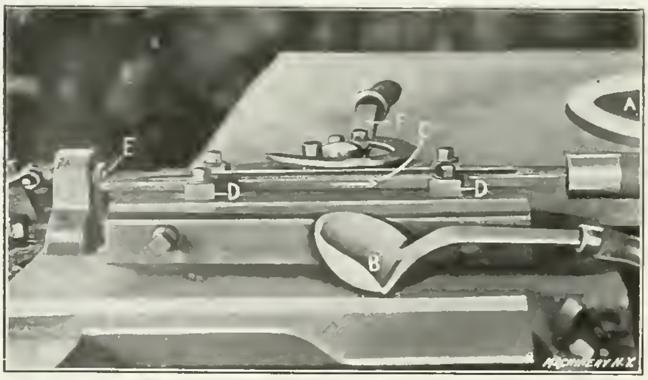


Fig. 12. Molds in which the Slugs for the Bullets are cast

the heading punch *c* has advanced and carried the shell into the die *b*. When in this position the heading bunter *d* advances, as shown at *C*, and commences to form the head on the shell. This action of the heading bunter upsets the head of the shell, close to the die, so that the heading punch can be withdrawn, as shown exaggerated at *D*, and the head on the shell completed. The punch and bunter now recede, and on the forward stroke of the punch it carries another shell into the die, forcing the previously headed one out, which is deposited in a box placed beneath the machine.

A heading machine equipped with an automatic feeding device is shown in Fig. 4. The feeding device is similar to that used on the automatic trimming machine shown in Fig. 8, so it will not be necessary to describe it further. The feeding of the shell to the die, however, is different to that shown in Fig. 14, the shell in this machine being fed by two fingers, one of which carries it from the tube connected with the hopper, to the other finger which transfers it to the die. This

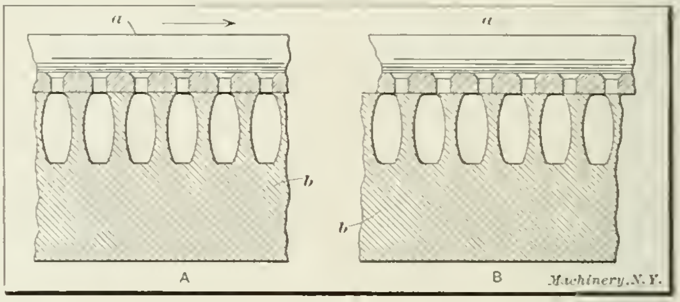


Fig. 13. Diagram showing how the Slugs are cast

header is seldom used for 0.22 long, its use being principally for heading B.B. and 0.22 short.

Priming—Putting the Fulminate into the Shells

After the shells are headed they are washed in the tubs shown in Fig. 3 and dried. They are then taken in a truck across the river and transferred to the priming department. Here the shells are shaken into plates and a charge of fulminate, which is held in a charger, is inserted in the shells. From the charging room the shells are taken to the priming machines, where they are placed on a friction dial which carries them to a punch. This punch has three grooves filed in its end, the function of which is to distribute the fulminate to the rim of the shell. As the punch is kept rotating, it forces the powder to the rim of the shell, by the action of centrifugal force, and locates it in a manner similar to that shown at *G* in Fig. 7. The fulminate is placed in the shells

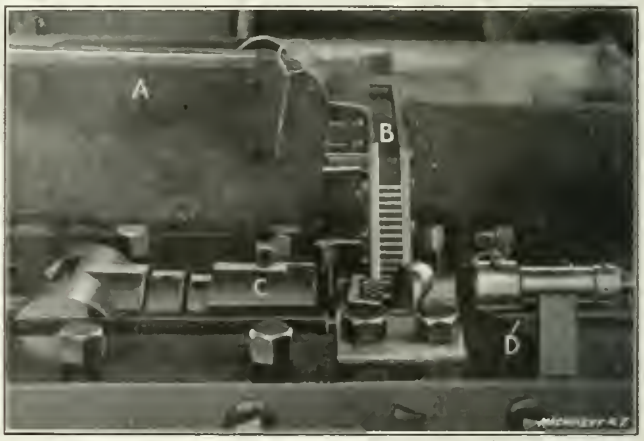


Fig. 14. Horizontal Header with Semi-automatic Feed for Forming the Head on the Shell

in a wet condition and will not discharge easily until dry. So the shells, after priming, are taken to what is called the "dry-house," where they are placed in sieves and left until dry in a very warm compartment, heated by steam. This completes the operations on the shell. We will next turn our attention to the making of the lead bullet.

Casting the Slugs from which the Bullets are made

Various devices have been tried for making the slugs from which the bullets are to be made. At one time a special machine was tried, which finished the bullet complete from a piece of lead wire. The wire was held on a spool and fed into the machine, where it was cut off and swaged. This machine did not prove satisfactory, however, owing to the fact that burrs were left on the ends of the slug as they came from the cutting-off dies, which prevented them from feeding properly into the swaging dies. The composition of the material used in making the bullets was also a governing factor in the discarding of this machine.

When this automatic swaging machine proved a failure, the

former method of making the bullets was reverted to. This consists in making the bullets first in slug form, and is accomplished by pouring molten metal into molds. These molds, which are made in halves, are shown in Fig. 12. The molten lead is kept at the correct temperature in the pot *A*, and is removed from it by the operator with the ladle *B*. The lead is poured into the filler *C*, which is located on top of the mold by guide blocks *D*. Then a foot lever situated beneath the machine is operated, forcing the pin *E* forward; this pin, in turn, moves the filler in the direction of the arrow, thus shearing the metal which has remained in the filler from that which has run into the mold. The operator now moves lever *F* to the left, which opens the molds and allows the slugs to drop

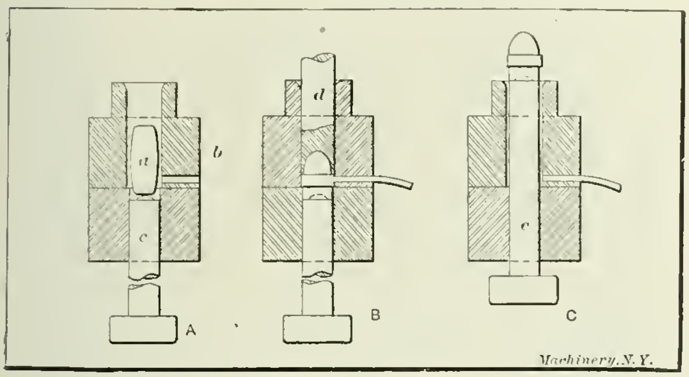


Fig. 15. Diagram showing the Action of Swaging the Bullets

out. The lever *F* is then moved to the right, closing the molds, and the operation is continued.

This operation is more clearly illustrated in Fig. 13, where a section of the filler and mold are shown. At *A* the filler *a* is shown in line with the holes in the mold *b*, when the metal is being poured in, and at *B* the filler is in the position that it occupies in relation to the mold after the metal has solidified and the foot lever is depressed. The surplus metal which is left in the filler is tapped out into the pot and remelted after the slugs which stick to the filler have been scraped off.

Tumbling and Inspecting the Slugs

The slugs as they come from the molds have fins and burrs on them, due to several reasons; one is that the operator does not close the mold tightly; another, that dirt or scrap gets in between the two halves of the mold, which leave fins on the slugs. If the slugs were taken to the swager in this condition, they would not pass down the tube, so it is necessary to tumble them to remove the fins and burrs. This is accomplished in an ordinary tumbling barrel which is revolved slowly. After the slugs are tumbled they are then dumped on a bench and inspected. This inspection consists in removing "half-slugs" and imperfectly formed ones. "Half-slugs" are due to the molder not having sufficient metal in his ladle to fill the mold. These would make imperfectly formed bullets, of light weight, which, of course, are undesirable.

Swaging the Bullets

After the slugs have been inspected and all half-slugs or imperfectly formed ones have been picked out, they are dumped into a hopper *A* (only the lower portion of which is shown), located at the top of the swaging machine shown in Fig. 9. From this hopper they drop down a tube *B* into the close-wound spring *C*. This close-wound spring *C* connects the tube *B* with the pocket or receptacle *D*, located over the finger-slide *E*. From the pocket the slugs are carried to the dies by fingers, which are held to the slide *E*. This slide is actuated by a bell-crank *G*, which is given a reciprocating motion by a cam *F*. fastened to a vertical shaft, and driven from the crankshaft through bevel gears. The slugs would not come down the sleeve and spring of their own accord, so it is necessary to agitate them. This is accomplished by fastening a yoke *H* to the ram of the press, and attaching this yoke to the sleeve *B*. The movement of the ram carries the sleeve *B* up and down in the hopper, which action agitates the slugs and causes them to drop down. The bullets are removed from the die by a knock-out connected to the ram of the machine by two studs *I*.

The action of swaging the bullets is more clearly shown in Fig. 15. The swaging dies are made in two pieces and are ground and lapped on the surfaces which come in contact. At *A* the slug *a* is shown as it drops down into the die *b*, and is located on the die-pin *c*. In the position shown at *B* the ram of the press has descended, carrying the punch *d* into the die, which action forms the bullet. The punch in forming the bullet, forces the excess material out of the vent hole provided in the upper die. This action is very interesting, as the excess material is gathered from the slug and forced out of the vent hole in the form of short wire. As the bullet is formed, the ram of the press again ascends and in its ascension the die-pin *c* is pushed up through the dies, carrying the base of the bullet flush with the top of the die. The bullet is removed from the top of the die by the fingers as they carry another slug to the die, and falls into the chute *J*, shown in Fig. 9. This swaging operation finishes the bullet to the exact size and also to the correct weight. The bullet for the 0.22 long-regular weighs thirty-five grains.

Loading—Putting the Powder and Bullets into the Shells

Now that the shell and bullet are completed, they are ready for loading. Both the bullets and shells are removed to an outside building where the loading machines are located. The shells are first shaken into what is called a "shell plate," which has a baseplate doweled to it. The bullets are shaken into a bullet plate, and the powder is then put in a charger which has holes in it registering with the holes in the shell plate,

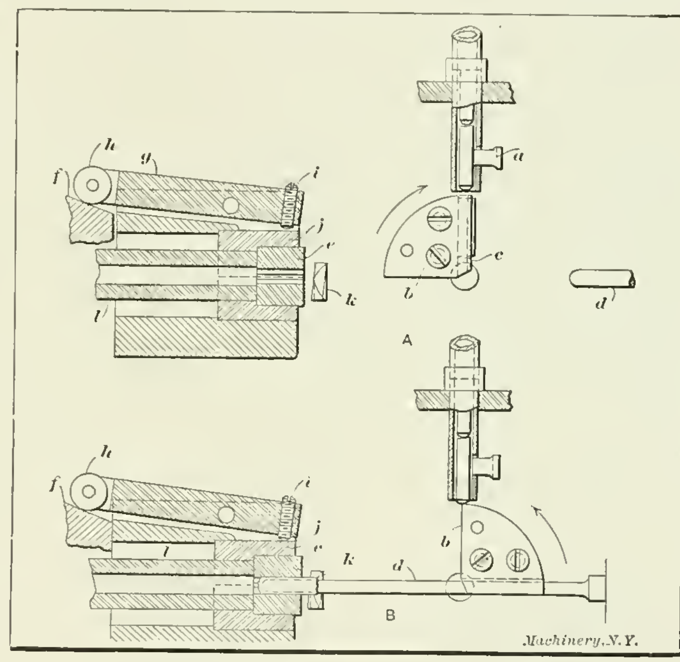


Fig. 16. Diagram showing the Action of the Automatic Trimming Machine

and slightly smaller in diameter than the inside of the shells. The thickness of these charging plates governs the amount of powder that is put in the shells. The charging plate is now located over the shell plate and tapped slightly, causing the powder to drop into the shells. The charger plate is then removed and the bullet plate substituted, being located by dowels. Both plates are taken to the semi-automatic loader, Fig. 10. (This loader is shown with the plates removed). The plates are put on the table *A*, and held by the clamp-bolt *B*. When everything is set properly, the operator presses the hand lever *C*, thus starting the machine. He then steps back from the machine, as occasionally a number of cartridges, and in some cases a whole plate of cartridges, explode, making it dangerous for him to stand in close proximity to the press.

The table *A* on which the loading plates are held is moved forward by means of a pawl engaging in a rack, fastened to the under side of the table. The table is moved a distance equal to the space between a row of holes for each stroke of the press. The pawl is actuated through a series of levers and the arm *D* which is connected eccentrically to the crankshaft of the press. When the last row of shells in the plate

has been operated on by the row of punches *E*, the machine is automatically stopped by a trip lever at the back of the machine.

A clearer idea of the method of loading the cartridges may be obtained by referring to Fig. 17. Here at *A*, the shells and bullets are shown located in the shell and bullet plates *a* and *b*, respectively, ready for assembling, or seating; and at *B* the bullets and shells are shown assembled, by the action of the seating punches *c*. The plates are now removed from the press, and the slip plate *d* removed, when the loaded cartridges drop out. After the bullets have been seated in the shells, the loaded cartridges are taken to an automatic machine, where they are crimped and cannelured.

Crimping and Canneluring

Crimping the cartridges consists in tightening the shell around the bullet, as shown at *I* in Fig. 7, to prevent the latter from falling out, and also to increase its velocity. This operation is performed in the automatic machine shown in Fig. 18. The loaded cartridges are dumped into the hopper *A* through which passes a belt (inclosed in the box *B*) having scoops fastened to it. These scoops *C*, carry the cartridges out of the hopper up to the top of the slide *D*. Here the cartridges drop out of the scoops into the slide. The slot in this slide is slightly larger than the body of the shell, but is smaller than the head, so that it is impossible for the shells to go down the slide unless they are head upwards.

As the cartridges come down the slide *D*, they come in contact with the wheel *E*, which is rotated by a round belt *F*. This wheel has slots cut in it, in which the cartridges hang, the under sides of the heads bearing on the periphery of the wheel, and as the latter is kept rotating it deposits the shells on the revolving dial *G*. The guard *L* prevents the cartridges from dropping out before they reach the dial. As the cartridges drop out of the wheel *E* onto the dial *G*, they are guided by the block *H*. The dial *G* rotates in the direction of the arrow and carries the cartridges around where they are lined up by the guide *I*. As they continue in their travel, they pass between the stationary segment block *J* and the revolving dial *K*, the action of which rotates the cartridges and performs the crimping and canneluring operations. As they pass around still further they are removed from the dial by a guide and drop into a box. The canneluring is done by means

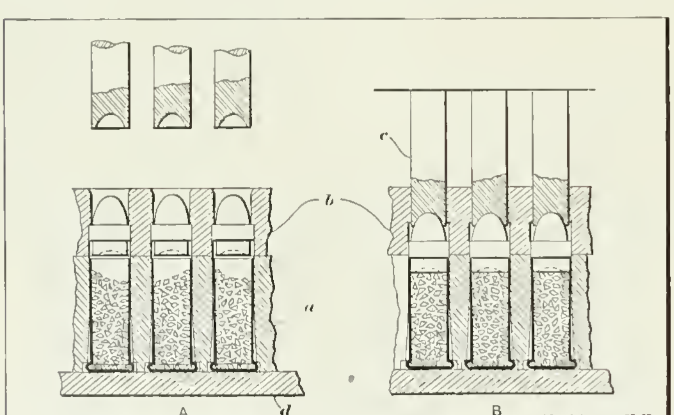


Fig. 17. Diagram showing how the Bullets and Shells are assembled

of narrow knurled projections formed on the edges of the dial *K*, which is fastened to the dial *G* and the segment block *J*. The crimping is also done by forms on the above-mentioned parts.

Greasing, Packing and Testing

The cartridges are now completed, as regards the manufacturing operations, and are ready for greasing and packing. Greasing is only done when the bullets are made from commercially pure lead, and not of composition of from 3 to 5 per cent tin. When made of the composition it is not necessary to grease the bullets. The object of the greasing is to prevent them from leading the bore of the rifle. The 3 to 5 per cent composition has the same effect as the grease, but is much cleaner and of a more finished appearance. The canneluring as shown at *I* in Fig. 7, forms narrow knurled grooves, during the crimping operation for the purpose of holding the grease.

If the bullets are made from commercially pure lead, they are shaken into plates and dipped into molten grease. The grease just sticks in the canneluring, leaving the remainder of the bullet practically clean—that is, if the grease is at the proper temperature. If slightly cooler than the correct temperature, the grease will form in clogs on the bullet, which have to be removed by wiping them with a rag. The shaker plates are now located on a packing plate. This packing plate has three hundred holes drilled through it in groups of fifty,

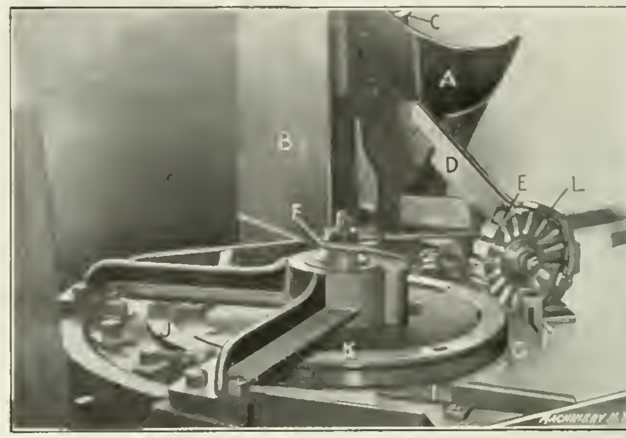


Fig. 18. Automatic Crimping and Canneluring Machine

which is the number of cartridges put in each box. The shaker plate holds only half the number of cartridges that the packing plate does, so it requires two shaker plates to fill the packing plate.

In operation, the first shaker plate is placed over the packing plate, and both plates are then turned over, when the shells drop into the packing plate. The shaker plate is then removed and a slip plate substituted for it. Another shaker plate is placed over the packing plate and the same operation repeated. This fills the packing plate and leaves half of the cartridges in the plate with their heads up, while the other half are reversed. The cartridges are now removed from the packing plate and placed in a slide provided with compartments, from which they are removed and placed in boxes. This packing arrangement is semi-automatic, and is considerably quicker than packing by hand.

Even though the cartridges have passed by all the inspections necessary for the manufacturing operations, they are still not ready to ship, but have to pass through a rigid test. A number, picked at random, are taken to the testing department where the tester in charge tests them for accuracy. As these cartridges are used only for sporting purposes, their velocity is not of very great importance, but they have to be correct as regards accuracy, which is of prime importance. There are various methods of testing the accuracy of the cartridge. One is to locate the rifle in a stock which holds it rigidly. The sight is then located accurately over the bull's eye, the trigger pulled, and the result noted. The cartridge is also tested for accuracy by off-hand shooting, and other similar tests.

* * *

Pitching-tanks consisting of U-shaped tanks installed on shipboard and extending from port to starboard through the hold have been used successfully for preventing the rolling of ships on two medium-sized Hamburg-American liners. The invention is that of Herr Frahm, and the principle of the pitching tank is that the water which rises and falls in the tank as the ship rolls neutralizes the movement of the latter. On the liners on which these pitching-tanks were installed, the rolling amounted to 11 degrees without the tanks; with the tanks in operation, this rolling was reduced to 2 degrees. It is stated in the *Mechanical Engineer* that the Hamburg-American line has directed that its new 60,000-ton steamer recently ordered is to be equipped with these pitching-tanks.

THE MAKING OF A KNIFE-EDGE SQUARE

By T. MILLER

For very fine work on gages, instruments and some kinds of tools, a square with a flat-edge blade will not answer the purpose, for the simple reason that the contact between the work and the edge of the blade is too broad, so that the light will be shut out when they are not really together at all; and the paper-strip method will not answer, because the paper is too uneven in thickness and too rough to give the required accuracy, and besides, most work of that character would be too small to handle in that way; so what are called "knife-edge squares" are used. For some reason—probably because of their necessarily high cost—this class of square, as far as the writer knows, is only made by one tool manufacturer and the few that are in use have mostly been made by the workmen using them.

A hardened steel square of a size usually below the three-inch, such as shown in Fig. 1, is sometimes used as a starter. The blade is heated and then taken out of the stock, and the latter is then refinished on its two edges by grinding and lapping until they are flat and as nearly parallel to each other as it is possible to get them by the use of the micrometer caliper or other gaging device. The inside and sometimes the outside edge of the blade is next beveled, as shown in the enlarged sectional view. The sharp edge is also slightly rounded like a knife-edge straightedge. The blade is then put in place in the stock, care being taken to have the contact surface nicely tinned and all the surplus solder removed. The stock and blade are set by trying on a block, preferably hardened, which is as nearly square as it is possible to make it, and then temporarily held by a clamp on the sides of the stock and over the blade. The parts are then heated sufficiently to melt the solder and secure the blade. On account of the heating necessary and the disturbing influence of contraction and expansion, it will be found rather difficult to get the blade set even approximately right, and sometimes as many as four or five trials are necessary. After this, hand lapping is resorted to in order to bring it to the required degree of accuracy.

This difficulty in setting the blade has led to several designs in which the blade is held by pins, screws or keys, doing away entirely with the necessity for heating. A square of

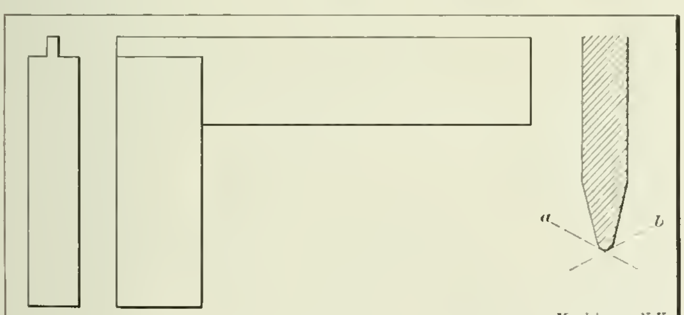


Fig. 1. Try Square and Enlarged Section of Knife-edge Blade

this variety, which has given entire satisfaction, is shown in Fig. 2. Every piece in this tool is hardened, even the screws and pins, as it is found that by so doing they "stay put" for a longer time. The stock *A*, is made of a single piece. The slot holding the blade ends in a round hole *B*, which serves the purpose of preventing fire cracks during hardening, and provides a clearance that is useful when lapping out the slot; the latter must fit the blade, which has previously been finished, closely—without play. The stock and blade are pivoted together and the blade is free to turn on pin *C* which need not be fitted with any great accuracy. In the stock are the two screws *D* and above them the two loose drill-rod pins *E*. It will be seen that with this construction, the blade may be quickly and accurately set and held firmly, and that when the fine edge of the blade becomes worn, it is a very small job to remove and reset it—that is if we have a square block to which to set it.

A good form of testing block for squares is shown in Fig. 3. This block should be of either tool steel hardened or machinery steel casehardened, and the sides, or edges, should be slightly longer than the square blade. This block is made in the following manner: From one side, the center is milled out, merely to make it lighter and more convenient to handle. After hardening it should be immediately drawn, slightly, to take out the strains—preferably in hot sand or oil and as slowly as possible. The block is then ground on a surface-grinding machine on its flat side and four edges, and all these are made as nearly square to each other as it is possible to get them by grinding. Then, unless the job is urgent, the block should be laid away at least a week, to allow it to settle before beginning to finish by lapping—the longer the seasoning period, the better.

It will, of course, be understood that for work of this character, the lap must be very true and flat to be of any use

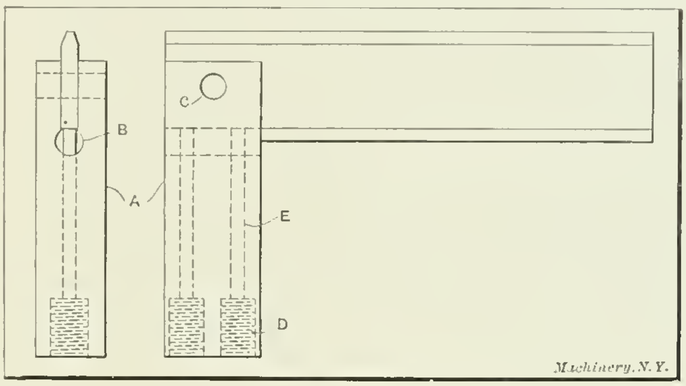


Fig. 2. Square with Adjustable Blade

whatever. A good lap for this purpose, and for general tool and gage work, should be about 15 by 24 inches, of cast iron, with the face cast downward. In form it is a flat plate, 2 inches thick, ribbed on the under side with ribs 3/4 inch thick and 4 inches deep, arranged like the ribs on the Brown & Sharpe surface plates, and bearing its weight on three points to avoid springing. To be able to get a flat plate and do anything like fine work, it is necessary to have three of these plates, all alike. They should be planed smooth on all four edges and on the top, which should also have grooves planed in it, running lengthwise only, about 1/4 to 5/16 inch apart, and of a shape that would be made by a 60-degree thread tool with the point slightly rounded. These grooves should be about 3/64 inch wide at the top and planed in at one cut, so that they may be slightly rough on the edges, to hold the emery better.

After planing, put one of the plates face up on a bench or box, where it can be gotten at from two opposite sides; then turn another plate on this one, with the faces together, and using benzine and No. 100 emery between them, proceed to grind or lap the plates together, keeping the surfaces wet with benzine. When they begin to bear all over, lay one aside and take a new plate; then lay aside the first plate and lap together the second and third, and proceed in this manner till all are finished. This, of course, is on the old principle that no three surfaces can all fit each other, unless all are true planes.

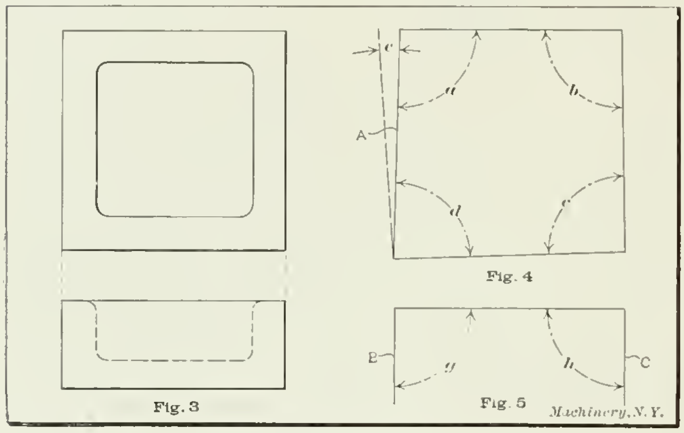
It is not at all necessary to use red lead or blue as a marking to indicate when the surfaces fit each other, as by wiping them clean with benzine and waste and standing off some ten or fifteen feet with the plate in a horizontal position between the eye and a window, it will be very easy to see where the bearing is, as of course there will be no small spots such as there are when two planes are being scraped together. The high places will appear to be highly polished, while parts which do not bear will appear dead and like ground glass. The finishing is done with the finest flour of emery, and very little of that. When the plates are new, they will warp and spring out of shape, and use will wear low places in them; they are then once more put through the lapping process with each other.

For spreading the emery and benzine and charging the

* Address: Bridgeport, Conn.

plates when in use, it is well to have a cast-iron charging block, measuring about 5 by 7 inches and 4 inches thick, with U-shaped handles on the top and one end. The face which is planed should have semicircular grooves, about 1/4 inch wide and about 1 inch apart, planed both ways to form squares. These grooves form air passages and prevent sticking, thereby facilitating the work. To charge, apply emery to the lap by shaking it from a box having small holes punched in the cover, and wet down with benzine from a common oil can; then rub the charging block over the surface from side to side, and, gradually working from end to end, cover the whole surface. This block is frequently used also to clean and sharpen the surface of the lap, when it is rubbed over simply with benzine. For finishing such work as we now have in hand, the charging block is rubbed over the lap with benzine only, and the lap is then wiped dry with waste, wiping from end to end only, and with the grooves, as in this way much less lint will be caught than if we try to wipe across them, or if the grooves were planed both ways. It is often convenient, in doing small work on a lap of this size, to have a little emery on one end and the other clean, so that both roughing and finishing may be done without waste of time.

Care should, of course, be exercised to distribute the wear as evenly as possible. In beginning to lap the parts of a square, benzine and flour of emery or carborundum are used till the wheel marks are out of the surfaces, while the finishing is done with the lap wiped perfectly dry and clean, the emery bedded into the cast-iron lap being sufficient to cut and polish.



Figs. 3 to 5. Test Block for Squares and Method of Developing a 90-degree Angle

We will assume that the square, Fig. 2, has been finished and the blade and stock set as nearly square as possible by other means. To finish the test block, which is represented in Fig. 4, the side A is first lapped perfectly flat and used as a starter. By lapping we now fit the angle a to the square. The testing is done by carefully wiping the square and block surfaces with the bare hand or a piece of chamois, applying the square to the block, and holding them up to the eye before a strong light. When they fit together so closely as to shut out the light the whole length of the blade, angles b and c should be fitted in a similar manner. When this has been done and the square is applied to angle d, we may find, as in the sketch (which is greatly exaggerated for illustration), that there is a considerable space e between the outer end of the blade and the block, and this shows that the "square" is just one-fourth of this opening over 90 degrees, or, in other words, that the "square's" error is multiplied by four, as shown by this opening, on the last or final angle tried. Should the opening appear at the other end of the blade, it would merely mean that the angles were less than 90 degrees. In either case the blade should be reset an amount equal to one-fourth of the opening shown, as near as can be estimated, and the block is again fitted to the square, as before; this process is repeated as many times as may be necessary to shut out the light on all four corners, or angles.

By having the surfaces clean and dry and carefully applying the edge of the stock with the blade a little ways off, and working it gently to get the air out, a good contact is obtained, and by gently working the blade down until it barely touches the block, a very accurate test can be made; for it seems to be pretty well known that under these conditions light may be seen through a space which is only one-forty-thousandth part of an inch wide. This will probably be as close to square as we care to go; but there is another method of testing that seems to admit of still greater refinement, which is as follows: After wiping the block as clean as possible with the bare hand, there will still remain on the surfaces a thin film of moisture. By gently moving to exclude the air, as before, bring the block and square stock into close contact, and then bring the blade to bear; when it does, give it a sidewise movement of about 1/32 inch. Upon removal, and in a good light, it will be seen that the blade has left a slight but distinct mark in the moisture upon the surface of the block. Unless this mark extends the full length of the blade, it shows that while it may have been close enough to shut out the light, it did not actually touch all over, and by careful work it may be made to do so. The color of this mark should also be noted, as it varies with the pressure between the edge and flat surface and is another guide to refinement. It should be uniform in appearance from end to end.

The outside or back edge of the square is left until the block is completed, when it is tested by standing both block and square on a true, flat surface and proceeding as before, except that the edge is now lapped with a small hand lap to bring it true instead of by moving the screws, as before; and, of course, the block is not lapped because it has been previously made square.

It is necessary, while finishing both edges of the blade, to tilt or roll it at an angle both ways over its slightly rounded edge, making it bear as shown by the dotted lines a and b, Fig. 1. Were this not done, the square might be anything but true if it were turned ever so slightly at an angle to the work. It is this rolling over and making the edge touch its full length in any position that takes the most time and patience. A tool of this kind is best made at odd times and worked in between other jobs, as it will not do to hurry it in the least, and neither the block nor the square can be held in the hand any length of time without being warped or expanded out of shape by the heat of the hand. If these operations be extended over several months or a year, at the end of that time the steel will become so settled as to stay in shape fairly well. For some time after the block is under way, it will be noticed that the corners fall away and the flat surfaces gradually become high in the center.

A quicker but somewhat less accurate way of testing a square is shown in Fig. 5. The piece is made parallel on its two sides B and C and the angle g is fitted, by scraping or lapping to the square. If the square be now applied to angle h the error, if any, will be multiplied by two instead of by four as in the other method. This last method has the further disadvantage of depending entirely on the parallelism of the two sides of the test block.

A rule that should be followed in squaring work is to hold the stock against the shortest side of the work, if there be one, whether or not that side is to be changed or corrected. In this way the angle of error, if there be one, between the work and the blade, is extended and much more readily seen than when the blade is applied to a short surface, such as the end of a bar.

* * *

The metric standard taper shanks, dimensions of which were given in MACHINERY, September, 1907, engineering edition, have been adopted by the railway shops of the Prussian State railways. These taper shanks were some time ago recommended by the Society of German Machine Tool Builders. Some German machine tool builders opposed the introduction of the metric taper shank, or, as it is called in Germany, the "German taper," but the machine tool builders belonging to the society mentioned above supply German taper shanks on the tools they make at the same price as other standard taper shanks, facilitating the introduction of the new standard.

RAPID WORK DONE ON THE AUTOMATIC SCREW MACHINE

From time to time operations performed on the Cleveland automatic screw machines, manufactured by the Cleveland Automatic Machine Co., Cleveland, Ohio, have been described in MACHINERY. (See the November, 1908, December, 1908, and April, 1910, numbers). These operations have been of interest to mechanics partly because of the ingenious methods used, and partly because of the rapidity with which the operations have been carried out. In the present article the method of making special knurled nut blanks is illustrated

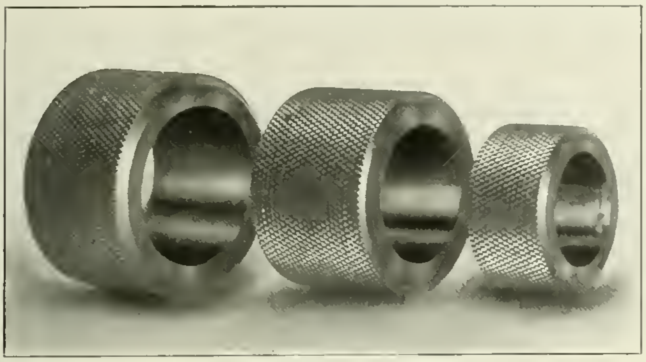


Fig. 1. Knurled Nut Blanks made at a Rapid Rate on the Cleveland Automatic Screw Machine

and described, the notable feature about the making of these nut blanks being the rapidity with which the work is completed.

In Fig. 1 are shown three sizes of nut blanks, all made in the same manner. The smallest one is 1⅞ inch outside diameter, 1 inch long, with a 1¼-inch hole drilled through it; the medium-sized nut is 2¼ inches outside diameter, 1½ inch long, and has a 1½-inch hole drilled through it; and the largest blank is 2½ inches outside diameter, 1½ inch long, and has a 1¾-inch hole drilled through it. The operations performed in the screw machine consist of drilling the hole in the blank, knurling it, chamfering the ends, and cutting off. The pieces are made at a very rapid rate by the methods to be described. Of the smallest size, 60 blanks are produced

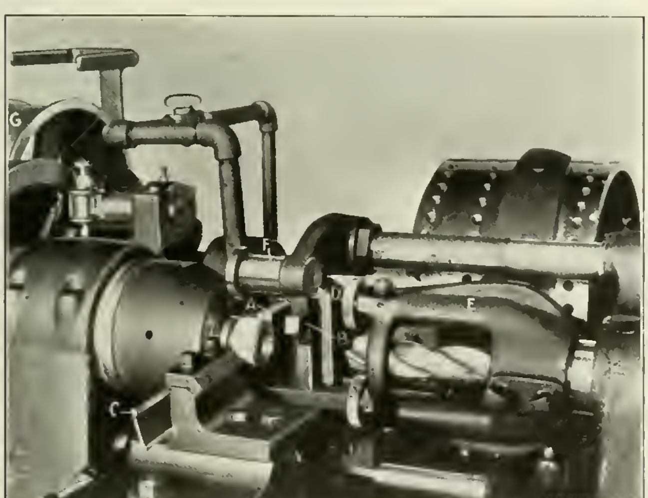


Fig. 2. Arrangement of Tools for Making Knurled Nut Blanks shown in Fig. 1

per hour, or one a minute. Of the medium size, 45 blanks are produced per hour, this being at the rate of 1 minute and 20 seconds a piece. Of the largest size, 36 blanks are produced per hour, or at the rate of 1 minute and 40 seconds a piece.

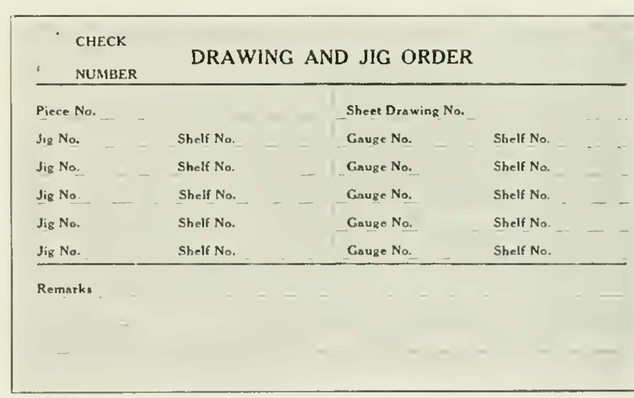
The halftone illustration, Fig. 2, shows the method and tools by means of which these results are accomplished. The tools used comprise a holder for the drills and knurls, tools *A* and *B* held in the rear toolpost, and cutting-off tool *C* in the front toolpost. The holder for the drills and knurls is shown at *E*. This holder is made from a steel casting, and is made of an open form so as to give ample space for the chips from the drilling operation. Owing to the rapidity with which the drilling is done, ample chip room is absolutely necessary. The knurls *D* are simply round disk knurls, mounted on eccentric studs, which permits of adjustment of the knurls. The tools *A* and *B* are held in separate toolposts clamped to the rear cross-slide, and each of the tools can thus be adjusted independently of the other. Tool *B* faces off the front end of the nut blank and brings the piece to exact length, while tool *A*, acting simultaneously with tool *B*, chamfers the corners and partially cuts off the piece. When these operations are completed, the cutting-off tool instantly commences separating the piece from the bar. The drilling and knurling operations proceed simultaneously with the operation of tools *A* and *B*, so that no time whatever is lost in having any of the tools idle at any time during the operation on the piece. The drill is of the oil-tube type, permitting ample lubrication. At *F* is shown a swinging gage stop. The only special feature about the machine is the flanged pulley *G* employed in this case. This pulley can be removed in a few minutes and the regular driving mechanism put in its place.

An interesting feature in connection with this work is that only a year ago the company manufacturing the machine considered that 3½ minutes would be very satisfactory time for making the largest blank in the series, whereas now this blank is completed in less than one-half that time. Three years ago the time for work of this kind was estimated at 5 minutes. These figures are of particular interest to the mechanic as indicating the rapid advance that has been made in large automatic screw machine work in the last few years, and the possibilities which are open for improvement in the manufacture of duplicate parts at a rapid rate.

* * *

DRAWING AND JIG ORDER

The manufacture of shapers and gear-cutting machines in the shop of the Cincinnati Shaper Co. and the Cincinnati Gear-Cutting Machine Co. (under common management), is



CHECK NUMBER — DRAWING AND JIG ORDER

Piece No.		Sheet Drawing No.	
Jig No.	Shelf No.	Gauge No.	Shelf No.
Jig No.	Shelf No.	Gauge No.	Shelf No.
Jig No.	Shelf No.	Gauge No.	Shelf No.
Jig No.	Shelf No.	Gauge No.	Shelf No.
Jig No.	Shelf No.	Gauge No.	Shelf No.

Remarks

A Drawing and Jig Order used in the Shops of the Cincinnati Shaper Co and the Cincinnati Gear-Cutting Machine Co.

typical of the practice of the best machine-tool makers of Cincinnati aud elsewhere, in that jigs and fixtures are provided for drilliug, boring, planing, aud otherwise machining all the parts. The low production cost and other benefits of interchangeable manufacturing thus resulting are not secured without some counteracting disadvantages, however. Where there are several types of machines built and several sizes of each type, the investment in these jigs and fixtures becomes very heavy, and the storing and caring for them so that any one can be readily found, is no small problem. Comprehensive storage and index systems are necessary if the best results are to be obtained.

The above reproduction of the "drawing and jig order," used by the before-mentioned concerns shows the form that is filled out when a workman is given a job. The foreman of his department writes the order, having a card-index system at his desk containing all the data required for the purpose. The order entitles the workman to the drawing, jigs and gages necessary for the job given him, and all the jigs and tools are delivered to his machine. This system is of somewhat greater complexity than that in which each jig is accompanied with the tools required for its use, but on the other hand there is less duplication of tools and, of course, less investment in the jig and fixture equipment.

A PORTABLE CYLINDER BORING BAR

By PERCY W. LOCKWOOD*

A few months ago when overhauling a large vertical twin-compound steam engine, it was noticed that the Corliss valves and their chambers were badly scored by the action of the steam, thus impairing the efficiency of the engine. It was decided to re-bore the chambers and make a new set of valves. The question then arose as to how this could best be done with the appliances available in the machine shop.

The engine formed one of a number of units in the power station attached to a large factory, and to remove the cylinders to the machine shop practically required the dismantling of the engine and its re-erection. Again, although the machine shop is a large one and equipped with an unusual variety of modern machine tools, there was no boring mill suitable for the work and at the same time large enough to take these cylinders. Finally, a great risk would have been incurred by using the light cranes available, to handle such heavy castings.

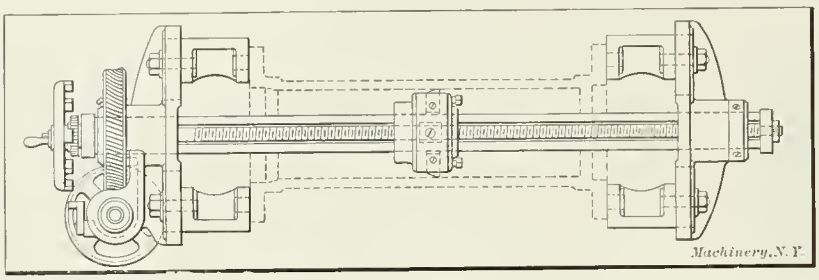


Fig. 1. General View of Portable Cylinder Boring Bar

Under these circumstances inquiries were made as to what manner of appliances were procurable for re-boring the valve casings with the cylinders still in place on the engine. A number of catalogues and circulars were received describing and illustrating various types of portable boring bars, but, owing to these being either too costly or unnecessarily elaborate for the requirements, or unsuitable for the work to be done, it was decided to make one. The accompanying illustrations give a general idea of the apparatus designed, and also show in detail how it was constructed.

Fig. 1 shows a general outside view of the tool with an imaginary cylinder (shown in dotted lines) in place between the heads. Fig. 2 is a sectional elevation showing the details of construction. Fig. 3 is a front elevation and Figs. 4 and 5 show further details of the tool-head. It was designed so that the bar could be driven by means of a small electric motor, for which there was ample room on the overhead starting platform between the cylinders.

All four valve chambers in the high-pressure cylinder had a 5-inch bore; in the low-pressure cylinder the two inlet valve chambers had a 7-inch bore, and the exhaust valve chambers, an 8-inch bore. Their respective lengths varied from 2 feet 9 inches to close to 4 feet. To provide for this range of diameters two sizes of tool-heads were made, one being 4¾ inches in diameter, for the smallest size of chamber, and the other 6¾ inches in diameter, for the two larger sizes. In the latter size of head only one set of tools was provided, and these tools were so designed that they could be adjusted and set to bore either size of chamber. In each case the work was completed in one roughing and one finishing cut, different sets of tools being used for each operation, the cutting speed in all operations being 45 feet per minute. This speed was maintained throughout by the simple expedient of changing the sizes of pulleys on the boring bar on the motor.

The apparatus comprises two bridge heads, the forward one, *A*, carrying the driving and feed mechanism, and the rear feed-screw *D* and carries the tool-head *E* with the tools *F* and the feed-screw nut *G*. The drive is obtained by means of the head *B* constituting a guide bearing. The bar *C* contains the triple-threaded worm *H*, having 0.3 inch lead, and the cast-iron worm-wheel *J* which has 100 teeth.

The worm is somewhat too large in size and could with advantage be made smaller, so as to reduce friction and give more power, but in this instance it was made to suit the only triple-threaded hob in stock of approximately the required size, and, as there was only one wheel to be cut, it was not worth while making another hob. The feed is obtained by means of a five-point star wheel *K* (dished so as to cover and protect the small gear wheels) and the fixed pawl *L*. Once in each revolution of the bar *C* one of the points of the star wheel is brought into contact with the pawl, and the star wheel is thereby rotated in the opposite direction to that in which the bar revolves, until, by reason of its eccentricity in relation to the latter, it is enabled to slip past the pawl and resume its former motion with the bar *C*. Keyed to the hub of the star wheel, and running free on its spindle, is a pinion *M* of 21 teeth, meshing with a spur wheel *N* of 42 teeth which is keyed to the feed-screw *D*. The feed-screw is 1⅛ inch in diameter, and is provided with four left-hand threads per inch. Thus, with a ratio of 1 to 2 between the pinion and the gear, five points in the star wheel and a pitch of 0.25 inch in the feed-screw, we have a feed of 1/40 inch per revolution of bar *C*.

The star wheel is provided with a handle, so that, when the wheel is in a position clear of the pawl, the tool-head can be brought back by hand, after the completion of a cut. The distance pieces *P* placed between the bridge heads and the cylinder to be operated upon are designed so as to afford ample room for adjusting the tools in the head prior to or after making a cut. For boring out cylinders larger in diameter than the capacity of the bridge heads, these distance pieces can take the form of long beams, extending across the cylinder flanges, and a tool-head of a tee or coupling flange shape may be substituted for the one illustrated, so as to bring the tool support closer to the cylinder wall. A groove is milled out of the entire length of the bar *C* for receiving the feed-screw, and within which the feed-screw nut *G* is also guided and travels.

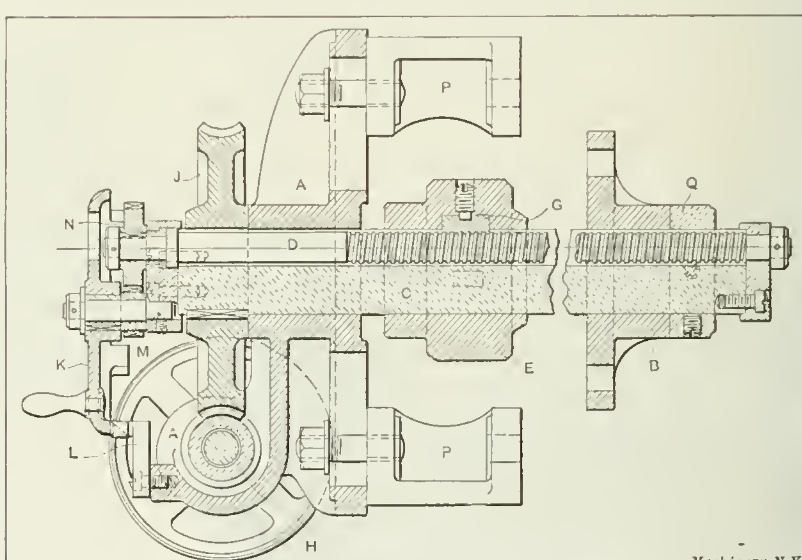


Fig. 2. Section of Device, showing Constructional Details

The feed-screw nut projects into the body of the tool-holder *E*, a portion of which is milled out to receive it. The arrangement of these parts constituted a very rigid, simple and compact device. The roughing tool only is shown in the illustrations, the finishing tool differing from it merely by having a short parallel cutting edge between the nose and the "backing-off."

The cutting tools *F* have each a conical countersink formed

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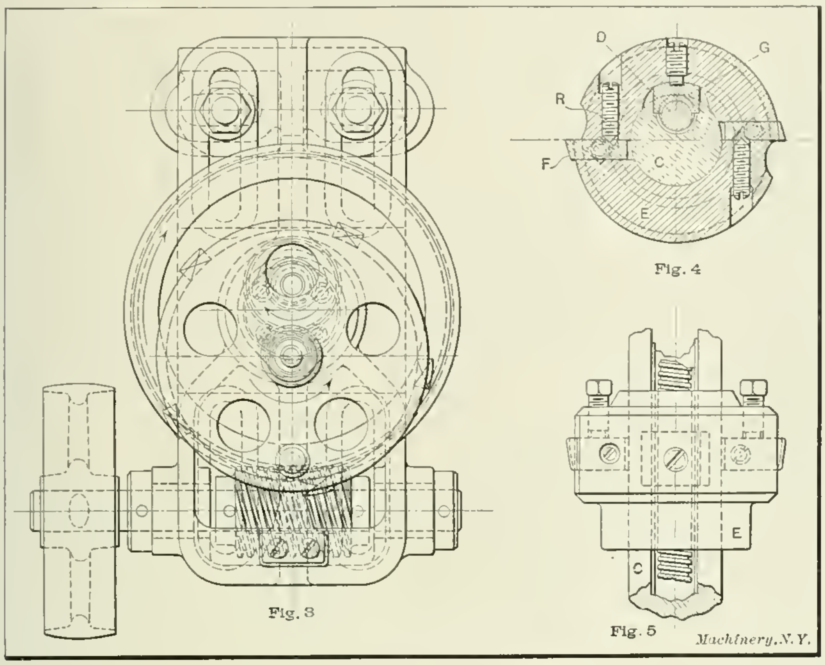
in their forward faces; these conical recesses have their centers situated closer to the bar than the adjusting screws *R* so that when the latter are screwed further into the tool-head, their points produce a lateral, outward adjustment of the tools *F*. The collar *Q* is provided with two set-screws so as to bind it to the bar in any position suited to the length of cylinder under operation.

An additional bearing bracket could also be provided on the forward bridge head *A* to carry a driving shaft placed at right angles to the worm-shaft and fitted with a pair of miter gears interposed between the shafts, so as to give a right-angle drive if desired. A modification of the rear bridge head *B* is shown in Fig. 2. The one illustrated here is designed to suit the rear end of a pump chamber which usually has a smaller size of opening and flange than is provided at the cover end of the pump. The apparatus, in general, is peculiarly adapted for the re-boring of pump barrels in place on board ship, and obviates the usual necessity of dismantling the pump and taking it ashore to the repair shop, a lengthy process which very often causes delay in the sailing of the vessel.



Figs 3, 4 and 5. Front Elevation and Details of Tool-head

* * *

MAKING PACKING BOXES

The general custom of packing small tools and hardware is to use stock-size packing cases and to select the size for the shipment that will contain the goods with the least amount of waste room. The practice of the Armstrong Bros. Tool Co. of Chicago, however, is to make up boxes for each shipment as near the required size as possible. The reason is to insure the goods being received with the individual strawboard cartons, in which each tool is packed, in good condition. This is an important consideration in the case of hardware shelf goods which must present a good appearance to the customers.

The orders are filled by gathering together all the items for a shipment on a sheet-steel table, arranging them to best suit the size and number of the individual cartons. When these have been grouped to the satisfaction of the packer, the three dimensions of the pile are measured and a box is made of these inside dimensions, in the box department immediately adjoining the shipping department. The box thus made, while more costly than a stock box, fits the shipment and carries it to its destination with a minimum of damage to the cases. Special care is taken to protect the tools from dampness, each tool being wrapped individually before being packed in its carton, the entire shipment then being enclosed in oiled paper within the packing case.

SPECIAL DRILLS AND REAMERS

By JAMES H. CARVER*

A number of special drills and reamers of different designs are illustrated in Figs. 1 to 14. These tools cannot be classified as standard types, but some of them have been widely used for special purposes and the various designs may prove of value to those engaged on work requiring special equipment.

In Fig. 1 is shown a tool that is known as a "hog-nose" reamer. This tool is used for enlarging a hole, cored or otherwise, and it is employed extensively in ordnance work for roughing out the steel forgings, jackets, tubes, etc., that are required in the construction of coast-defence mortars and rifles. A reamer of this type, when mounted on the boring-bar of a gun lathe, will bore the entire length of a tube. It may also be used to advantage in the lathe, on much smaller work. When this reamer is made in large sizes, a cast-iron body is used, whereas for comparatively small work the body is made of machine or cold-rolled steel. The copper oil tube shown may, of course, be omitted when the reamer is to be used on cast iron.

A finishing reamer designed to follow the "hog-nose" reamer is shown in Fig. 2. The body of this reamer is also made of cast iron for large work, and either machine or cold-rolled steel is used for smaller sizes. The reamer has two semi-circular wooden pieces of oil-soaked maple fastened to each side as shown. On the large reamers these pieces are attached by bolts, and on small sizes button-head screws that tap into the body are used. When this reamer is in use, the wooden pieces, which are a close-working fit in the finished hole, push the chips ahead as the reamer advances. The two cutters used are backed off and stoned on lathe centers before the wooden blocks are turned. The tool used for turning these blocks is set a trifle over the reamer size by placing a piece of tissue paper between it and the cutters. In case these blocks need re-turning, they are first shimmed by the use of thin wooden strips.

Fig. 3 shows a reamer that is used for finishing a spherical surface at the bottom of a hole. The bronze semicircular pieces *B* attached to the pilot, prevent it from seizing or cutting, as it is likely to do when steel is used. The work is indicated by the dotted lines, and both the large and small holes are, of course, finished before using this reamer.

A roughing and finishing reamer for brass work is shown in Fig. 4, the only change for roughing or finishing being in the clearance given the cutting edge. This is an efficient tool on brass, and it is good for diameters up to about 6 inches, and lengths of, say, 20 inches. The body is a piece of flat steel, which is turned about 1/32 inch below the size, nearly to the cutting edge, as shown by the dotted lines. The wooden guide blocks are held by round- or fillister-head screws.

An all-metal cutter of the hog-nose type, much used in gun shops when a square bottomed hole is necessary, is shown in Fig. 5. As nearly one-half the body of the tool is cut away, there is plenty of room for the chips. This cutter is made in the milling machine, and is ground after the hardening operation.

Fig. 6 shows a hollow drill that is used for cutting test pieces from the interior of a solid piece of metal. The piece secured in this way, which is, say, about 1⅛ inch in diameter and 9 inches in length, is turned down to 1 inch in diameter in the middle, thus leaving enlarged ends for gripping, when the tests are being made. This tool will not work very well with a body that is less than three-quarters of the circumference, and it cannot be forced much when used on steel. As obtaining test pieces is rather a rough job, the body of the tool need not be ground unless it is distorted in hardening.

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The reamer shown in Fig. 7 is a type used when putting in primer seats in the breech ends of mortars and rifles. The cutting edge at the chamfer is the only part that does any cutting. The hole is drilled and reamed before using this tool which simply finishes the bottom tapering. This style of reamer is used chiefly on small work.

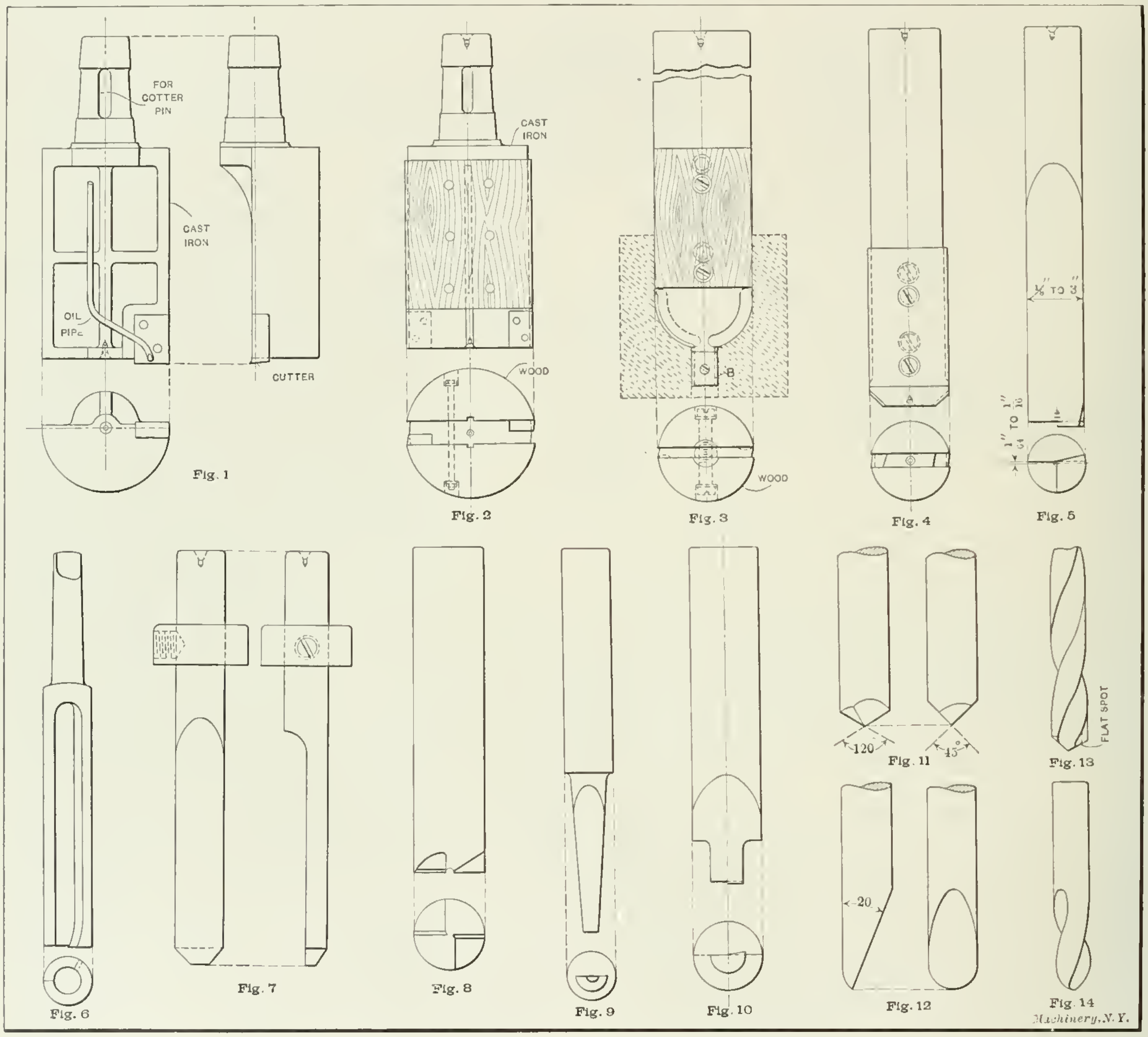
Fig. 8 shows a drill that is made from drill rod by filing square cutting edges as shown, and it is used for squaring up the bottoms of small holes of odd sizes. A taper reamer that is also made from drill rod is shown in Fig. 9. This tool is much used on drop-forged dies, in which small taper holes are often needed for projections in the finished work, such as parts to be riveted, etc. Another useful tool for drop-forged work, that is made from drill rod is shown in Fig. 10. A little over half of the rod is milled or filed away and the reduced cutting end is given clearance as shown. A transfer drill, much used on die work for transferring holes from the dies to the stripper-plate, is shown in Fig. 11. This drill is also made from drill rod and it is given a very blunt cutting angle as shown. It is merely used to spot centers for a regular drill by using the holes in the die as a guide. Fig. 12 shows a reamer that can be made from any size of drill rod by simply filing the end at an angle as shown. This tool is used to ream thin stock and it has an advantage over other styles in that it does not cut over size, the diameter of the reamed hole being practically the same as that of the drill rod used for making the reamer. A drill is, of course, used first, and only a few thousandths should be left for reaming.

In Fig. 13 the old "stunt" of giving an ordinary twist drill negative clearance or back slope on the hook or lip of the drill, is illustrated. A twist drill ground in this way does not tend to "pull in" when drilling brass.

A form of cutter much used by die-sinkers either in a vertical miller or die-sinking machine, is shown in Fig. 14. This tool is known as a "router," and it is made from a regular twist drill. The router is very useful for cutting out corners in dies, cutting sprues, and for other work where there is considerable metal to be removed.

* * *

The Poldi Steel Works of Sheffield, England, have placed a quality of steel on the market which is intended especially for the manufacture of rifle barrels, and which has remarkable non-corrosive properties. It is stated that the steel also resists the action of acids, and can be used to advantage for the manufacture of pump shafts, valve spindles and seats, check-rings for valves, plug valves, etc. The rust-proof tests were made, according to *Engineering*, with barrels fired with smokeless powder five times a day, at intervals of ten days, the tests lasting over a period of fifty days. The barrels were meanwhile kept in a damp cellar and never cleaned, but did not reveal the formation of any rust. The steel has a high tensile strength, the ultimate strength being about 127,000 pounds per square inch and the elastic limit 108,000 pounds per square inch. The elongation in two inches is 25 per cent. The steel can be machined without any particular difficulty, provided a good sharp cutting tool is used.



Figs. 1 to 14. Showing Various Styles of Special Drills and Reamers

EXTERNAL CUTTING TOOLS—3

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

In the present installment, examples of various designs of box-tools, swing tools for external work, and taper-turning tools are described.

Designing Box-tools

The designer of screw-machine tools is frequently confronted with difficulties when designing special box-tools, owing to the fact that the Brown & Sharpe automatic screw machines are very compact. This makes it necessary to design all the tools so that they will not interfere with any part of the machine or the tools which are used on the cross-slides. The following considerations must also be borne in mind:

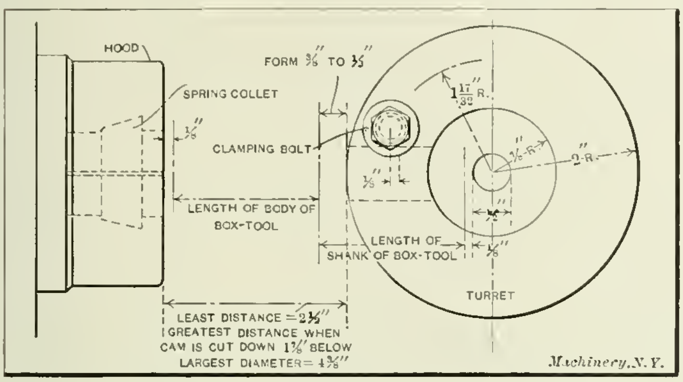


Fig. 8. Method of Determining Length of Body and Shank of Box-tool

1. Character of material, whether rough or cold-drawn;
2. Cross-section of the material, whether cylindrical, square, or hexagonal, etc.;
3. Character of the longitudinal cut, whether straight, tapered or irregular;
4. Length of the work to be turned;
5. Number of different diameters to be turned;
6. Position of the box-tool in relation to the cross-slide tools, when in action on the work;
7. Amount of material to be removed from the diameter.

In addition to the factors mentioned, one of the first things to consider when designing a box-tool, is the length of the body and shank of the tool. As a rule, the length of the body is governed by the length of the work to be turned, especially when the hole in the shank cannot be made large enough to let the smallest diameter of the work pass through. Another consideration to take into account, is the distance from the center of the hole in the turret to the side of the chute. This limits the width of the box-tool, and is a governing factor in its design. Still another point which might be mentioned, is the distance between the point where the box-tool cutter finishes on the work, and the face of the chuck. When this is less than ⅛ inch it is usually necessary to have the cutter project slightly in advance of the face of the box-tool body.

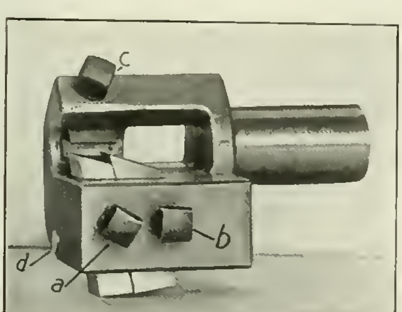


Fig. 9. Standard Box-tool made by the Brown & Sharpe Mfg. Co.

If a special box-tool is to be designed, it is advisable to make a layout of the machine on which this tool is to be used. A plan and side elevation of the turret and cross-slides should be drawn, and the tools used on the cross-slide should also be drawn in the positions they will occupy when the box-tool is in operation on the work.

A method of laying out a box-tool for determining the length of the body and shank is shown in Fig. 8. This diagram is for a No. 0 machine, but the same principle can be used for the other sizes. When designing a standard box-tool, the body is made about ⅝ inch less than the least distance between the face of the turret and the face of the chuck. The shank is allowed to project through the turret to within ⅛ inch of the ½-inch hole through the turret spindle. All the other important points regarding the design and uses of supports, turning-tool holders, etc., have been previously described, so it will not be necessary to enlarge on them here.

* Associate Editor of MACHINERY.

Various Types of Box-tools

As there are so many designs of box-tools in use, it will be impossible to mention all of them, but a few of the most common designs will be described. In Fig. 9 is shown a standard box-tool, as made by the Brown & Sharpe Mfg. Co. This box-tool, as shown, carries two cutting tools. The cutting tools rest on a pin *d* and are held by set-screws *a* and *b*, and by two other set-screws, not shown, which are on the under side of the box-tool. The support, which is of the V-type, is located at the back of the box-tool at an angle of 45 degrees with the vertical center line, and is held by the set-screw *c*. This box-tool is used for general work, for turning both one and two diameters, as required. When one diameter is being turned, the cutter in the rear is pushed back out of action. The method of determining the thickness of these cutters was illustrated in the first installment of this article.

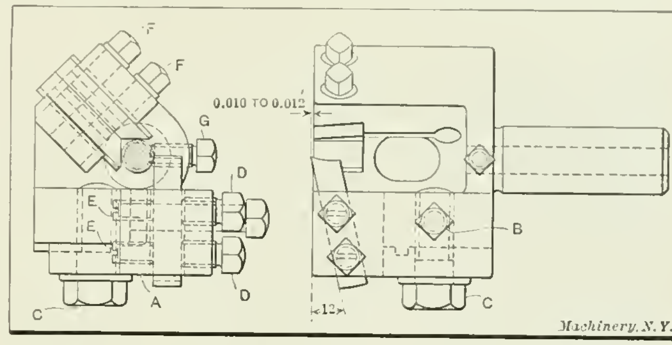


Fig. 10. Finishing Box-tool largely used for Steel Work

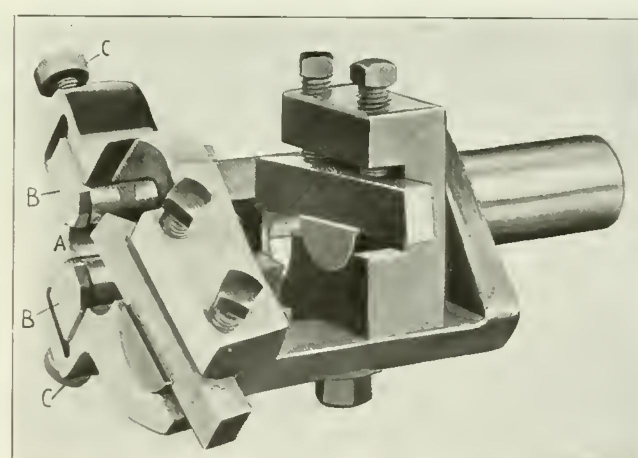


Fig. 11. Box-tool of the Roller Support Type

In Fig. 10 is shown a standard finishing box-tool which is used largely for steel work. In this box-tool the turning tool is held in an adjustable block *A* which is adjusted up and down on the body of the holder by the set-screw *B*, and held to the body by the cap-screw *C*. A projection is formed on the body of the box-tool and a corresponding groove is cut in the block to guide it in a perpendicular position. The turning tool is held by means of two set-screws *D* and the headless screws *E* in the block *A*. The headless screws *E* are for adjusting the turning tool, in order to increase the clearance between the tool and the periphery of the work.

The V-support is held in beveled grooves cut in the body of the holder, by two screws *F* which pass through the two parts of the body binding them together. A slot is cut in the body to facilitate the drawing of the two parts together. The cutting edge of the turning tool is located from 0.010 to 0.012 inch in advance of the face of the supports. A hole is drilled through the shank of the box-tool for holding a pointing tool.

or other internal cutting tool, which is held with the set-screw *G*.

The value of roller supports for turning aluminum, cast iron, etc., was previously mentioned, and in Fig. 11 is shown a box-tool of the roller-support type, as made by the Brown & Sharpe Mfg. Co. This box-tool, as may be seen, is provided with roller supports for the front cutter, and V-supports for the rear cutter.

The general design of this box-tool can be seen from a study of the illustration Fig. 11, but a clearer view of its construc-

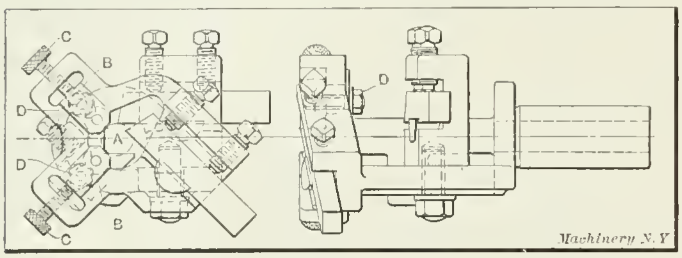


Fig. 12. Details of Box-tool shown in Fig. 11

tion is shown in Fig. 12. This illustration shows the method of holding and adjusting the roller supports. The supports *A* are held by pins in a slot cut in the two blocks *B*, which are adjusted in and out by the knurled-head screws *C*. The blocks *B* are held to the body of the box-tool by cap-screws *D* which are tapped into them. A slot is provided in the body of the holder in which the bodies of the cap-screws slide, thus

centering tool, the bushing for which is shown at *H*. *I* is a pointing tool of a somewhat similar design to that shown at *G*. *J* and *K* are also pointing tools which are used largely for small work. These illustrations show clearly the design of box-tools which are used, in general, for automatic screw machine work.

Swing Tools for External Work

Swing tools, besides being used extensively for internal cutting, are also used for external work. There are some cases where a box-tool or a circular form tool cannot be used, owing to the irregular contour and the length of the work in proportion to its diameter. Of course it is obvious that a form tool can be used where the length of the work being turned is not more than from 2½ to 3 times its diameter, but where it exceeds this amount it is necessary to use some other type. For this class of work, a swing tool such as that shown in Fig. 14 can be used to advantage. The work can be roughed down with this tool and finished with a shaving tool, which will bring it to the correct shape, and also to the desired diameter. (The use of shaving tools will be taken up in a subsequent article.) This tool, of course, can only be used when the diameter of the work is large enough to make a support unnecessary.

There are some cases, however, where the work being turned must be supported, especially where it is small in diameter in proportion to its length. A tool which gives very satisfactory results for this class of work is shown in Fig. 15. This tool is provided with a telescopic support which recedes

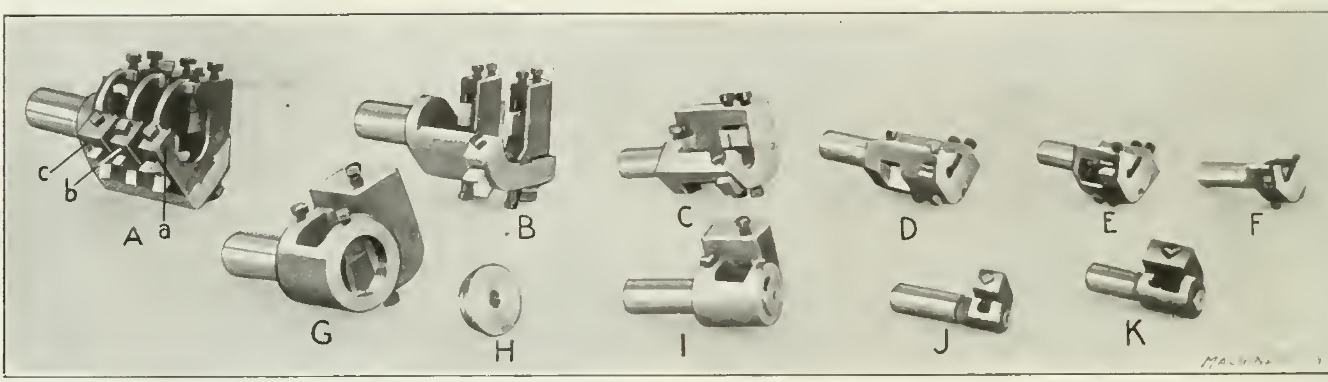


Fig. 13. A Collection of Interesting Designs of Box-tools

making provision for turning different diameters. All the other details of this box-tool can be clearly seen from the illustration.

Some interesting desigus of box-tools are shown in Fig. 13. These tools are all the product of the Brown & Sharpe Mfg. Co. and are used for various classes of work. At *A* is shown a box-tool which is equipped with three turning tools, and three sets of V-supports. The turning-tool and V-support holders *a*, *b* and *c* are made in one piece and are held to the body of the box-tool by cap-screws. A tongue is formed on the base of the holders *a*, *b* and *c*, which fits in a longitudinal groove cut in the box-tool body. It will be noticed that the supports in this case are double supports, that is, they are notched on both ends, the purpose of this being to increase their range. The end of the support shown facing the turning tool is for work of small diameter, while the end projecting from the box-tool is for work of a larger diameter. This box-tool can be used either for roughing or for finishing work, and it is especially adaptable to work having three different diameters.

At *B* is shown a box-tool with two cutting tools, but with only one support. It will be noticed in this case that the holders for the turning tools are very narrow, thus permitting the tools to be set close together. The box-tool shown at *C* has two turning tools which are set close together. A hole is drilled through the shank, and a set-screw is provided for holding a centering or other internal cutting tool. At *D* is another box-tool similar to that shown at *C*, except that the supports in this case are double-ended. *E* is a finishing box-tool having two turning tools. *F* is a box-tool of similar design, but carrying only one turning tool. *G* is a pointing and

into the holder as the tool advances on the work. The other features of this tool are similar in design to the standard swing tools, so it will not be necessary to describe them. Mention might be made, however, of the method of holding the telescopic support *A*. A sleeve *B* is driven into the body and shank of the holder *C*, and held by the headless screw *D*. The support proper is turned down on the shank, so that an open-wound coil spring can be inserted behind it. The

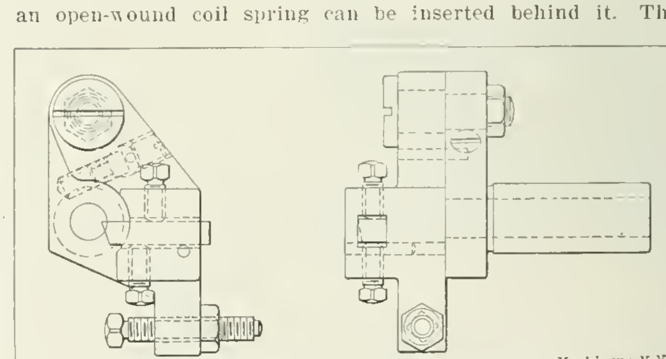


Fig. 14. Swing-tool used for External Cutting

support is kept from being forced out of the holder by a screw *E*, which is tapped into it, and which has a head larger than the hole through the end of the sleeve *B*. This method of supporting the work is found to give satisfactory results when turning work of very small diameter. It is preferable when using this tool to point the end of the work so that it fits snugly in the cone-pointed hole in the end of the support. A similar tool for delicate turning was illustrated and described in the June, 1908, number of MACHINERY.

Taper Turning

Thus far we have confined our attention to tools used for straight turning; but of course taper work can also be accomplished on the automatic screw machine if a suitable tool is provided. A tool which can be used for taper turning is shown in Fig. 16. This is the standard taper turning tool made by the Brown & Sharpe Mfg. Co. and is recommended for taper turning where accurate work is desired. The illustration shows the taper turning tool and the rising block for operating it. This rising block is similar to that previously described, and can be set at any desired angle. The angle to which the rising block is set, governs the taper on the work. When in operation, this rising block presses on the point of the screw *a*, which, in turn, forces the holders carrying the supports and turning tool out from the center.

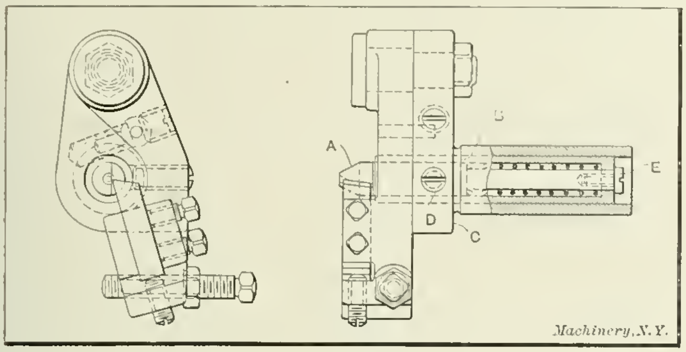


Fig. 15. Swing-tool used when the Work Turned must be supported

A clearer idea of the operation of this taper turning tool can be obtained by referring to Fig. 17. In this illustration an end view, longitudinal-section and cross-section are shown at *A*, *B* and *C*, respectively, to illustrate the working mechanism of this tool. As the rising block (shown in Fig. 16) presses against the point of the screw *a*, which is tapped into the sleeve *b*, it forces the latter in the direction of the arrow. Now as the sleeve *b* is forced in, it pulls on the band spring *c*, which is attached to the circular block *d*, thus turning the latter around in the direction of the arrow. The band spring is made from sheet steel, 5/16 inch wide by 0.012 inch thick, which is left soft. This spring, as shown, is fastened in a slot cut in the circular block *d*. The circular block *d* has eccentric projections *e* formed on it, which fit in slots cut in the tool-holder *f* and support-holders *g*. From a study of the illustration it can be seen that as the sleeve *b* is forced in, it carries the spring *c* forward, which rotates the circular block *d* in the direction of the arrow, thus forcing the holders carrying the supports and turning tools out from the center. This, as can be seen, will produce a taper on the work, the extent of which will depend on the angle to which the rising block is set.

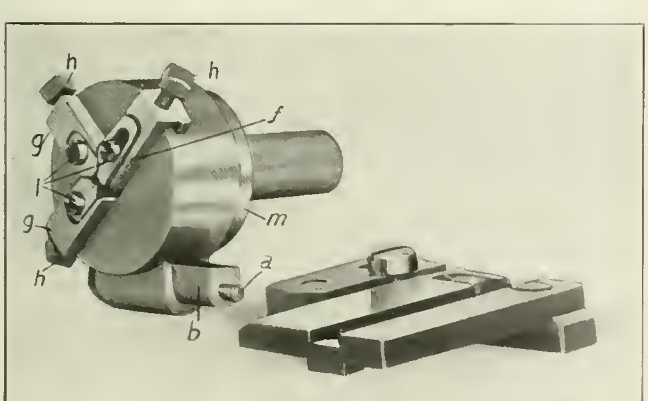


Fig. 16. Standard Taper Turning Tool

In the end view shown at *A* the turning tool and support holders are shown in the position they occupy before the rising block operates on the holder. The supports and turning tool can be adjusted independently of each other by the set-screws *h*, and are held by the fillister screws *i*. After the turret drops back, disconnecting the screw *a* with the rising block, the turning tool and supports are returned to their former position by means of the coil spring *j* (shown at *B*) which is held in an annular groove cut in the rear of the circular block *d*. The spring *j* presses against a pin *k* (shown at *C*) which is riveted to a plate *l*; this plate is held to the shank of the holder by a pin fitting in a slot. The plate *l* is held up against the outer casing of the holder by the nut *m*, screwed onto the shank of the holder. All the other details of this tool can be clearly seen from the illustration.

* * *

ELEMENTARY MATHEMATICS

The simple mathematics of percentage seems to be a stumbling block for some of the young advertising sharps. One not long ago claimed a reduction of cost of five hundred per cent, blissfully unconscious of the fact that the greatest possible saving could be only one hundred per cent, and that saving would require the cost to be absolutely nothing. Another was too modest in his claim. A farm produced seventeen bushels of wheat per acre while the adjoining farm produced sixty-one bushels—"a gain of seventy-two per cent." As a matter of fact the gain was two-hundred-fifty-nine per cent. If these young men who have forgotten some of their common arithmetic training will remember that the elements of percentage are: the *base*, the *per cent*, the *percentage*, and the *amount* or *difference* and will determine what is the base in all problems, no perplexity need result. In the case of the saving, the original cost was the base. The production was increased five times or five hundred per cent. it is true, but the cost was cut four-fifths, and four-fifths of one-hundred per cent is eighty per cent. In the other case the base was the yield per acre of the poor farm. The difference between the yield of the poor farm and that of the good farm was forty-four bushels per acre, and as this gain is to be expressed in percentage of the lesser yield, the latter must be the base for calculation.

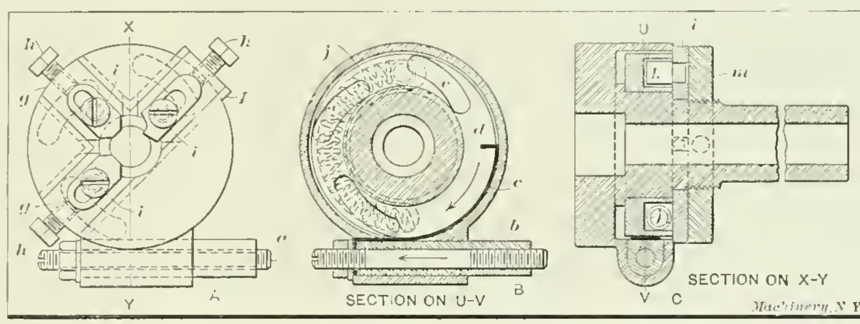


Fig 17. Details of Taper Turning Tool shown in Fig. 16

* * *

TESTS OF BEARINGS AND JOURNALS

Two years ago the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, made a comparative test of bearings for lathe spindles on two of the engine lathes in its plant, to determine the relative durability of the following combinations, *viz*: hardened steel journal in cast-iron box; hardened steel journal in bronze; soft steel journal in bronze; and soft steel journal in babbitt. The experiment was made on both ends of the spindles, thus making the four combinations named. Both lathes were kept in constant use, the general character of work being the same for both. When examined recently, the condition of the hardened steel journal and cast-iron box was the best of all, neither the spindle nor the box being appreciably worn, the grinder and scraper markings still being visible. The hardened steel journal and bronze box combination was in good shape, but the journal was slightly ridged in the center, showing more wear than the first. The soft spindle in bronze was worn appreciably, but the soft spindle in babbitt was in first-class condition. The bearings were provided with oil rings and oil reservoirs, and the main bearings with oil reservoirs and felt wicks.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Fred. H. Moody,
Associate Editors

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MARCH, 1911

PAID CIRCULATION FOR FEBRUARY, 1911, 26,164 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

PLANNING A MACHINE SHOP

The tendency of manufacturers when planning new shops and factories has been to lay out the buildings in accordance with certain ideals or notions, and to arrange the machinery and routing of work to conform to the buildings. In some cases, of course, the economical utilization of the available land makes this course to a large degree necessary, but where land is cheap a better plan can be followed.

The proposition can be treated almost entirely with reference to the logical arrangement of the machines for performing the operations on the product to be built, grouping them so that the raw material may enter the plant at one point and the finished product pass out at another, without retracing its course at any point. If the product consists of light and heavy machines of the same general type, they may be carried through in parallel lines, all arriving at a common destination. The planning of the building is then simply a problem of housing or roofing over a machine shop whose preliminary arrangement has been laid down on a certain sized lot. The saw-tooth roof building harmonizes with this conception admirably, and has been utilized with marked success by several machine tool builders in the Cincinnati district.

* * *

THE CAMERA IN THE SHOP

Some machine tool builders make very effective use of the camera in the shop by securing photographs, whenever there is an opportunity, that will illustrate the capability and capacity of their tools; and this practice could be extended with good results to other kinds of machinery and tools. Views of a machine at work indicate in many instances important features that are not apparent from an illustration of the idle machine, and they are also of value in showing the adaptability of a tool for handling various classes of work. The power of a tool and its probable output can be demonstrated by views showing the possibilities in the way of roughing cuts, etc. The output of the machine per hour per day, when shown by a picture, is also a very effective way of indicating its efficiency, and is more impressive than mere figures.

To obtain pictures of this kind without considerable inconvenience, a shop should have proper facilities for doing photographic work, so that the views can be secured whenever there is an opportunity. It is the practice of at least one machine tool builder to photograph his machines whenever they are engaged on different classes of work of an interesting nature. The plates thus obtained are filed in a cabinet that is kept in a room especially fitted up for photographic work. When an inquiry is received regarding the best method of machining a certain part, a picture is often available from the file that will show a machine actually engaged on work that is similar or perhaps identical with that referred to in the inquiry; and in this way the camera is made an important member of the sales department. These views are also used to advantage for illustrating catalogues or pamphlets, and in various other ways. The principal value of pictures of this kind would doubtless be found in connection with the introduction of comparatively new lines of work. When a machine tool builder enters a new field and endeavors to show the superiority of a method or machine, as applied to a certain class of work, he always encounters more or less indifference to any change in existing manufacturing methods. This was the experience of the pioneers in the milling machine field, and the manufacturers of grinding machines and other modern tools have had the same difficulty. Doubtless similar conditions exist in other lines where machinery is used; and a somewhat extensive use of the camera along the lines suggested would accomplish much toward encouraging the use of the most efficient methods and tools.

* * *

THE MILLING MACHINE AND THE GRINDER

A few years ago a great deal was said and written about the future of the milling machine, and some enthusiastic advocates of this tool predicted that it would usurp the place of the planer in the machine shop. But as time went on it became pretty well settled that each machine had a distinct field, not perhaps definitely limited within given boundaries, but nevertheless of such a character as to assure to each machine a permanent place in machine shop practice.

Some remarkable developments in the art of grinding have recently brought forth the suggestion that the grinding machine, properly designed and equipped, may in the future supersede the milling machine for plain finishing operations. To a certain extent this change probably will take place, but it will not make the milling machine superfluous nor less valuable. The development of the grinder along such lines as will make it efficient as a finishing machine for plain surfaces will, if anything, increase the value of the milling machine, because the latter machine is far more productive as a roughing than as a finishing tool; and its total efficiency will be increased if it can be relieved from performing finishing operations. Hence the development of the grinder will not be detrimental to the future of the milling machine. Each has plainly its distinct field, and there are operations suited to each which cannot be performed as economically, if at all, on the other; but it seems that the development of each will tend to increase the relative efficiency of both, much the same as the development of the cylindrical grinder has increased the efficiency of the lathe, and the use of high-speed steel for roughing has increased the total efficiency of the lathe and grinder combined in a ratio which no one dreamed of ten or fifteen years ago.

In general, new developments in any field have the tendency to merely increase the efficiency of the tools, methods, or operators they are at first expected to replace. The sewing machine did not eliminate the workers at the tailor's trade, nor reduce their number; it merely increased their efficiency, cheapened the cost of production and therefore stimulated the demand. The advent of the steam locomotive did not decrease the number of people engaged in transportation—the number increased. Nor will the improved grinder lessen the demand for milling machines. The demand will increase, because the improvement is but another step in the progress towards increased production at less expenditure of labor, and all such advances increase the usefulness of machinery in general.

DEFECTIVE METHODS OF ACQUIRING FOREIGN TRADE

Foreign merchants complain a good deal of the lack of attention of American manufacturers to the requirements of the buyer, and many thousand dollars' worth of orders have been lost through inattention to details in the inquiry. Not long ago an American manufacturer was requested to quote prices for his products delivered freight prepaid at a German port; but he replied quoting prices F. O. B. New York, and stating that it was impossible to quote prices in the form requested. It would have been very little trouble to find out the freight charges from New York to almost any European city—especially to one where there is direct steamer communication; and ordinary business judgment would have suggested taking the trouble necessary in this instance. Another case which we had occasion to mention in MACHINERY some time ago, referred to a request for a complete price list to be sent with the catalogue of the machinery inquired for; instead of sending the price list the catalogue was accompanied with a letter stating that prices would be quoted on application. The neglect to comply with this simple request meant the loss of an order amounting to nearly $75,000.

Most of the troubles which arise with foreign buyers come from neglect to observe small requirements which would take very little time here, but represent a great deal of trouble on the other side if they are not attended to. Those of our manufacturers who are familiar with European methods comply with these requests, and their business moves along smoothly. Those who do not attend to them are generally new comers in the foreign field.

* * *

WORM VS. CHAIN DRIVE FOR AUTO TRUCKS

The compactness and simplicity of the worm gear are generally attractive to mechanical engineers and designers, and many have been led against their better judgment to use it in devices for which it is not suitable. Of all ordinary transmission mechanisms the worm gear requires the best workmanship, both in making and in mounting, to secure maximum efficiency; and even when everything possible has been done to make for the best efficiency, it is still relatively low. When high speed ratios are required in small space, in devices with few parts, or the self-locking feature is important, the worm is the ideal transmission to use, but if other transmission gear of high efficiency and durability can be used, why use something inferior?

A movement in the design of motor trucks to be deprecated is toward the use of the worm drive in the transmission to the rear axle, a worm and wormwheel taking the place of bevel gears. We believe the move will be disastrous if generally followed by the builders of motor trucks, because reliability is required first of all in cars for commercial uses. Neatness of outline and freedom from noise are prime considerations in pleasure cars, but it appears like poor design to employ a rear axle in a heavy truck containing the differential and a worm drive, in place of the plain axle and a parallel lay shaft carrying the differential and chain sprockets for the intermediate transmission to the wheels. The latter form of drive is easily repaired; drivers can make shift to get along if one side is badly damaged, and are doing it every day. Hooking the rear wheel into an obstruction with force sufficient to bend the axle does not necessarily put the truck out of running, but it surely would if furnished with the worm drive and differential in the axle. Another disadvantage of the latter is the greater dead weight—that is, weight not spring supported—carried on the rear wheels as compared with the load carried by the differential rear axle type. The chain transmission gear may not be pretty, but if incased as it should be it is comparatively noiseless, highly efficient, long-lived, and simple to repair.

* * *

The real greatness of a man's business success becomes manifest only when he has made his success in a competitive business.

DISAPPOINTING RESULTS OF ALTRUISM

By J. CROW TAYLOR*

Ever since the writers of history have kept a record of things, we have found from time to time instances where fine theories and altruistic ideas that should have borne the best fruit in the world have proved disappointing. We often find cases where it seems that theory and practice do not get hitched up together right to do good work. Whether it is because they are mismated or because of some unfortunate blunder or misconception of circumstances, it is impossible to say, but the fact remains just the same that we do come across these occasions of good theories going wrong.

There are at hand now two instances in point; one of these is in the discontinuing of a profit-sharing plan undertaken by Sir Christopher Furness, of England, who, in 1908, took his employes, numbering 3000, into a co-partnership with him in a shipbuilding business. This case was one of the most conspicuous on record of modern efforts at profit-sharing. It was heralded all around the world, and it has been watched with a great deal of interest. A report from Consul-General John L. Griffiths, of London, says that in December, 1909, the employes received a dividend of 9 per cent in addition to their wages, but were dissatisfied with the arrangement, and by a majority vote have decided to discontinue it. In this case, strange as it may seem, the report states that the objection to the profit-sharing plan came largely from the trade unions, and after nearly two years' trial it has been discontinued and other plans put into operation to prevent friction and disputes between employer and employe, or rather to prevent any disastrous results from differences of opinion. There has been organized a sort of works council, which will handle all questions of wages and other matters that might come up and cause dissention; but it seems that the profit-sharing plan has gone and in its place the workers will receive specific wages, and whether they buy shares of stock and take a part in the dividends of that company or any other company will be a matter of individual preference and action.

The other instance containing a note of disappointment comes in a report from Consul Augustus E. Ingram, of Bradford, England, concerning the annual report of the chief inspectors of factory and work shops of the United Kingdom. It may be recalled in this connection that back in 1906 there was put into operation in England a workmen's compensation act to compel the carrying of insurance for industrial accidents and a proper compensation of all employes injured by accidents while at work. The report of accidents for the calendar year of 1909 shows a total of 116,554 accidents (946 of which were fatal); in 1904 the number of accidents was only 91,954 (1018 fatal).

This report, Consul Ingram says, confirms a statement made by him in previous reports, that the number of industrial accidents had materially increased since the workmen's compensation act of 1906 has been in operation throughout the United Kingdom.

Therefore, we have had another case of disappointing results from putting into practice a fine theory based on altruistic ideas. It is probable, however, in this instance, that the disappointment is not as real as it seems, or rather that we are disappointed because too much was expected. The natural inference to be drawn from these figures is that the enforced compensation and the knowledge that compensation would be forthcoming has made workmen careless and reckless of accidents. Probably it has, too, in some instances, but it is difficult to conceive of a right-thinking man purposely endangering himself, even though he may know he will be compensated in case of injury. It is likely that we will be nearer right in this instance to assume that there really were no more accidents happening, but there were more *reported*, because of the fact that the compensation would make it worth while to report them, whereas previous to this there was no occasion to report trivial accidents or accidents wherein the one injured had no hopes of compensation or nothing to gain by making the report.

* Address: Masonic Building, Louisville, Ky.

THE DESIGN OF GROUPED HELICAL SPRINGS*

By EGBERT R. MORRISON†

It is the intention to present here, a study of the design of grouped helical springs, developing the subject upon the basis of the relation which exists between the diameter of the bar and the mean diameter of the spring. In the discussion only round bar coils will be considered.

Notation

The following notation will be adopted:

S = stress solid, or maximum stress, usually assumed to be 80,000 pounds per square inch for heavy steel springs;

G = modulus of torsional elasticity, taken as 12,600,000 ponnds per square inch for steel springs;

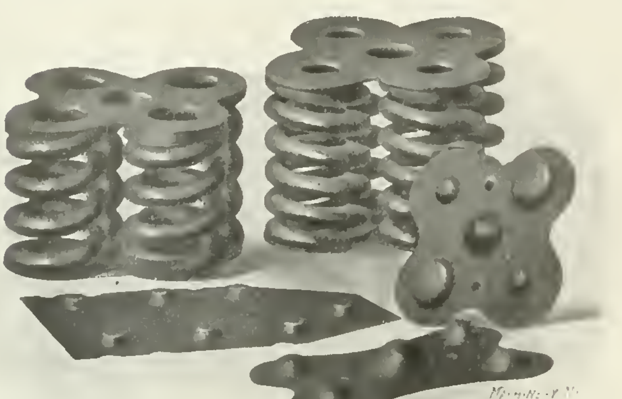

Fig. 1. Groups of Coil Springs held together by Plates at Top and Bottom

w = weight of one cubic inch of the spring material;

π = 3.1416;

f = total deflection;

H = free height;

h = solid height;

h_1 = any other height;

P = capacity at solid height, or weight necessary to produce complete deflection;

P_1 = load at h_1, or weight necessary to compress to h_1;

W = weight of spring;

L = blunt length of bar, or length before tapering;

D = mean diameter of coil;

d = diameter of round bar;

r = spring index, or $D \div d$.

Definitions

In addition to the above notation, the following definitions will serve to clear the discussion:

Spring: any single coil, combination, or group of coils.

Coil: a spring composed of one bar only.

Turn: a wind or rotation, a part of a coil.

Turns are fundamental elements; *coils* are composed of winds; and *springs* consist of one or more coils.

The Spring Index

The *deflection* of a helical spring may be expressed as

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h \qquad (1)$$

The *capacity* may be expressed by

$$P = \frac{\pi S}{8}\left(\frac{d}{D}\right) d^2 \qquad (2)$$

The *weight* may be expressed as

$$W = \frac{\pi^2 w D^2 h}{4}\left(\frac{d}{D}\right) \qquad (3)$$

The *length of bar* to form the spring may be expressed

$$L = \pi\left(\frac{D}{d}\right) h \qquad (4)$$

* For additional information relating to the design of coiled springs, see the following article published in MACHINERY, railway edition, "The Design of Heavy Helical Springs for Railroad Cars," January, 1910.

† Address: Sharon, Pa.

These four standard eqnations being solved, the length of bar required to make the spring will be known, as well as the spring weight, capacity and deflection. A further inspection of these formulas will show that all properties depend upon the ratio between the diameter of the bar and the mean diameter of the spring. This all-important ratio may, therefore, be aptly called the *spring index*, expressed as

$$r = \frac{D}{d}$$

Fundamental Principle of Grouped Springs

Equation (2) gives one value of $\frac{d}{D}$, while equation (3) affords another. Equating,

$$\frac{8P}{\pi S d^2} = \frac{4W}{\pi w D^2 h} \qquad (5)$$

Whence

$$P = \frac{WS}{2\pi w h}\left(\frac{d}{D}\right)^2 \qquad (6)$$

This is the fundamental principle of grouped spring design and means that when a constant weight of material is uniformly stressed, the resultant capacity varies inversely as the square of the spring index, and that the actual number of coils or dimensions thereof is immaterial for a constant weight and spring index.

To Ascertain the Value of the Spring Index

Having given the desired capacity, free height, solid height and material of a spring, it may further be assumed that the maximum fiber stress and modulus of elasticity are also known. If then, the spring index be ascertained, the ratio of mean diameter of coil to diameter of bar that must be maintained in order to produce the results desired, will thus be given.

The value of the spring index from equation (1) is,

$$r = \frac{D}{d} = \sqrt{\frac{fG}{\pi S h}} \qquad (7)$$

which may readily be solved since $f = H - h$, the difference between two known quantities.

Constant Areas, the Basis of Bar Sizes and Dimensions

No matter of how many bars or coils the spring unit may be composed, the sum of the cross-sectional areas of the individual bars is constant. This fact furnishes a basis from which to ascertain the sizes and dimensions of the bars, according to whether there is one or more coils used. It is important, therefore, to deduce an expression for this constant area. Consider a single coil spring.

Fig. 2. Double and Triple Coil Concentric Springs

The product of equations (1) and (2) is

$$Pf = \frac{\pi^2 S^2 d D h}{8G}$$

which may be expressed

$$Pf = \frac{S^2}{2G}\left(\frac{\pi^2 d D h}{4}\right) \qquad (8)$$

Then

$$\frac{\pi^2 d D h}{4} = \frac{2GPf}{S^2} \qquad (9)$$

Equation (3) may now be written

$$W = \left(\frac{\pi^2 d D h}{4}\right) w \qquad (10)$$

Substituting the value of $\frac{\pi^2 d D h}{4}$ as given in equation (9)

$$W = \frac{2 G P f w}{S^2} \qquad (11)$$

The total weight divided by the unit weight will give the volume, or

$$V = \frac{W}{w} = \frac{2 G P f}{S^2}$$

From equation (4) the length of the bar will always be

$$L = \pi r h \qquad (12)$$

The volume, divided by this constant length, will therefore result in an expression of the constant area, or

$$\frac{V}{L} = A = \frac{2 G P f}{\pi S^2 r h} \qquad (13)$$

Substituting from equation (1) the value of f, placing $\frac{D}{d} = r$, gives

$$A = \frac{2 P r}{S} \qquad (14)$$

which is the constant area value sought, and being in known terms may be readily obtained.

This applies equally well for a multi-coil spring, for the weight is uniformly taken up by each of the units of the spring. Therefore the total cross-sectional area is constant.

Determinate Equations for Bar Sizes and Dimensions

In concentric coils, let all the properties of the inner coil be denoted by the subscript 1; of the next coil by the subscript 2; of the next coil by the subscript 3; and so forth. The total sectional area will then always be

$$\frac{\pi d_1^2}{4} + \frac{\pi d_2^2}{4} + \ldots\ldots\ldots + \frac{\pi d_n^2}{4} = \frac{2 P r}{S} \qquad (15)$$

which may be expressed

$$\frac{\pi}{4}(d_1^2 + d_2^2 + d_3^2 + \ldots\ldots\ldots + d_n^2) = \frac{2 P r}{S} \qquad (16)$$

It is possible also from the relation of the diameters of the coils to form as many equations as there are coils less one,

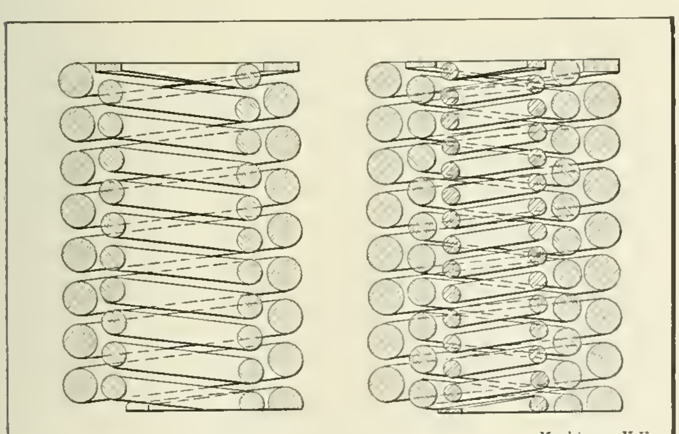

Fig. 3. Double and Triple Coil Concentric Groups, showing Right- and Left-hand Coiling, to prevent Binding

so that there may be always found as many equations as there are unknown quantities, or bars, or values of d.

Equations based on the relations of coils are deduced as follows, where D_n' = inside diameter and D_n'' = outside diameter of nth coil.

$$D_n'' = D_n' + d_n = d_n\left(\frac{D_n'}{d_n}\right) + d_n \qquad (17)$$

or

$$D_n'' = (r + 1) d_n \qquad (18)$$

In the same way

$$D_n' = (r - 1) d_n \qquad (19)$$

Then let the difference between the outside diameter of one coil and the inside diameter of the next be taken as any desirable clearance, c. Or

$$D_n' - D''_{n-1} = c \qquad (20)$$

This gives the series of equations sought, thus:

Between first and second coils,

$$(r - 1) d_2 = (r + 1) d_1 + c \qquad (21)$$

Between second and third coils,

$$(r - 1) d_3 = (r + 1) d_2 + c \qquad (22)$$

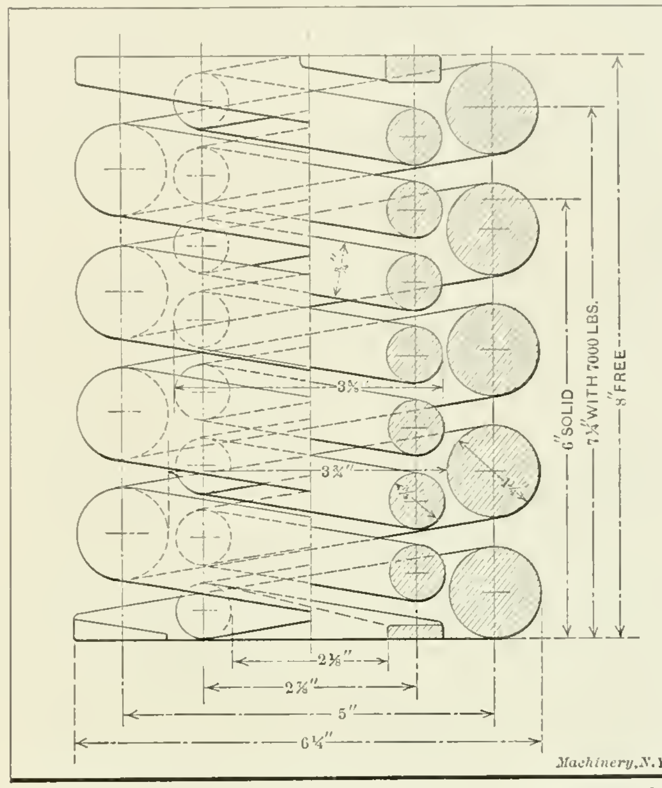

Fig. 4. A Concentric Group showing what is meant by "Solid", "Loaded" and "Free Heights". The Clearance between Coils is usually one-sixteenth inch.

Between third and fourth coils,

$$(r - 1) d_4 = (r + 1) d_3 + c \qquad (23)$$

and so forth.

Equation of d_1 for Single Coil Spring

The value of d_1, or the diameter of the inner (in this case the only) bar may be obtained by writing equation (16) simply as:

$$\frac{\pi d_1^2}{4} = \frac{2 P}{S} r \qquad (24)$$

which may be readily solved for d_1 after making the proper numerical substitutions of the other quantities, thus:

$$d_1^2 = \frac{8 P}{\pi S} r \qquad (25)$$

Equation of d_1 for Double Coil Spring

If there are reasons for desiring two coils in the spring, equation (21) gives

$$d_2 = \left(\frac{r + 1}{r - 1}\right) d_1 + \frac{c}{r - 1} \qquad (26)$$

and from equation (16)

$$\frac{\pi}{4}(d_1^2 + d_2^2) = \frac{2 P}{S} r \qquad (27)$$

Substituting the above value of d_2 in this gives an equation which after substitution of constants may be readily solved for d_1, after which d_2 and the outside diameters may be readily found. This substitution results in

$$d_1^2 + \left[\left(\frac{r + 1}{r - 1}\right) d_1 + \frac{c}{r - 1}\right]^2 = \frac{8 P}{\pi S}(r) \qquad (28)$$

Equation of d_1 for Triple Coil Spring

If now three coils are desired, from equation (21) as before:

$$d_2 = \frac{r+1}{r-1} d_1 + \frac{c}{r-1} \qquad (29)$$

and from equation (22)

$$d_3 = \frac{r+1}{r-1} d_2 + \frac{c}{r-1} \qquad (30)$$

whence

$$d_3 = \left(\frac{r+1}{r-1}\right)^2 d_1 + \frac{r+1}{(r-1)^2} c + \frac{c}{r-1} \qquad (31)$$

Then from equation (16)

$$\frac{\pi}{4}(d_1^2 + d_2^2 + d_3^2) = \frac{2P}{SG} r \qquad (32)$$

whence

$$d_1^2 + \left(\frac{r+1}{r-1} d_1 + \frac{c}{r-1}\right)^2 + \left(\frac{(r+1)^2}{(r-1)^2} d_1 + \frac{r+1}{(r-1)^2} c + \frac{c}{r-1}\right)^2$$
$$= \frac{8P}{\pi S} r \qquad (33)$$

Equation of d_1 for any Number of Coils

From equation (14) it is apparent that if there be n number of coils, the nth value of d, or d_n, is always

$$d_n = \frac{r+1}{r-1} d_{n-1} + \frac{c}{r-1} \qquad (34)$$

The general formula for d_1 may therefore always be written, although every additional coil adds greatly to the complexity of the final expression.

Obstacles in the Design of Concentric Coils

The increasing complexity of the equation of d_1, offers an obstacle to the solution of the multi-coiled springs on strictly mathematical lines. A still greater obstacle in the use of the formulas deduced lies in the fact that commercially it is found economically practical to use only such sizes of bars as are commonly rolled by the mills. In the absence of tables giving the properties of various spring coils from which a selection may be readily made, it is believed that the above formulas, (25), (28), (33) and other similar formulas which may be readily deduced, will serve as guides to the best commercial sizes to use, which sizes being once determined may then be investigated and their futnre combined action ascertained with certainty. To make the manner of proceeding clearer, assume a definite problem.

Solution of Problem by Foregoing Formulas

Problem: To ascertain the proper coils to use to support 35,464 pounds at 5.022 inches solid height, the free height to be 6.625 inches.

From equation (7) the spring index is

$$r = \sqrt{\frac{(6.625 - 5.022)\ 12{,}600{,}000}{3.1416 \times 80{,}000 \times 5.022}}$$

whence $r = 4$, closely.

Size of Bar for One Coil Spring:

By equation (25)

$$d_1^2 = \frac{8 \times 35464 \times 4}{3.1416 \times 80{,}000}$$

whence $d_1 = 2\frac{1}{8}$ inches.

Therefore $D = 4d_1 = 8\frac{1}{2}$ inches
and $D'' = 5d_1 = 10\frac{5}{8}$ inches.

Size of Bar for Two Coil Springs:

Assume the usual clearance of 1 16 inch between coils, whence $c = \frac{1}{8}$ inch. From equation (28)

$$d_1^2 + \left(\frac{5}{3} d_1 + \frac{1}{24}\right)^2 = \frac{8 \times 35464 \times 4}{3.1416 \times 80{,}000}$$

or

$$\frac{34}{9} d_1^2 + \frac{10}{72} d_1 - \frac{1}{576} = 4.5156$$

whence $d_1 = 1.07$ inch and $d_2 = 1.825$ inch. Therefore $D_1'' = 5.35$ inches, and $D_2'' = 9.125$ inches.

Result of Adopting Bars of Commercial Sizes

The closest commercial sizes to suit the solution would then be

$$d_1 = 1\tfrac{1}{16} \text{ inch, and } d_2 = 1\tfrac{13}{16} \text{ inch, and}$$
$$D_1' = 5\tfrac{3}{8} \text{ inches and } D_2' = 9\tfrac{1}{8} \text{ inches}$$

The actual value of c is then

$$D_2' - D_1' = 5\tfrac{1}{2} - 5\tfrac{3}{8} = \tfrac{1}{8} \text{ inch}$$

Now turn the investigation to the two coils which have been selected. The spring index of the inner coil will be

$$r_1 = \frac{D_1}{d_1} = \frac{4\frac{5}{16}}{1\frac{1}{16}} = \frac{69}{17} = 4\tfrac{1}{17}$$

Of the outer coil,

$$r_2 = \frac{D_2}{d_2} = \frac{7\frac{5}{16}}{1\frac{13}{16}} = \frac{117}{29} = 4\tfrac{1}{29}$$

It may now be seen that although the design was based on a constant spring index, the limitations of practice and economy have rendered it impossible to maintain this ideal condition. As the spring indexes of the inner and outer coils are of different values, it is known at once that the deflections and lengths of bar will not be identical for the same solid height. This means that commencing with the same free height and compressing to the same height will cause one coil (that having the least value of spring index) to be stressed higher than the other.

If the value of the spring index has been diminished only slightly from that assumed, it is a safe assumption that the fiber stress will be increased but slightly beyond that assumed, in which case it is not necessary to calculate the actual stresses, but the real capacities may be arrived at directly by basing the calculations upon the modulus of elasticity. It is more satisfactory, however, to ascertain the fiber stresses also, and where the value of the spring index has been considerably altered such a course is imperative in order to keep within safe limits of stress.

Solution of Actual Problem—Stresses

The results will be the same whether similar free heights be taken and compressed to the same maximum fiber stress, or whether a beginning be made with the same solid height extending to the same maximum stress; the maintenance of a uniform final stress results in final heights which are not uniform. Instead of different final heights the usual practice is to use uniform free and solid heights, with the result that each coil is then stressed differently as pointed out before.

In this case the actual stress in each coil is found by the formula

$$S = \frac{Gf}{\pi h}\left(\frac{d}{D}\right)^2$$

which is simply an expression of the fact that where the material used, and the free and solid heights are uniform, the stress varies inversely as the square of the spring index.

In the particular problem at hand, the stress in the inner coil would then be

$$S_1 = 4{,}010{,}695 \frac{6.625 - 5.022}{5.022}\left(\frac{17}{69}\right)^2 = 77{,}700 \text{ pounds}$$

and in the outer

$$S_2 = 4{,}010{,}695 \frac{6.625 - 5.022}{5.022}\left(\frac{29}{117}\right)^2 = 78{,}600 \text{ pounds}$$

Or, since

$$S_1 : S_2 :: \left(\frac{1}{r_1}\right)^2 : \left(\frac{1}{r_2}\right)^2$$

then

$$S_2 = \left(\frac{r_1}{r_2}\right)^2 S_1$$

or

$$S_2 = \left(\frac{29}{117}\right)^2 \left(\frac{69}{17}\right)^2 77{,}700 = 78{,}600 \text{ pounds}$$

which is the same as before.

The stresses being known, the load on each coil may now be solved by the following formula:

$$P = \frac{\pi S d^3}{8 D}$$

Solution of Actual Problem—Capacities

Where the deviation from the assumed index is slight, the variation in the maximum stress will be correspondingly small, and the experienced designer is therefore safe in proceeding to estimate the capacity of his spring directly from dimensions and without reference to actual stresses. In this case use the formula

$$P = \frac{G f d^5}{8 h D^3}$$

TABLE I. COMPARISON BETWEEN ESTIMATED AND ACTUAL COIL SPRING RESULTS

	Estimated	Actual
Free height } Assumed same as actual	6 625	6.625
Solid height } Assumed same as actual	5 022	5.022
Deflection } Assumed same as actual	1.603	1.603
Stress, inner coil	80,000	77,700
Stress, outer coil	80,000	78,600
Capacity	35,464	33,640
Diameter inner bar	1.07	1.0625
Diameter outer bar	1.825	1.8125
Outside diameter inner coil	5.35	5 375
Outside diameter outer coil	9.125	9.125

or, where G is 12,600,000 for steel springs

$$P = 1{,}575{,}000 \frac{f d^5}{h D^3}$$

This would give for the inner coil

$$P_1 = 1{,}575{,}000 \frac{6.625 - 5.022}{5.022} \cdot \frac{(1.0625)^5}{(4.3125)^3} = 8490$$

and for the outer,

$$P_2 = 1{,}575{,}000 \frac{6.625 - 5.022}{5.022} \cdot \frac{(1.8125)^5}{(7.3125)^3} = 25150$$

The capacity of the two coils together will then be

$$P_1 + P_2 = P = 33{,}640 \text{ pounds}$$

Some idea of the difference which exists in the theoretical and practical design may now be gained from Table I, which makes a detailed comparison.

Limitations of Concentric Grouping

It is now apparent that in a spring concentrically arranged the inner bars are properly the smaller, and the greatest load is naturally upon the outer. There is a point, however, beyond which more inner coils will cease to be of advantage owing to the small gain in capacity. The addition of outer coils is also soon limited by the impossibility of coiling and tempering large bars. It is therefore evident that the load which may be carried by the concentric group is limited.

Spring Plate Groups

Where greater capacity is desirable than can be obtained by concentric grouping, several single coils, or several concentric groups, may be held together between spring plates of malleable cast iron or pressed steel. Such groups naturally offer greater stability than concentric groups; but, where the concentric group affords sufficient capacity and stability it should be used, as it is more economical of space and does not necessitate the use of spring plates to hold the different coils together. As the load should be supported firmly upon the center of the unit, the group should be arranged with such symmetry that the supporting forces, or spring resistances, will balance about any axis.

The designing of groups of this kind consists in the simple operation of dividing the load into as many parts as there will be units in the group. Then, maintaining the desired free heights and solid heights, and hence the same constant spring index, proceed to design the separate unit in the manner just presented for the simple concentric. Ordinarily much time and labor may be saved by remembering that halving the diameters of bar and coil reduces the capacity and weight to one-quarter, but does not affect length of bar or deflection of coil. This is due to the fact that this really halves the spring index with effect as indicated in formulas (1), (2), (3) and (4).

As illustrating clearly the comparison between different but equivalent springs, Table II is included in this article, showing four equivalent arrangements. The reader will note that as more coils are used a more compact design becomes possible for the concentric arrangements. The size of the bars reduces also, which makes possible better tempering.

* * *

TABLE II. COMPARISON OF FOUR COIL SPRING GROUPS FOR SAME CAPACITY

	Description		O. D. or Equivalent, Ins.	Free, Ins.	Solid, Ins.	Bars, Ins.	Spring Index	Capacity, Pounds	Weight per Inch Solid Height, Pounds	Length of Bar per Inch Height, Ins.
Group A	Four similar coils in spring plates		11 to 12	6⅝ between plates	5.09 betw'n plates	$1\frac{1}{16}$	4	4 × 8866 = 35,464	4 × 3.1569 = 12.63	12.57
Group B	Single coil		10⅝	6⅝	5.09	2¼	4	35,464	12.63	12.57
Group C	Double coil, concentric	Outer	9⅝	6⅝	5.09	1⅞	4	37,611	9.83	12.57
		Inner	5	6⅝	5.09	1	4	7,853	2.80	12.57
								35,464	12.63	
Group D	Triple coil, concentric	Outer	8¾	6⅝	5.09	1¾	4	24,076	8.56	12.57
		Medium	5	6⅝	5.09	1	4	7,854	2.80	12.57
		Inner	$2\frac{13}{16}$	6⅝	5.09	$\frac{9}{16}$	4	2,485	0.88	12.57
								34,415	12.24	

FLOW OF METALS UNDER COMPRESSION

It was demonstrated several years ago at McGill University that bronze chips could be welded together cold by heavy pressure. The experiment showed that the bronze flowed under pressure like water and that the molecules of adjacent pieces coalesced the same as lead when subjected to a much less pressure. This interesting fact has an unpleasant side, as several machine-tool builders have discovered. It had become a common practice to bush working parts with a certain bronze, these bushings being forced into the holes with considerable pressure. When the bearing parts were immediately put to use, little or no trouble was experienced, but when laid away in the stock-room for some months the bronze bearings were likely to seize the shafts and make refitting necessary. The cause is that the bronze flows inward under the pressure of the cast-iron part holding it and reduces the shaft clearance to zero. This has happened only, of course, where the allowed limits of clearance have been narrow, a change of bore diameter of one-thousandth inch, perhaps, being sufficient to cause trouble.

* * *

An expert on the valuation of automobile factory equipment charges off 10 per cent annually for depreciation of standard machine tools, 35 to 50 per cent for depreciation of jigs and fixtures, and 100 per cent for depreciation of reamers, counterbores, drills, etc.

STRENGTH OF STEEL CASTINGS*

By E. F. LAKE†

Along with the general advance that has taken place in the chemical composition and physical properties of all metals, steel castings have shown a decided improvement in the past decade or two. Some of these improvements have been due to new ingredients that have been added to steel to make the numerous alloys now on the market; others are due to a better knowledge of the chemical composition of steel; of how to remove the impurities; of how to melt, mix and pour the metal, and how to make, vent and gate the molds into which the metal is poured to form the castings. This knowledge has enabled the steel foundries to greatly improve the ordinary carbon steel castings. Their tensile strength, elastic limit,

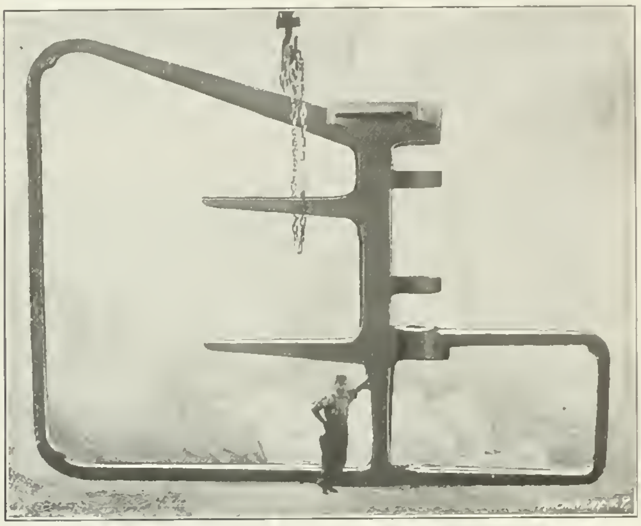

Fig. 1. Steel Casting for the Rudder Frame of a Large Naval Vessel

etc., have been increased something like 50 per cent over that of twenty-five years ago; and their resistance to hydraulic pressure and impact has been increased even more than this. As they are many times stronger than wrought, cast or malleable iron, and have an extreme toughness, they are very useful for machine parts that must carry heavy loads and withstand thrusts or other jolts and shocks incident to hard service.

Strength Required in Steel Castings

The increase in strength is well illustrated by a comparative study of the early editions of Wm. Kent's handbook, which gave the tensile strength of steel castings as 40,000 pounds per square inch and the elastic limit as 20,000 pounds. This was the greatest strength that could be guaranteed by the

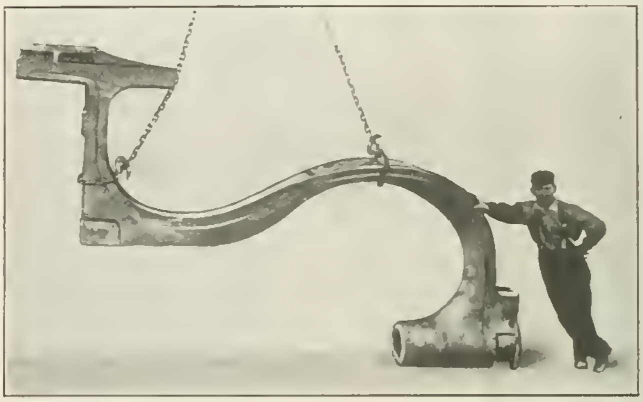

Fig. 2. Stern-post of a Torpedo Boat Destroyer made of Cast Steel

foundries at that time for the ordinary soft or low-carbon steel castings. To-day, however, there is hardly a steel foundry in the country but what will guarantee a tensile strength of 60,000 pounds and an elastic limit of 30,000 pounds for soft steel castings. In the case of the high-carbon steel castings these figures are exceeded by from 25 to 50 per cent.

Steel Castings for U. S. Army and Navy

The ordnance department of the United States army and navy demand steel castings with a tensile strength varying from not less than 60,000 to 85,000 pounds per square inch; an elastic limit of from 25,000 to 45,000 pounds per square inch; an elongation in 2 inches of from 25 to 12 per cent; and a reduction in area from 30 to 18 per cent, according to the service to which they are to be subjected. For moving parts of machinery, a tensile strength of at least 70,000 pounds, with an elongation of at least 20 per cent in 2 inches is demanded. Test bars ½ by 1 inch must be capable of being bent cold 180 degrees, without fracture, around a radius that is not greater than 1 inch.

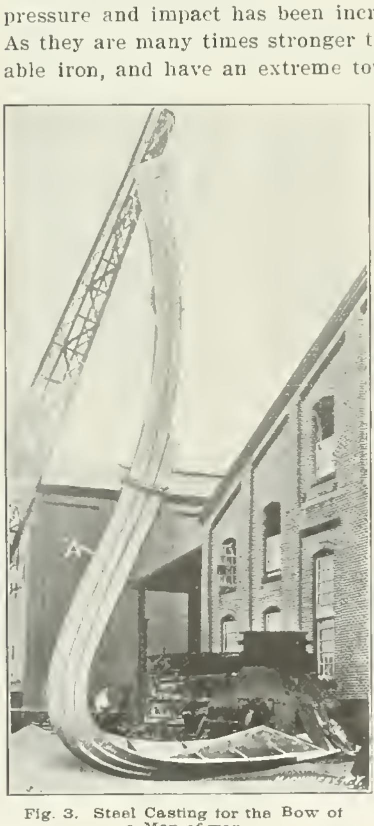

Fig. 3. Steel Casting for the Bow of a Man-of-war

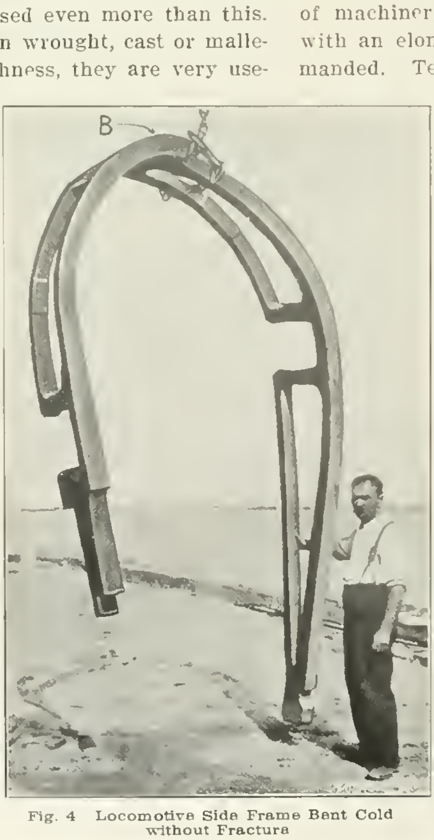

Fig. 4 Locomotive Side Frame Bent Cold without Fracture

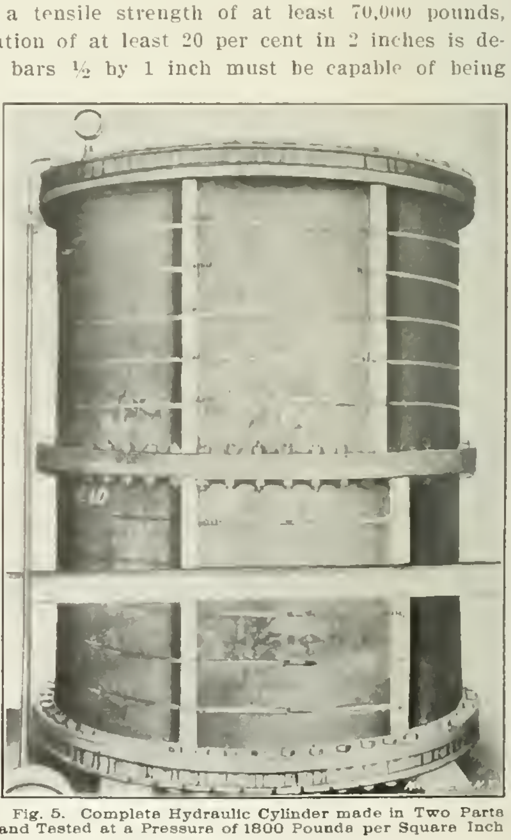

Fig. 5. Complete Hydraulic Cylinder made in Two Parts and Tested at a Pressure of 1800 Pounds per Square Inch

Some of the largest steel castings that have been made to meet these requirements are shown in Figs. 1, 2 and 3. These, as well as the other castings illustrated in this article, were made by the Penn Steel Casting & Machine Co. of Chester,

* See MACHINERY, June, 1903, engineering edition, 'Steel Castings.' See also MACHINERY'S Reference Series No. 36, "Iron and Steel." second edition, Chapter III.

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Pa. They were used on different vessels that have been built for the U. S. navy. In comparison with other metals, the greater strength and toughness of steel permits of a material reduction in the section for a given strength. Thus a corresponding decrease in weight is obtained, and for this reason steel castings have displaced all others in the construction of the war vessels of the navy. The merchant marines have also adopted them in places where great power or special strength has been required.

In Fig. 1 is shown the cast-steel rudder frame of one of the largest vessels in the navy. It is about 22 feet high and 28 feet long, over-all, and its weight is something like 40,000 pounds. The comparatively small section for a casting so large, over-all, makes it a difficult one to mold and retain the required strength in the metal. As the total shrinkage in its height and length would be from 2 to 3 inches, the mold must be rammed loose enough so that the metal will crush it when cooling. If this did not occur, the metal would either stretch and thus become weakened, or would crack. As soon as the metal solidifies, the cope must be removed and the casting uncovered to further aid the shrinkage.

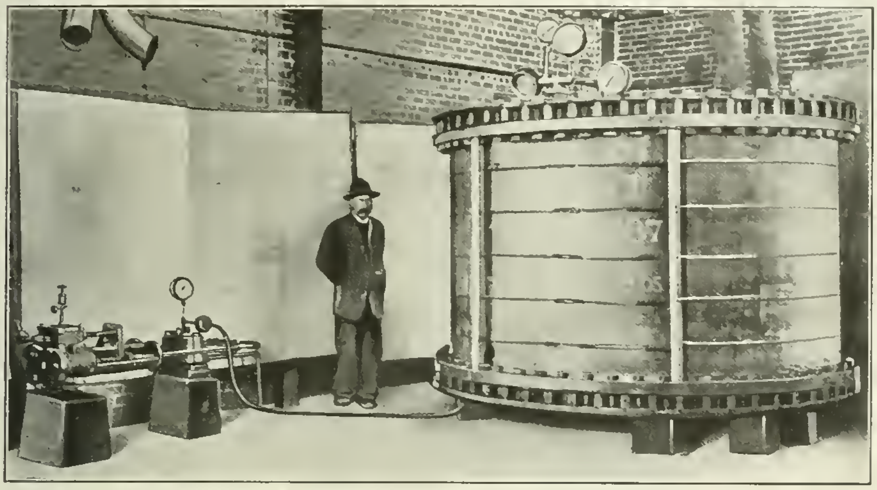


Fig. 6. Testing the Hydraulic Cylinders for the Locks at Peterboro, Ontario

If castings of this size can be made to the specifications just given there can be no good reason for not being able to make ordinary machine parts that would excel them. In smaller castings, blow-holes, porous or spongy metal, etc., are more easily kept out of the casting, and it is possible to get a denser and finer grained metal. Therefore, greater strength could be obtained.

Fig. 7. Tee and Globe Valves Tested to Destruction

In Fig. 3 is shown the casting that fits over the extreme front end or bow of a naval vessel. The edge at *A* is quite sharp for cleaving the water and minimizing the resistance to speed. The bulge of the bow is for the purpose of ramming other vessels. In Fig. 2 is shown the stern post of a torpedo boat destroyer.

Locomotive Side Frames

Many locomotive side frames are cast, and these are usually made of ordinary carbon steel containing about 0.30 per cent carbon. Some railroads, however, use vanadium steel side frames. The side frame shown in Fig. 4 was made of 30 point carbon steel, and in the molding it developed an indentation at *B* that was probably caused by gas or air being trapped in the mold in the form of a bubble. This gave the inspector for the railroad an idea that blow-holes were present, and he condemned the casting. In order to prove to the inspector that the casting was good, the foundryman placed it under the drop hammer and bent it as shown, with several blows. The casting in this shape showed no indications of cracking, or even checking, at the bend. This shows the toughness obtainable in ordinary carbon-steel castings.

Hydraulic Cylinders

When the hydraulic-lift lock was built at Peterboro, Ont., a large number of steel castings were used, and the Penn Steel Casting & Machine Co. furnished the entire hydraulic outfit. One pair of the cylinder castings is shown in Fig. 5, as arranged for testing. The two castings form a complete cylinder and were tested with 1800 pounds hydraulic pressure per square inch after the castings had been annealed. In Fig. 6 is shown a single casting with covers clamped on the top and bottom, and the apparatus that was used for making the tests. To the left in the half-tone will be seen the pump, while on top of the casting the gages are arranged. The five bands shown around the casting were placed there to show any enlargement of the casting that might take place from the pressure exerted on the inside.

The first casting that was tested was not annealed. Owing to its large size it was thought best to save this expense, if possible. When it was subjected to 1200 pounds hydraulic pressure per square inch, however, the circumferential bands showed that it had sprung 1¼ inch, and it was not considered safe to raise the pressure any higher. When the pressure was released the bands recorded a permanent set of ¼ inch. After this the castings were annealed, and when twenty others were tested to 1800 pounds pressure, no permanent set was indicated. On the first one it was thought that the elastic limit had been exceeded, but this proved not to be the case. The chemical analysis of the metal used in the castings was as follows:

Fig. 8. Cast-steel Retorts Tested with a Pressure of 600 Pounds per Square Inch

Carbon	0.24	per cent.
Silicon	0.31	per cent.
Manganese	0.60	per cent.
Sulphur	0.037	per cent.
Phosphorus	0.038	per cent.

Destructive Tests on Steel Castings

Some smaller castings made from the same metal were tested to the bursting point. These are shown in Fig. 7. The

one to the left is an 8-inch tee, with walls 3/4 inch thick, such as is used for the high-pressure fire main system in Philadelphia. This tee did not burst until the hydraulic pressure reached 6800 pounds per square inch. The other two castings are 2 1/2-inch globe valve bodies, with walls 7/16 inch thick. The one in the center stood a pressure of 9500 pounds per square inch before it burst, and the one to the right withstood 9900 pounds.

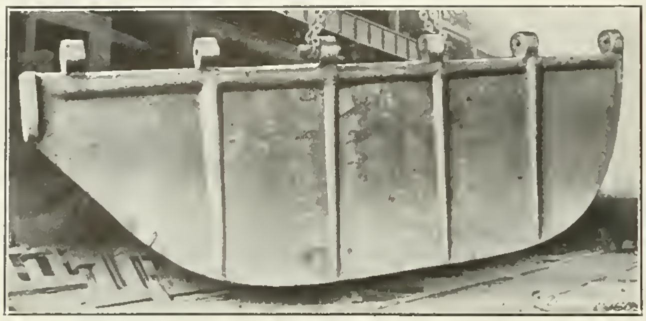


Fig. 9. A Cast-steel Rudder about 27 1/2 Feet Long and Weighing 45,000 Pounds

The cast-steel retorts shown in Fig. 8 are all tested with a pressure of 600 pounds per square inch before they leave the foundry. This hydraulic test not only proves that the steel castings made to-day have the necessary strength, but also that they are free from blow-holes, porous or spongy spots, etc., because the water would certainly find its way through the metal in the castings at much lower pressures than those given above, if there were any weak spots in them.

RESULTS OF TESTS ON STEEL CASTINGS

Kind of Steel	Heat Number	Mark Number	Pounds per Square Inch		Percentage of	
			Elastic Limit	Tensile Strength	Elongation	Reduction of Area
Soft	8451	1	33,000	67,600	31.0	40.9
	8451	2	34,400	64,600	29.0	39.4
	8451	3	31,600	69,200	31.5	41.9
	8451	4	34,400	68,400	34.0	42.4
	8451	5	35,200	67,600	33.0	41.9
	8451	6	35,200	68,000	29.5	36.3
	8451	7	35,600	67,600	32.0	42.7
	8451	8	33,800	64,400	31.0	39.0
	8480	1	34,000	67,600	28.0	39.7
	8480	3	34,400	69,000	30.0	38.4
	8480	5	33,600	67,000	31.5	41.7
Medium	8410	1	36,000	73,500	28.0	37.2
	8410	2	36,500	74,000	27.0	36.0
	8436	1	36,000	72,500	26.0	40.3
	8436	2	36,500	75,000	27.0	42.5
	8464	1	36,000	70,500	32.0	47.8
	8464	2	35,500	71,000	30.0	44.9
	8464	3	36,000	72,500	27.0	37.2
	8464	4	35,500	71,500	29.5	46.3
	8464	5	36,000	72,000	32.0	46.3
	8464	6	36,000	72,500	27.0	35.7
	8473	1	36,000	72,500	27.5	37.2
	8473	2	37,000	73,000	26.0	40.3
Hard	8476	2	45,000	85,000	17.5	24.1
	8476	3	45,500	85,000	18.0	21.0
	8476	4	45,500	85,500	19.0	24.1
	8476	5	45,000	85,000	18.0	21.3
	8476	6	45,000	85,000	22.0	24.1
	8476	7	45,500	85,000	18.5	22.0
	8476	8	45,000	88,000	17.5	22.0
	8476	10	45,500	87,000	15.0	20.6
	8476	11	45,500	87,000	17.0	20.6
	8476	12	46,000	86,000	17.0	20.6
	8485	1	45,800	85,200	19.0	22.4
	8485	2	45,500	85,000	21.0	32.7

The rudder shown in Fig. 9 is one of the largest steel castings made. It is about 27 feet long and weighs about 45,000 pounds. The casting shown in the two views Figs. 10 and 11 weighs 98,000 pounds.

Results of Tests

The uniformity with which steel castings can be made to the government specifications is shown in the accompanying table. The tests were made by the Ordnance Bureau of the U. S. Army and Navy, from test bars that were cast on the various castings.

The soft and medium steels bent 180 degrees around a 1-inch radius, and the hard steel 160 degrees, without showing any signs of fracture. When broken, all the test pieces showed a silky fracture. The test pieces were 0.505 inch in diameter with an area of 0.2 square inch.

The many other properties characteristic of steel castings made for special purposes, may be taken up at some future time. As an instance, may be mentioned the castings made for electrical purposes, which have a softness, homogeneity and soundness that insures a high and uniform permeability. This metal shows magnetic saturation curves and a hysteresis curvature that is equal to the best so-called "Norway" iron.

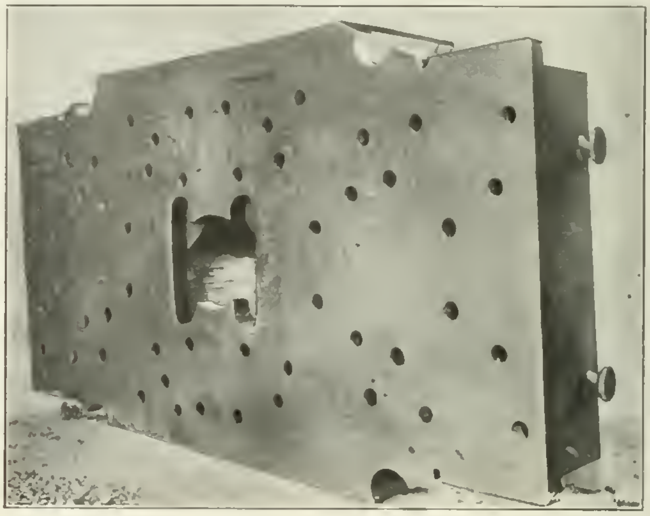


Fig. 10. A Steel Casting Weighing 98,000 Pounds

Numerous metals that are more or less rare are also added to steel to make alloys with special properties. Where steel castings can be used, nearly any condition or requirement demanded of the part can be met with by the addition of these alloying materials, or by the careful work necessary to produce pure, sound and homogeneous metal, or by both.

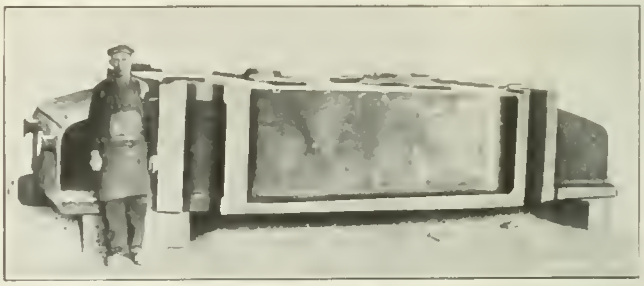


Fig. 11. Another View of the Steel Casting shown in Fig. 10. This is One of the Largest Steel Castings made

* * *

APPLYING SCIENTIFIC KNOWLEDGE

One of the common faults of some educated men is that they make little or no application of the scientific facts learned in school to the everyday problems of life. Perhaps it is because they are literal-minded, the principles having for them only the applications mentioned in the book. For instance, two young men, both graduates of the same high school, some years after graduation got into an argument on whether the weight of a block of wood floating in a pail of water is added to the weight of the pail and water or not. Experiment, of course, showed that it is, whereupon the one who was worsted quoted the Archimedean law to the effect that a floating body displaces its weight of the liquid, and was inclined to doubt the soundness of the old Greek's dictum after making the test. The fact that the mere displacement of a liquid does not alter its weight had never before been made plain to him, and not until a pail brimming over was tested did he grasp the full significance of the law.

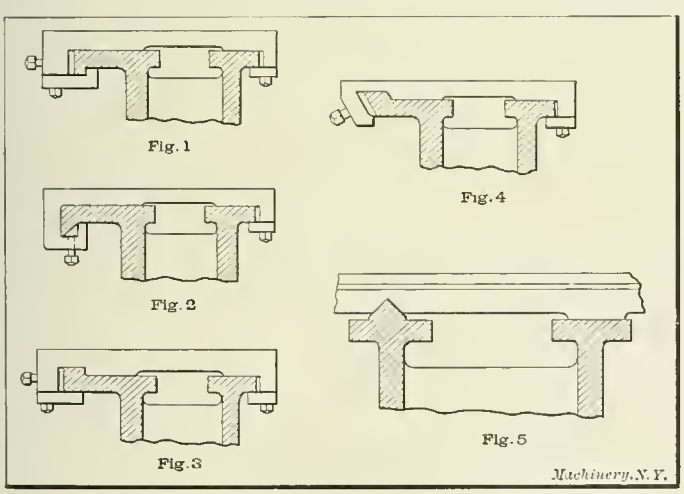
LATHE BEDS AND DOUBLE BACK-GEARS—A COMMENT

By RACQUET

In the December number of MACHINERY, engineering edition, an English 24-inch lathe was illustrated and described. The general design of this machine seems excellent, but the the writer wishes to comment on a few of the statements made

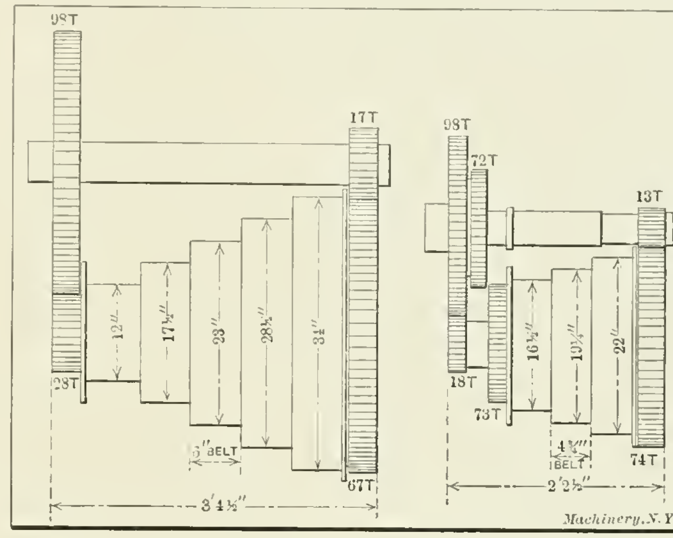
The "narrow" guide for the carriage is, in the writer's opinion, one of the best on the market. The lead-screw and the feed-rack are by this device brought quite close to the center of the guides, and the surface on which the straightness of the carriage motion along the bed depends, is so located that it is impossible for it to be bruised by a blow, or cut by the chips. It is stated in the article referred to that this feature is protected by patents, but it is difficult to see how this patent could be sustained. In the accompanying illustrations Figs. 1 to 5, are shown five designs of lathe beds, each of which is provided with some form of "narrow" guide. These designs are all taken from "Modern Machine Shop Practice" by Joshua Rose, a work which was published about 1887. This construction, therefore, it would seem, should be more generally known than it appears to be. The designs shown in Figs. 1 and 2 are practically identical with that described in the article referred to, although, of course, the new machine is provided with the modern taper adjusting gibs. The designs shown in Figs. 3 and 4 are similar to a design brought out eight or ten years ago by the Scotch lathe manufacturers, Messrs. Lang. The design in Fig. 5 embodies the principle applied to the American or raised V-type of bed, which design, more or less modified, is becoming popular with American lathe designers. Hence, it is apparent that the narrow front guide is a comparatively old idea, although it is a very important one, and one which ought to be applied, particularly, to the flat or English type of lathe bed.

In an editorial foot-note accompanying the article mentioned, it is stated that the coarse-pitch screw-cutting arrangement was used many years ago on a Putnam lathe. In Rose's "Modern Machine Shop Practice," already referred to, a drawing of a headstock of a Putnam lathe is shown, having a coarse screw-cutting arrangement similar to that of the Ward, Haggas & Smith lathe, the only difference being that the Putnam lathe has a single sliding gear and no reverse gears; and as it had no double back-gears, only two pitches could be cut with each train of change gears, instead of three.



Figs. 1 to 5. Five Different Designs of "Narrow Guide" Lathe Beds

In speaking of double back-gears, attention is called to the possibility of removing more metal per hour by a double back-geared lathe than is possible with a lathe using a much larger cone and single back-gear. To emphasize this idea the writer would call attention to the accompanying illustrations Figs. 6 and 7. In Fig. 6 is shown the ordinary back-gear arrangement as it appears in a well-known make of 32-inch lathe. It will be seen that the driving cone is very large, the largest step in fact being two inches larger than the swing of the lathe, and the belt six inches wide. In Fig. 7 is shown a double back-geared lathe head arrangement, also for an existing 32-inch lathe, the cone diameters and gear ratios being slightly modified so that the two arrangements may be more easily compared. Now if we use the formula $P = D \times W \times R$, in which D = diameter of the cone step; W = the width of belt, and R = ratio of gearing, and find the value of P for each of the spindle speeds, and then take the average of these, we are in a position to compare the driving power of the two arrangements. Ordinarily, if one saw the two drives shown in Figs. 6 and 7 side by side, one would say that the drive shown in Fig. 6 is at least twice as powerful as that shown in Fig. 7. This conclusion is quite reasonable from a casual glance. If, however, the calculation indicated above is carried out, one would find that the small cone, instead of making



Figs. 6 and 7. A Comparison of Two Lathe Cone and Back-gear Designs

the lathe less powerful, actually is 12 per cent more powerful, due to the higher belt speed. The average horsepower transmitted by the belt is also greater, and there is no doubt whatever that a 4¾-inch belt is more easily manipulated than a 6-inch belt, while the shortening of the headstock by 14 inches is an item worthy of consideration.

The detailed information relating to the head shown in Fig. 6 is as follows: Gear ratio, 13.8 to 1; countershaft speeds, 212 and 166 R. P. M.; average belt and gear purchase, 1,020; average horsepower of belt, 17¼; range of spindle speeds, 4.25 to 600 R. P. M. For the head shown in Fig. 7 the data are: Gearing ratios, 5.6 to 1 and 31 to 1; countershaft speeds, 450 and 190 R. P. M.; average belt and gear purchase, 1,140; average horsepower of belt, 19½; range of spindle speeds, 4.6 to 600 R. P. M.

In the writer's opinion the double back-geared cone drive is but a step removed from the geared head or single pulley drive, and the simplicity of the double back-geared drive counteracts to a considerable extent the advantages of the single pulley drive which can be fully realized only by the introduction of a more or less complicated design.

* * *

An interesting item relating to the cost of railway travel in Europe is published in the *Daily Consular and Trade Reports*, of December 8, issued by the Department of Commerce and Labor. In this, Consul-General John H. Snodgrass, of Moscow, states that "the actual cost of traveling in Russia is much less than in the United States, especially if one takes a second-class ticket, which is quite as satisfactory as first class, provided the trains are not crowded. The actual second-class tariff is very little over 1 cent a mile." This is but another testimony to the fact that the cost of travel is less on the European continent than in America, the assertions of many persons to the contrary notwithstanding.

* * *

The manufacturers of the Santos-Dumont monoplane have, according to a French contemporary, offered to supply this monoplane at the price of $750 apiece if ten machines are ordered at a time. With prices for flying machines cut to such a figure, it appears that flying races might become as popular as automobile races, and nearly as dangerous.

CALCULATION OF CIRCULAR FORMING TOOLS*†

By WILLIAM W. JOHNSON‡

When a large number of circular forming tools are to be designed, it involves a great deal of labor to compute the different diameters separately. The usual method is as follows (see Fig. 1):

First find the value of W in the right-angle triangle BCD:

$$W = \sqrt{R^2 - h^2}$$

in which

R = radius of largest diameter of circular tool,

h = distance which the center of the tool is set, either above or below the center line of the work.

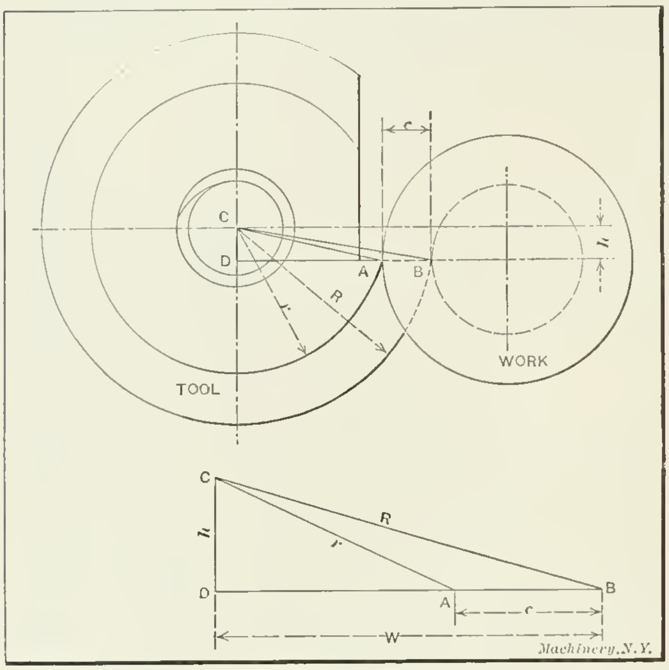


Fig. 1. Notation used in Formulas for Forming Tool Calculations

Now, find the value of r in the right-angle triangle ACD:

$$r = \sqrt{(W - c)^2 + h^2}$$

in which

c = one-half the difference between the required diameters of the work,

r = the required radius of the circular tool.

This method is quite long and cannot be materially shortened by using a table of squares. Therefore, anything that can be done to aid in computing the different diameters of circular forming tools will no doubt be appreciated. The purpose of this article is to show how to compute tables giving the diameters of circular tools corresponding to differences of one-thousandth inch in the radius of the work. Such tables are given in the accompanying Data Sheet Supplement.

TABLE I. DIMENSIONS FOR FORMING TOOLS FOR BROWN & SHARPE SCREW MACHINES

Number of Machine	D	h	Tap, Left-hand	W
00	$1\frac{3}{4}$	$\frac{1}{8}$	$\frac{3}{8}$—16	$\frac{1}{4}$
0	$2\frac{1}{4}$	$\frac{5}{32}$	$\frac{1}{2}$—14	$\frac{5}{16}$
2	3	$\frac{1}{4}$	$\frac{5}{8}$—12	$\frac{3}{8}$

In Table 1 are given the dimensions required for designing circular forming tools for Brown & Sharpe automatic screw machines. (See Fig. 2 for notation used.) For the purpose of illustration, a table of diameters for circular forming tools for the No. 2 machine will be computed. The method can be applied universally, however, provided the tools have no top rake. The conditions of the problem are shown diagrammatically in Fig. 3. The notation is the same as that used in Fig. 1.

Let

n = the numbers 1, 2, 3, 4, etc., successively,

$c = 0.001\,n$.

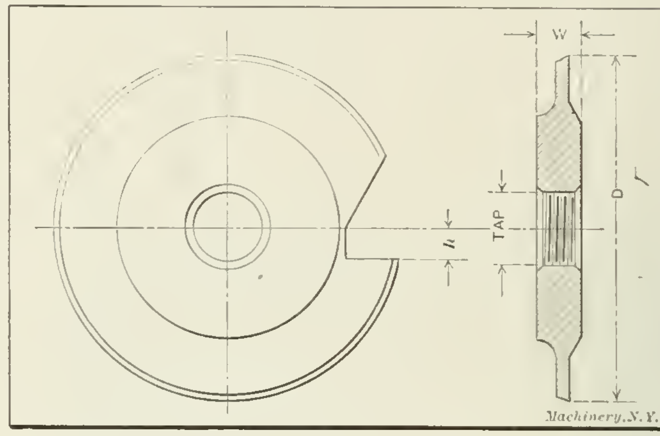


Fig. 2. Notation used in Table I

From Fig. 3 we have:

$$\sin CBD = \frac{h}{R}.$$

From Table 1 we have $h = \frac{1}{4}$ and $R = 1\frac{1}{2}$, and hence:

$$\sin CBD = \frac{1}{6}$$

$$\cos CBD = \sqrt{1 - \sin^2 CBD} = \sqrt{\frac{35}{36}} = 0.9860133$$

From the "law of cosines" in trigonometry, we obtain:

$$r = \sqrt{R^2 + c^2 - 2\,Rc \times \cos CBD}$$

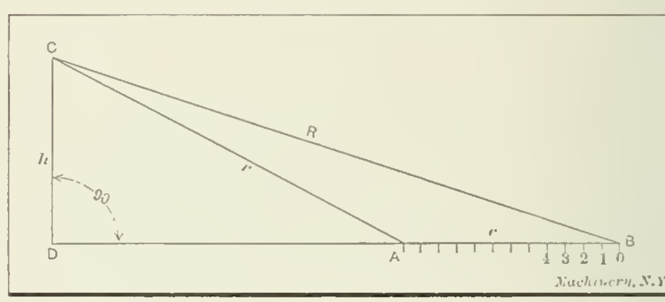


Fig. 3. Notation used in Formulas for Calculating Table II

Substituting the known values, we have:

$$r = \sqrt{2.25 + 0.000001\,n^2 - 0.0029580399\ n}.$$

To shorten the numerical work we can now calculate r for $n = 50$, $n = 100$, $n = 150$, etc., which is equivalent to considering the distance AB, Fig. 3, divided into a number of equal divisious, each 0.001 inch long, and computing the radius r for $AB = 0.050$, $AB = 0.100$, etc. By trial it can be determined that the values of r for other values of n can be interpolated between those calculated, so that the interpolated values will be correct to four decimal places. Hence, by computing the

TABLE II. VALUES OF r FOR DIFFERENT VALUES OF n

n	r	Difference between Radii for n = 50	Corresponding Difference for n = 1	2 r	Double Difference (n = 1)
0	1.500000	0.049277	0.0009855	3.000000	0.001971
50	1.450723	0.049225	0.0009845	2.901446	0.001969
100	1.401498	0.049169	0.0009834	2.802996	0.001967
150	1.352329	0.049105	0.0009821	2.704658	0.001964
200	1.303224	0.049035	0.0009807	2.606448	0.001961
250	1.254189	0.048955	0.0009791	2.508278	0.001958
300	1.205234	0.048866	0.0009773	2.400468	0.001955
350	1.156368	0.048765	0.0009753	2.312736	0.001951
400	1.107603	0.048650	0.0009730	2.215206	0.001946
450	1.058953	0.048517	0.0009703	2.117906	0.001941
500	1.010436			2.020872	

* With Data Sheet Supplement.

† For previous articles relatiug to circular forming tools, see MACHINERY, March and April, 1910, "Circular Form and Cut-off Tools"; January, 1908, "Formulas for Circular Forming Tools"; October, 1904, "Charts for Forming Tools"; June, 1904, "Straight and Circular Forming Tools."

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values of r, as stated, by the formula just given, we obtain the values in Table II. The fourth column in this table gives the differences of radii corresponding to a difference of 0.001 inch in the length of a line AB. By multiplying the values of r and the differences for 0.001 inch, by 2, we obtain the diameter and diametral differences directly, as shown in the last two columns. The tables in the Data Sheet Supplement are computed by simply subtracting these diametral differences, as given in Table II, from each preceding diameter, as indicated below.

For

$n = 0,\ 2r = 3.000000$

$n = 1,\ 2r = 3.000000 - 0.001971 = 2.998029$

$n = 2,\ 2r = 2.998029 - 0.001971 = 2.996058$

and so forth to $n = 49$.

For

$n = 50,\ 2r = 2.901446 - 0.001969 = 2.899477$

$n = 51,\ 2r = 2.899477 - 0.001969 = 2.897508$

$n = 52,\ 2r = 2.897508 - 0.001969 = 2.895539$

and so forth to $n = 99$. In this way the calculations are continued until the table is completed.

The following example will illustrate the practical application of the tables in the Data Sheet Supplement. Assume that we wish to design a circular forming tool to turn the piece shown in Fig. 4, on a No. 0 Brown & Sharpe automatic screw machine. Let the largest diameter of the circular tool

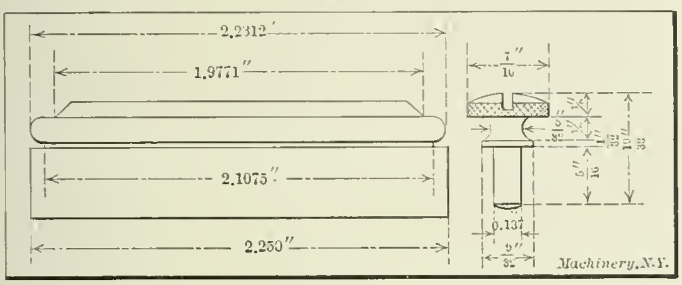

Fig. 4. Dimensions of Work and Tool in the Practical Example Given

correspond with the smallest diameter on the piece. Then find one-half the difference between the required diameters of the work as follows:

$$\frac{\frac{5}{32} - 0.137}{2} = \frac{0.156 - 0.137}{2} = \frac{0.019}{2} = 0.0095 \text{ inch}$$

$$\frac{\frac{9}{32} - 0.137}{2} = \frac{0.281 - 0.137}{2} = \frac{0.144}{2} = 0.072 \text{ inch}$$

$$\frac{\left(\frac{7}{16} - 0.024\right) - 0.137}{2} = \frac{0.276}{2} = 0.138 \text{ inch}$$

From the tables in the accompanying Supplement, we find opposite 0.0095,* in the column headed No. 0 the value 2.2312, which is the diameter to which to turn the circular tool to produce the 5/32 inch diameter on the work when the largest diameter of the circular tool turns the smallest diameter on the work to 0.137 inch diameter. The other diameters are found opposite 0.072 and 0.138, in the column headed No. 0; they are 2.1075 inches and 1.9771 inch, respectively.

* * *

A British contemporary relates the following regarding the opening of the works of the Power Gas Corporation, Ltd., which has just erected a gas plant near Moscow. The ceremony of starting the plant was very impressive. There was a blessing service over the producers and engine; the priests and choir from the church read prayers and sprinkled the engine and producers with holy water and blessed them, and erected an image of a guardian saint over the producers and another one over the engine. The managing director then officially started up the plant before hundreds of spectators, when everything passed off successfully.

* The table only reads to thousandths of an inch, but values corresponding to ten-thousandths inch can be found by interpolating.

THE MAKING OF SEAMLESS GOLD WIRE

By CHESTER L. LUCAS*

Wire, in its various forms, plays an important part in our every day affairs. To the mechanical man, the principles of wire making are generally understood; but in the work of making seamless gold wire for jewelry and optical manufacturing, there are a great many interesting operations that are little understood to those "on the outside." Solid gold wire might be made, of course, by the same methods that are used in making brass or copper wire, and indeed that is the way that very small gold wire is made, but wire of this kind in any of the larger sizes would be too expensive; hence we have seamless gold hollow wire and seamless gold-filled wire.

There are many concerns in the business of making seamless gold wire, but it is doubtful if there are any that have as

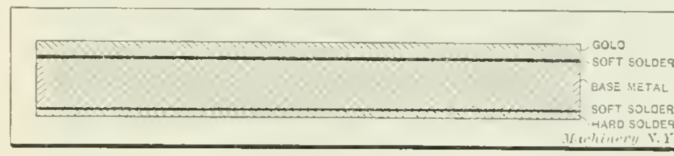

Fig. 1. Construction of the Flat Ingot

good a process or any that are better equipped for doing their work than the Improved Seamless Wire Co., of Providence, R. I. It is to Mr. T. F. Carlisle, president of this company, that credit is due for the courtesy shown the writer while at the factory.

"Improved" Seamless Gold Wire

The difference between the ordinary seamless gold wire and improved seamless gold wire, lies in the methods used in uniting the gold shell and the base metal, which is used to "fill" the wire. The process of making improved seamless gold wire consists essentially of building up a flat ingot from a layer of gold, a layer of base metal, and a thin layer of hard solder. This metal plate is then reduced in thickness by means of a rolling mill, and from the rolled sheet are cut disks that are afterward drawn into tubes. In order to give the wire strength, a core of base metal is turned up, fluxed and pushed into the shell and soldered in place by means of

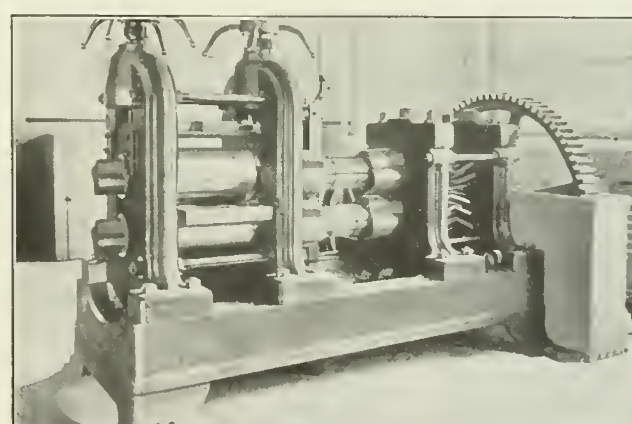

Fig. 2. "Breaking-down" Rolls used to reduce the Metal for Wire-making

the solder lining of the tube. This ingot is then made into wire by swaging and drawing.

The principal advantages claimed for this process of wire making are: First, that it perfectly unites the gold covering with the core, making an ingot that can be converted into wire without blistering the outer shell of gold; and second, that with this process it is possible to make gold plated wire whose gold covering is much lighter than that made in any other way.

The above description is given to make clear the fundamental points of the process before going into the details of the various operations employed in seamless gold wire making.

Preparing and Rolling the Stock for Wire Making

The first step in making seamless gold wire is the preparation of the stock. A block of base metal, as shown in Fig. 1,

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resembling gold in color, and about 2 inches wide by 15 inches long and ¾-inch thick, is cleaned and fluxed on both sides. On one side is laid a sheet of very thin soft solder and above the solder is placed a sheet of gold, the thickness of which depends upon the quality of wire that is being made. The other side is next covered with another very thin sheet of soft solder, outside of which is placed a sheet of hard solder 0.002 inch thick. These five sheets are clamped together and placed within a furnace and heated sufficiently to allow the solder to fuse and unite the three plates: gold, base metal, and hard solder.

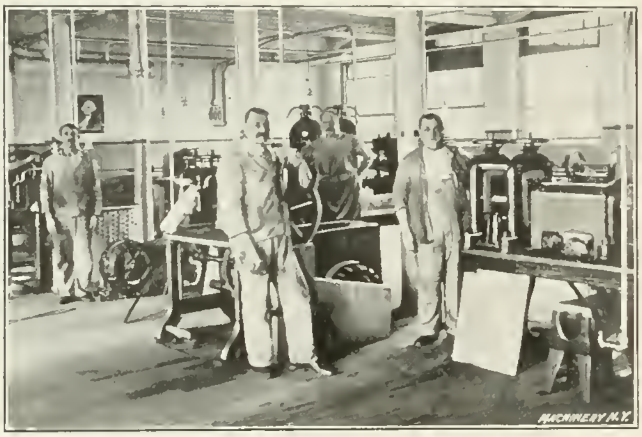


Fig. 3. General View of Rolling Department

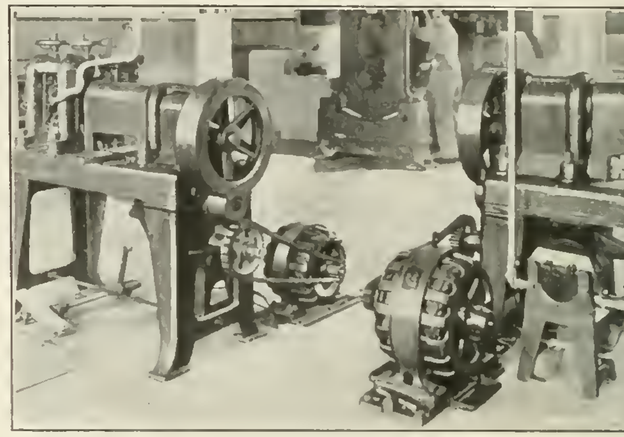


Fig. 4. Method of Driving Rolling Mills with Morse Chains

This composite block of metal is then taken to the breaking-down rolls shown in Fig. 2. The rolls themselves are 12 inches in diameter and 20 inches long, and the machine is extremely powerful in design and construction. As in most rolling mills, the weakest parts of the machine are the cast-iron couplings, purposely made so in order that they will break before the rolls themselves, in case they "get a bite." In addition, the necks of the rolls are double, so that they may be reversed in case of injury to one end. Here the stock is rolled down to No. 6 B. & S. gage, reducing it approximately 0.100 inch at each pass.

Fig. 5. Annealing Room for Rolled Stock

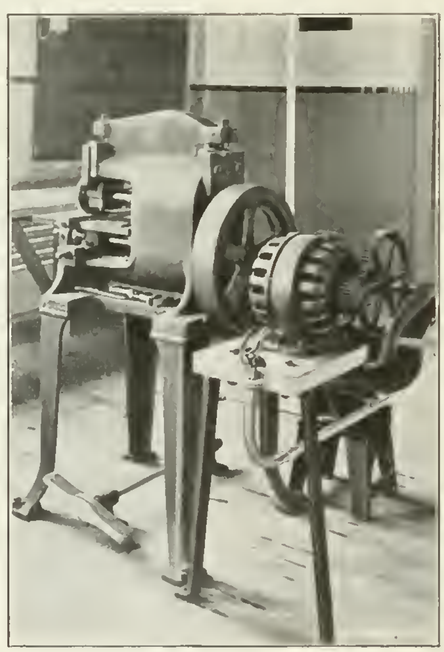


Fig. 6. Backgeared Rotary Slitting Shears

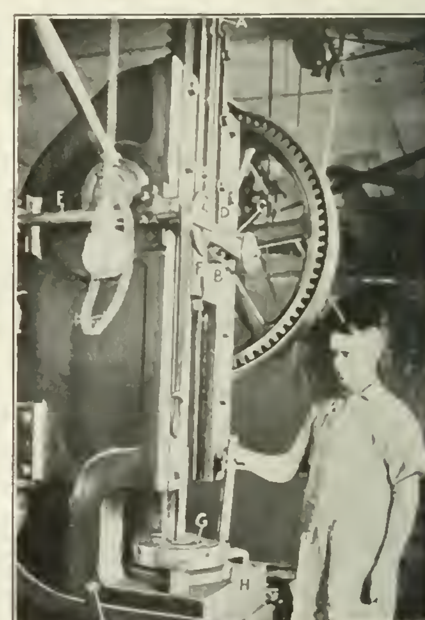


Fig. 7. One of the Special Presses for Tube Drawing

A good deal of rolled plate is made by the Improved Seamless Wire Co. for other purposes than wire making, and when the stock is to be rolled thin, it is passed from the breaking-down rolls to a 5 by 8-inch Mossberg rolling mill, where it is reduced to No. 24 B. & S. gage, after which it goes to a 4 by 6-inch rolling mill and is further reduced to any desired thickness. Fig. 3 shows the rolling department with the 5 by 8- and the 4 by 6-inch mills in the foreground. This room is a model of cleanliness for a rolling department. Fig. 4 shows a closer view of two of the small rolling mills and is reproduced to show the method of driving the machines by the use of motors and chains. It is stated that by the use of these chain drives, a 90 per cent efficiency is secured, and it is apparent that this method of driving is practically noiseless.

Annealing and Trimming

The rolling operations reduce the thickness of the gold in the same proportion that they do the base metal, no matter to what extent the stock is rolled. The hard solder also becomes proportionally thinner. As the metal is rolled, it becomes harder; consequently it is necessary to anneal it between every few operations to prevent the development of cracks and seams that would spoil the stock. The annealing is done in a room that is specially fitted up for the work, in which the light is controlled by adjustable blinds over the windows. Fig. 5 shows two of the furnaces in which the annealing is done, the one at the left being used for the short thick bars in the early stages of the rolling, while the other furnace is the one employed for the long thin strips that come with the last rolling operations. Before being placed in the fire, the strips are painted with a thin coat of brown ochre and boracic acid. This coating prevents the formation of scale while the stock is being heated. The strips are passed through the furnaces, being kept slowly moving to allow every part of the metal to reach the low red heat at which the best results are attained. In this room are also located the pickling baths of diluted sulphuric acid and the sawdust boxes for drying the stock after pickling.

As the thickness of the metal is reduced by the rolling, the length of the strip greatly increases. The width of the metal

also increases, but to a much smaller degree. The edges of the strip take on an irregular and ragged appearance, and often when the rolling strains are taken out by the annealing, the strip becomes "kinky" and warped. For these reasons the strips must be trimmed after each annealing and this part of the work is done on the rotary slitting shears shown in Fig. 6. An interesting feature of this machine is the method of applying the motor drive, the motor being back-geared to adapt the speed of the motor to the machine. It is on this machine, also, that the strips for the wire making are finally cut to 7-inch squares preparatory to the drawing operation.

Drawing the Tubes

One of the most interesting parts of seamless wire making is the making of the tubes from which the wire is drawn. The 7-inch squares of rolled plate stock, the making of which has just been described, are first trimmed into disks by an ordinary blanking die, after which they are ready to be drawn into tubes, by means of special presses, one of which is shown in Fig. 7. These presses were made by the Waterbury Farrel Foundry & Machine Co. and differ essentially from the ordi-

Fig. 8. Rack of Cores and Set of Dies for the Tube Drawing

nary drawing press in that they have an extra long stroke actuated on the rack-and-pinion principle, and an automatic trip and reverse. The press is fitted up with speed changing gears to accommodate the conditions involved in drawing the various sizes of tubes. The length of stroke is determined by setting the adjustable dogs, *A* and *B*, in the T-slot in the ram. As the ram descends, dog *A* approaches swinging arm *C*, and pushes it down as they meet. This movement causes the knob at the lower side of the arm to push the rocker arm *D* downward, thus turning the shaft *E* which is connected with the belt reversing mechanism. If it is necessary to check or reverse the movement of the ram at any point between the points set by the dogs, it is only necessary to operate the rocker arm by means of the hand lever *F*. As the work done in these presses is all cylindrical in form, it is an easy matter to hold the punches and dies. The punches are made with a shoulder and a threaded shank that screws up into the headlock of the ram, while the dies are merely laid upon the die shoe *H* that is kept clamped in place on the bed of the press. This die shoe has a threaded shoulder over which clamping ring *G* is screwed, the tapered opening in this ring pulling down on the corresponding taper on the dies themselves.

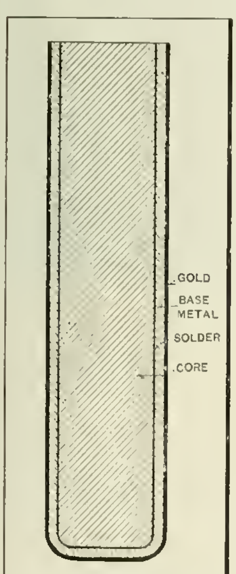


Fig. 9. Sectional View of Completed Tube with Core Inserted

The first operation in making the tubes after the 7-inch squares have been trimmed to disks is to draw the disk into a cup about 5 inches in diameter and 1½ inch deep. The blanks are laid on the die with the gold face down, so as to have the gold plate on the outside of the tube and the thin, hard solder lining on the inside. Next, this shell is run through a die which transforms it into a deeper shell that is smaller in diameter. This process is repeated, drawing the shell through eleven dies in all, each of which makes the shell, or tube as it finally becomes, still deeper and narrower. The finished tubes are 1¼ inch in diameter and 14 inches

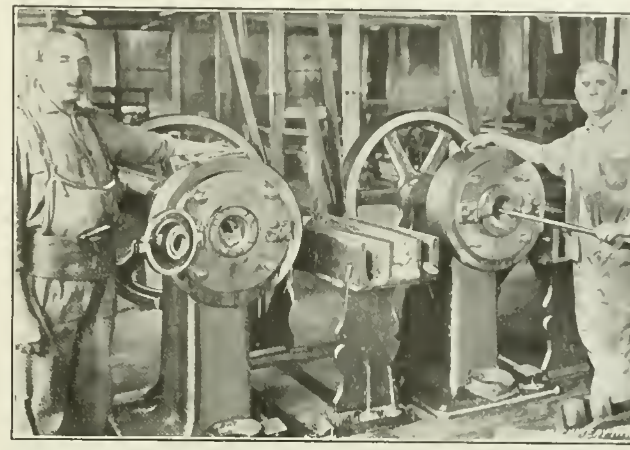


Fig. 10. Starting Solid Gold Wire in the Large Swaging Machines

long. The perimeter of the blank at the beginning was 22 inches, while the perimeter of the top of the finished tube is only about 4 inches.

The rack in Fig. 8 contains over a thousand cores. These cores are of different base metals to match the particular kind of shells that they are to go within. The cores are thoroughly cleaned, fluxed, and then pushed into the shell. After coating the exterior of the shell with yellow ochre and boracic acid, the shell and core are heated hot enough to flow the hard solder lining, thus firmly uniting shell and core. As it requires a good red heat to flow hard solder, the gold would easily scale if it were not for the yellow ochre and boracic acid protection. The tubes for hollow wire require no cores, except in special wire, in which hollow cores are inserted to

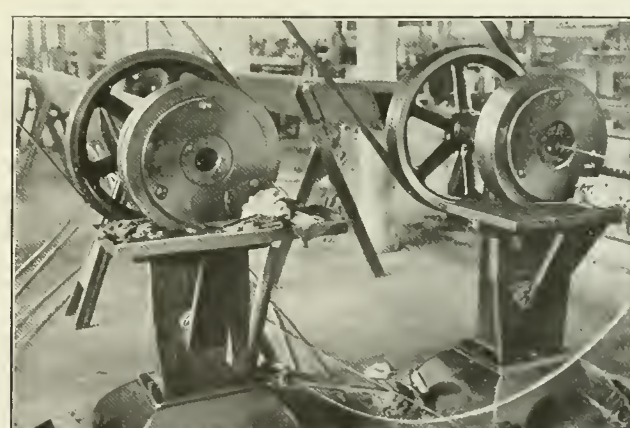


Fig. 11. Two of the Small Swaging Machines

give the necessary thickness to the walls of the tube. Fig. 9 shows the completed tube and core in cross-section.

On the bench in the illustration Fig. 8, appears a set of the punches and dies for preparing tubes for seamless wire ingots. As with other drawing operations, the tubes must be annealed after passing through every third die. At the extreme left of the bench is a completed tube that has been trimmed, and beside it is a tube with the core soldered in place.

The importance of this method of applying the hard solder to the metal should not be overlooked: First, because the application of the solder is uniform; second, it is economical, requiring much less solder than would be used by any other method; and third, on account of the method of application the joint is much stronger than the average soldered joint. It should be possible to apply this kink to other lines of manufacturing that require good hard soldering.

Starting the Solid Wire

We must now divide our attention for a while over the two divisions of the wire—the solid and the hollow varieties—for the methods of roughing down in size vary, although the finishing operations are the same. Fig. 10 illustrates two of the Excelsior swaging machines that are used to reduce the bars to somewhere near the finished size of the wire. The operator in the illustration is just starting through for the second time a bar of solid 10 carat gold, which is to be made into very small wire. The machine at the left is shown with the front plate thrown open. Within the opening may be seen one die of the pair. In a nearby rack are sets of dies for all sizes between ¼ and 1½ inch. After passing through the machine, the rod is slid back in the trough between the machines, and sent through for another reduction. After the rods reach the ¼-inch size, they are passed along to the smaller swaging machines shown in Fig. 11. These machines reduce the wire very nearly to the size that it is to finish. As with the rolling and drawing operations, swaging hardens the stock that is being worked; therefore, frequent annealing is necessitated. This operation is done in the wire

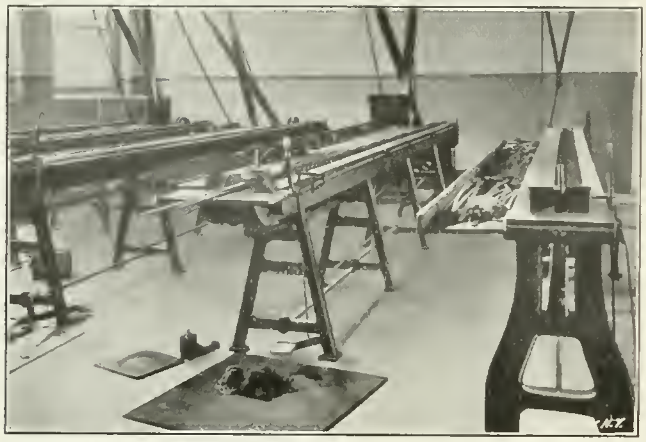


Fig. 12. Draw Benches for Starting the Hollow Gold Wire

annealing room, in which are located special furnaces and pickling baths, very similar to those described in the stock rolling room. After passing through the small swagers for the last time, the solid wire is ready for the finish drawing. Leaving it at this stage, we will take up the first operations in making the hollow wire.

Starting the Hollow Wire

In making the thin hollow wire, the tubes are trimmed after being drawn and then annealed. Fig. 12 shows the set of draw benches that are used to start the tubular or hollow wire. In their rough state, the tubes are 1¼ inch diameter and 13 inches long. First, a ⅜-inch hole is drilled centrally through the bottom of each tube. Next the tube is slipped over a 1-inch arbor, one end of which has been turned to ⅜

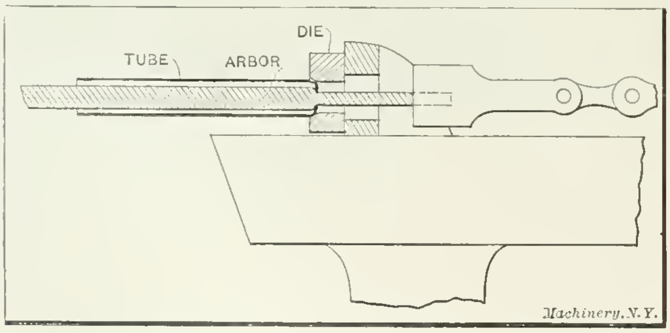


Fig. 13. The Way the Hollow Wire is started

inch for a distance of 3 inches. This ⅜-inch end projects through the hole in the tube. The arbor is now placed over the die plate on the draw bench, with the small end reaching through the die. The jaws of the carrier come forward, grip the arbor by the ⅜-inch section and thus the arbor and tube are pulled or drawn through the die. This operation is best explained by the illustration Fig. 13 in connection with Fig. 12, in which the second draw bench from the right is shown about to start the forward stroke. Each drawing operation reduces the diameter of the tube by about 1/16 inch. By means of these draw benches, the tubes are reduced to ¼ inch diameter and the length, of course, increased to from 20 to 30 feet.

Finishing the Wire

Fig. 14 illustrates the operation of finishing the wire of both kinds, solid and hollow. These draw benches are of

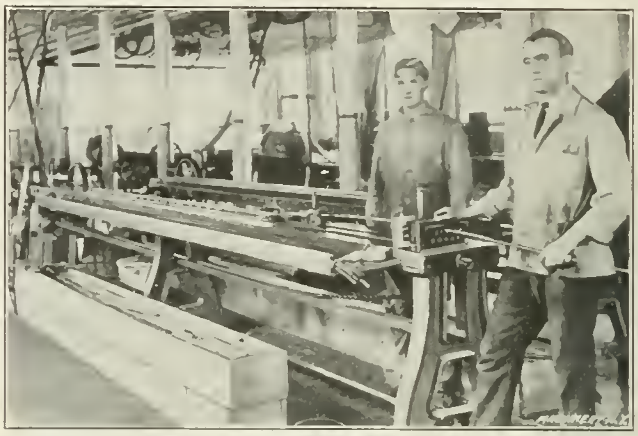


Fig. 14. Finishing the Wire

the same design as the ones used to start the hollow wire, but they have a capacity for handling 30-foot lengths of wire. The dies for the finish drawing resemble thick drill gages, for they have a series of 20 holes, ranging from ¼ down to 0.040 inch. This latter size is the smallest wire made by the company. The dies naturally receive very hard wear; but in spite of this fact, the 20-hole dies "stand up" for a long time, averaging about a year apiece. As with the pre-

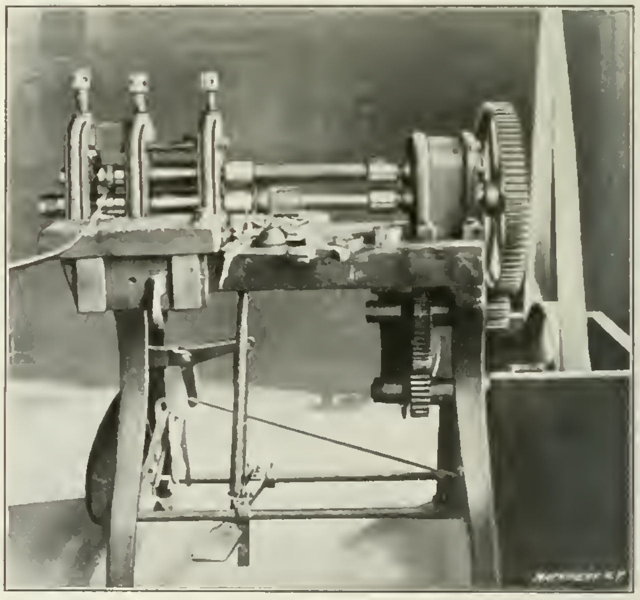


Fig. 15. Shaping the Wire to Special Sections

vious operations of rolling and swaging, annealing is necessary in the wire drawing. Between every ten "numbers," as the operators express it, annealing is required. As will be noticed in the illustration Fig. 14 the operator of the draw bench stands at the head of the machine, within easy reach of the starting lever. As the wire passes through the die he guides it and at the same time lubricates it with a pad that is kept soaked with lard oil.

The solid and hollow wire are both finished in the same way. If the wire is to be used for optical work, such as bows or other spectacle parts, the annealing is less frequently done, so as to produce a wire that is tough and hard. Silver wire is very easily drawn, but as the demand is small, very little of this product is made.

Special Wire Sections

We are apt to think of gold wire as wire of a simple round section, yet the Improved Seamless Wire Co. makes hundreds of different styles and sizes in round, flat, square, oval and

other fancy shapes, plain as well as embossed, or knurled with different patterns. We have followed, step by step, the various operations in making the plain round wire; let us now consider the method of producing the various shapes and finishes that part of the wire assumes.

In Fig. 15 is shown a corner of the room in which the wire is shaped to special sections, and embossed as required. The rolling mill in the foreground is one of several that are used for this special rolling. This machine is shown converting round gold filled wire into a half-round wire that will later be made into wedding rings. This operation is a simple one, and by substituting rolls with different shaped grooves, flat, square or in fact nearly any section may be rolled.

The fancy wire is produced by the use of knurls or embossing rolls. Many kinds of ornamented wire are made for

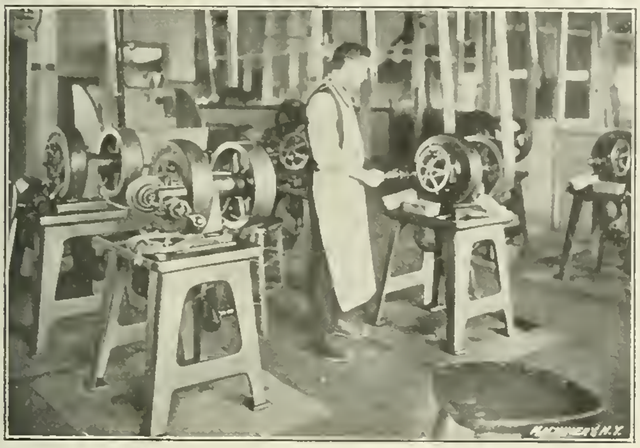


Fig. 16. Langelier Swagers for Ring Shank Making

jewelry and decorative work and some of the knurls are very elaborate. In view of this fact, it is often that the engraving of a pair of knurls amounts to thirty or forty dollars. It will be easily understood, therefore, that the collection of knurls used in this department is very valuable, and for this reason they are kept in the fire-proof safe shown in the background of Fig. 15. The value of this collection of knurls is roughly estimated at three thousand dollars. It must be borne in mind that throughout all the operations of making, forming and embossing the wire, the outer covering of gold is undis-

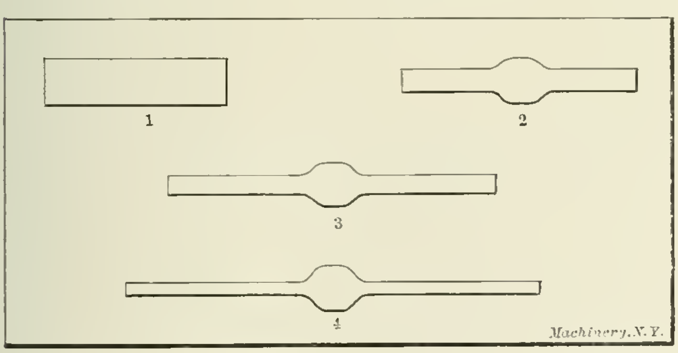


Fig 17. The Evolution of a Ring Shank

turbed, as regards its thickness in proportion to the total wire diameter.

Making Ring Shanks

Another interesting department in this factory is the one in which ring shanks are made. A "ring shank" is distinctly a manufacturing jeweler's term, and is defined as a piece of stock from which a ring is made; at the center, the metal is thick and spherically shaped. This part is to become the setting, while the ends that are to be bent to form the band of the ring, are small in diameter. The illustration Fig. 17 conveys a good idea of a ring shank, although ring shanks are made in a great many different sizes and styles. The round seamless wire about 3/16 inch in diameter is cut off in what seems to be very short lengths, about ¾-inch long. Fig. 16 illustrates a group of the Langelier swagers that are employed to reduce the ends of the blanks for the ring shanks. Each end of the blank is reduced in from three to five operations, varying with the size ring shank being made. Fig. 17 shows four successive stages of this swaging operation.

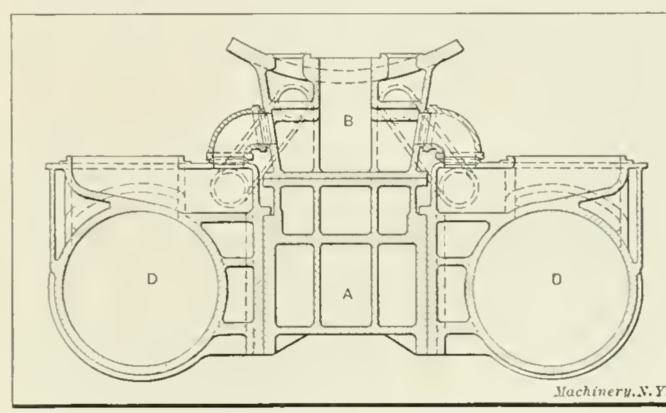
The completed ring shanks still retain their covering of gold plate. In this state they are furnished to the ring manufacturers, who emboss them under the drop hammer, bend them to shape, solder and finish them for the retail trade—an interesting evolution from a piece of sheet metal.

* * *

LOCOMOTIVE SADDLE AND CYLINDER ARRANGEMENT

A new type of locomotive saddle and cylinder arrangement is embodied in U. S. Patent Number 975,183 (November 8, 1910) taken out by Samuel M. Vauclain, of Philadelphia, assignor to Baldwin Locomotive Works, of Philadelphia, Pa. The cylinders in place of being cast with a half saddle, are made separately, with an intervening part, on top of which is the saddle, as shown by the accompanying engraving. The main object of this arrangement, is that the parts may be more readily handled, thereby facilitating repairs when necessity should arise, and a further object is that the frame *A* might be made of steel and the saddle *B* of cast-iron, the cylinders castings *D* being made separate and bolted to the steel frame, thereby making a substantial structure.

The main frame *A* is ribbed for strength and has arms projecting forward and backward, which are bolted to the loco-



New Arrangement of Cylinders, Frame and Saddle

motive frame, making a more rigid construction, which is not only stronger, but also forms a very substantial support for the front end of the boiler.

As illustrated, the exhaust passages form separate elbows, but, in connection with this patent, there are drawings illustrating a locomotive with the exhaust passages through the central frame *A*. Other drawings illustrate the application of this new construction to piston valve engines.

* * *

One of the most interesting alloys is that known as "monel-metal." It consists of copper and nickel, but is not made from melting these two constituents and mixing them together. Instead monel-metal is a so-called "natural" alloy, being made from a copper and nickel ore, no attempt having been made to separate the two metals. As the cost of producing either nickel or copper for these ores becomes very high, the curious condition is produced that monel-metal sells at a cheaper price than either of the two metals, nickel and copper, of which it is composed. Were it possible to profitably separate the nickel and the copper in the monel-metal ore, this metal would at once rise in price. The composition of monel-metal varies somewhat. It contains usually from 24.75 to 26.5 per cent of copper, from 70 to 74 per cent of nickel and from 0.5 to 5.25 per cent of iron.

* * *

The City of Liverpool is planning to construct a new dock 1020 feet long with an entrance 120 feet wide, capable of holding four ships 1000 feet in length. It is generally supposed that this development is intended to provide accommodations for the new mammoth Cunard liners of which much has been spoken, but about which little definite information has as yet been obtained.

THE FILING AND INDEXING OF ENGINEERING DATA*

By CHAS. G. MAHANA†

The question of how to index and file engineering data is often a perplexing one. An efficient filing system means a much more extensive use of the data collected, with the corresponding benefits of such use. The larger the collection of data, the less use will be made of it, if it is not filed and indexed in some convenient way. The system of filing must make it easy to find the articles or data collected on any particular subject, and yet it must be so simple that the indexing does not consume too much time. The system described in this article is extremely simple and efficient; there is very little labor connected with keeping it up to date; and the data collected on any subject may be almost instantly located.

Manila envelopes of the thickness known as "40-pounds," 6½ inches by 9½ inches in size, open at one end and with the flap removed, are used for filing the larger part of the articles and similar data. These envelopes are a stock size and may be purchased for about fifty cents for two hundred. As most technical magazines are nine inches by twelve inches, or close to those dimensions, pages which it is desired to save can be removed from the magazines, folded once, and the envelopes are just the proper size to receive them. The envelopes are then filed exactly as if they were cards in a card-index system; that is, an envelope containing an article on valves is marked "Valves" in the upper left-hand corner, and filed alphabetically with the other envelopes in a card-index cabinet.

As many articles as desired may be placed in one envelope, so long as it is not filled so full as to bulge and partake of the nature of a package more than of a card. As many envelopes bearing the same title may also be used, of course, as desired, as they will all be located together in the file, and when one is found all are found. As much descriptive matter of the contents of the envelopes may be added as one sees fit. For instance, there may be several envelopes each containing one or more magazine articles and other data on cylinders. The titles of the various envelopes may then be made to read, "Cylinders, Air-cooled"; "Cylinders, Two-cycle"; "Cylinders, Machining"; "Cylinders, Offset"; etc.

Index cards 6½ inches by 9½ inches are also used and are filed with the envelopes the same as if all were cards. Guide cards are also used. The index cards are used for cross-references, indexing of short clippings, and the indexing of data which it is impossible, or at least impracticable, to cut out and file in the envelopes. Data in books and similar places may be indexed on the cards, or, if short, may be written on a card and put in the file. If desired, of course, longer articles may be typewritten on paper and put into envelopes.

Short clippings are either copied on cards or pasted on cards and indexed. It often happens that in magazines a short article will occupy small portions of two or more columns, as for instance when it begins at the bottom of one column and ends at the top of the next, and an illustration or two may appear in other columns, or possibly on the next page. In such a case it is most convenient to cut out the various portions and paste them together on one card for use in the file.

For cross-references, the cards are used in the same manner, of course, as in any card index. It seldom happens that two articles on different subjects, which it is desired to save, appear on the same leaf of a magazine, but when they do or when an article treats of more than one subject, cross-reference is provided for as follows: In the first place, all cards and envelopes are numbered in the upper left-hand corner. These numbers are merely for the ready identification of any particular envelope or card, the envelopes and cards being filed alphabetically, and not numerically. The writer simply numbers a supply of blank cards and envelopes at a convenient time, and uses from that supply until they are exhausted, paying no attention to whether they are used in numerical order or not.

If an article on pistons should appear on one side of a sheet and an article on frames on the other, and it were desired to index both of them, it would be done by enclosing the clipping in an envelope indexed under one of the titles, "Piston," for instance, and the number in the corner of the envelope, "314," for instance, would be inclosed in parentheses. Parentheses around a number signifies that there is a clipping in that envelope treating on more than one subject and indexed under more than one title, and that no other clippings are ever to be put into that envelope. A card would then be written under the title of "Frames" and with a reference to the envelope as follows: "See Pistons, 314."

Suppose now that we are looking for data on frames. We refer to our file and find the card just described, referring us to "Pistons, 314." We turn to "Pistons" and find perhaps ten or twelve envelopes under that head, some of them containing several articles. We do not have to look through all of the envelopes and all of the clippings to find the one on which also appears an article on frames; we simply select the envelope bearing the number 314, and we know that that envelope contains the clipping we want and no others. Every time we have had a clipping on pistons to file, the parentheses around that number 314 has warned us not to put it into that envelope.

From the description given, it will be seen that the clerical work involved in indexing is very small. Often there is nothing to do but cut out the article and put it into one of the envelopes already indexed, there being no writing to do at all.

If an article takes more than one sheet, the sheets should be fastened together by pasting at one corner. If in later issues of the magazines, discussions, corrections, or future installments of the article appear, they may be attached to that which has already been filed. This feature is one of the valuable points of the system. In a bound volume of a magazine, the various installments of an article, and the corrections and discussions, if any, are scattered all through the book, and sometimes through two or three, while with the system described above all are gathered together in one envelope and all other articles relating to the same subject are in adjacent envelopes.

Bound volumes are heavy and bulky to handle for reference, and it is extremely inconvenient for one to carry data to his home or to the office if it is contained within two or three bound volumes of a nine-inch by twelve-inch magazine.

The fact, too, that obsolete or out-of-date matter can be so easily weeded out is an advantage over bound volumes. Valuable room is often taken up on the book shelves by old volumes of a magazine for the sake of only half a dozen articles worth saving. If the magazines are torn apart and the valuable articles filed about as fast as they are received, the filing system is always up to date. The new live matter is in the files where it may readily be referred to, instead of being stowed away in a pile of unbound magazines waiting to go to the bindery, or at the bindery, waiting to be bound and returned. The value of the magazines one takes is more than doubled, because every article considered worth saving, even for a short time, is at one's finger tips.

* See MACHINERY, January, 1911, "The Systematic Scrap-book."

† Address: Three Rivers, Mich.

* * *

The February issue of MACHINERY, engineering edition, contained a brief item relating to the loss of power in gas engines, due to elevation above sea level. The statement made to the effect that about 1 per cent of the indicated horsepower was lost for each 1000 feet increase in elevation, was based upon an article in an English contemporary. This has been corrected by the journal publishing the original article, and the loss instead amounts to not less than about 3¼ per cent for each 1000 feet increase in elevation. This agrees also more nearly with the experience of makers who have roughly allowed about 2½ to 3 per cent for each 1000 feet of elevation.

A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION

By H. A. S. HOWARTH*

So far as the writer knows there has been, heretofore, no very satisfactory way to draw an ellipse by a two-arc construction. There are a few methods given in handbooks and works on mechanical drawing, but they are useful only for a small range of proportions. The following method is believed to be new, and it is surprisingly accurate for all proportions. This is due to the fact that the point where the two arcs join is on the exact ellipse and is so chosen that the shorter of the two arcs will pass exactly through the ends of the major axis for some proportions and *almost* exactly through them for others. The error is practically negligible.

The method is as follows: In Fig. 1, AB and CD are the axes of an ellipse, and O is their intersection. The minor axis CD is drawn long enough to contain the center S which is to be found. Lay off the distance OE equal to OA. With E as a center draw the arc OHG having the radius OE equal to OA. Parallel to AB draw CH cutting this arc at H. Through H draw the radial line OHJ. It will be noted here that the inclination of this radial line depends upon, and varies with, the width of the ellipse. It is this fact that makes this method suitable for ellipses of all proportions.

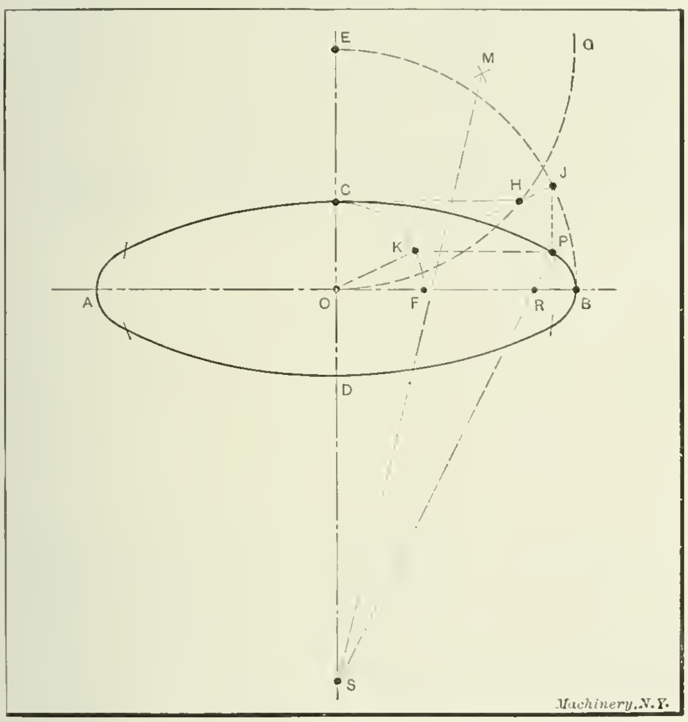


Fig. 1. An Accurate Method for Constructing an Ellipse by Circular Arcs

With O as a center, draw the arcs CKF and EJB, cutting the radial line OH at K and J. Draw KP parallel to AB, and JP parallel to CD. They will intersect at a point P which is a point on the *true* ellipse. Having this point P, it is only necessary to find the center S so that an arc may be drawn from C to P. To find this point, draw the line MS so that it bisects and is perpendicular to a line drawn from C to P. Point S, where MS cuts the minor axis, is the required center.

Having S, draw PS cutting AB at R. Taking R as a center and PR as a radius the arc PB may be drawn. Since the centers R and S are on the same line as P, the two arcs will meet perfectly at P. The whole ellipse may now be drawn easily if short arcs, centered at O, are first drawn, cutting through P and the three other points where the curves meet. These are indicated in Fig. 1. Fig. 2 shows an ellipse of other proportions drawn by the same method. Both ellipses are evidently satisfactory and quite pleasing to the eye.

The question which now remains is: Does an arc with a radius PR and a center at R pass exactly through the end of the major axis at B? A careful construction of a number of ellipses failed to show any error other than that which would be expected on a drawing board. Hence the matter was investigated mathematically. Fig. 2 is constructed like Fig. 1, with the addition of some lines required for the mathematical analysis. The point B is assumed to be the end of the major axis, and P is a point on the true ellipse, determined by this new construction. The error of the method will be the difference in the lengths of PR and BR. Hence,

$$\text{Error} = PR - BR.$$

If the ratio of the minor to the major axis be taken as r, and half of the major axis be taken as unity, then half of the minor axis will equal r. That is, $OB = 1$ and $OC = r$. Draw EH. By construction it equals OB and that equals unity. Also we have $EC = OE - OC = 1 - r$. It is evident that CH may now be found in terms of r. Hence OH may be found. The triangles OCH, JPK and JVO are similar. By continuing the use of simple geometry, expressions may be found for both PR and BR in terms of r.

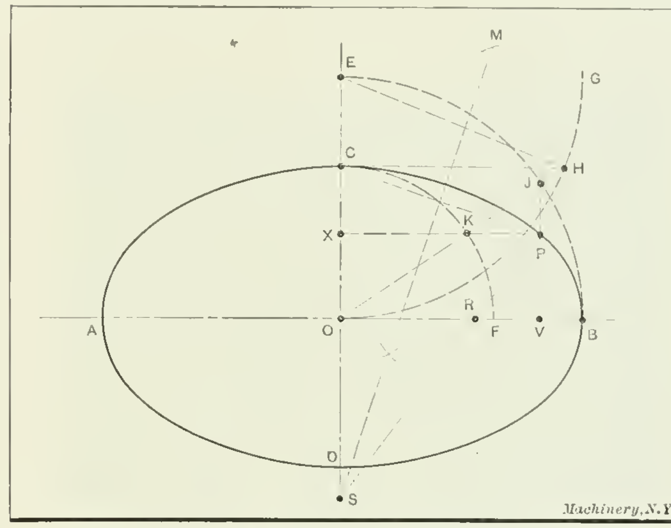


Fig. 2. Method applied to Ellipse with Less Difference between Major and Minor Axis than that in Fig. 1

By the use of a formula deduced from those simple geometrical relations, the following errors were found:

When $r = 0.00$, the error $= 0.0000$
$r = 0.06$, the error $= -0.0058$
$r = 0.10$, the error $= -0.0062$
$r = 0.20$, the error $= -0.0040$
$r = 0.40$, the error $= +0.0023$
$r = 0.50$, the error $= +0.0040$
$r = 0.60$, the error $= +0.0043$
$r = 0.80$, the error $= +0.0021$
$r = 1.00$, the error $= 0.0000$

Where the error is positive, PR is greater than BR, and the smaller arc would pass slightly beyond the end of the major axis. Where it is negative, PR is less than BR, and the smaller arc would pass slightly within the end of the major axis.

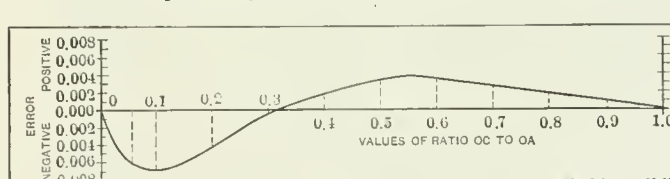


Fig. 3. Diagram showing the Limits of the Errors introduced by the Method for Drawing Ellipses

When the major axis is two inches long the above errors obtain, and the variation is from zero to 0.006 inch. Since the sign of the error changes from plus to minus as r decreases from 0.4 to 0.2 there must be a value of r in the neighborhood of 0.3 at which the error is zero. This value of r may be found by drawing the curve shown in Fig. 3. The abscissas are values of r and the ordinates are the errors. The curve cuts the straight line at about 0.32, and for this value of r this new method is very exact.

The maximum negative error (0.0063) occurs when r is about 0,08, *i. e.*, when the ellipse is about twelve times as long

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as it is wide. This very narrow proportion is seldom met with. The maximum positive error (0.0045) occurs when r is about 0.55. This is a common proportion, but an error of 0.0045 is negligible on small constructions. It must be remembered, however, that the errors are proportional to the size of the ellipse. If the major axis is 20 inches instead of 2 inches, and the minor axis 11 inches instead of 1.10 inch, the error will be ten times as great, *i. e.*, it will be 0.045 inch.

Persons who may have occasion to use this construction for large ellipses will appreciate its value in locating very closely the useful center R. One advantage of the method, in addition to its accuracy, is its applicability to *all proportions*. In fact, the curves so closely correspond to the theoretical ellipse (which cannot be drawn by circular arcs) that they are an excellent substitute for it. There are a few three-arc methods

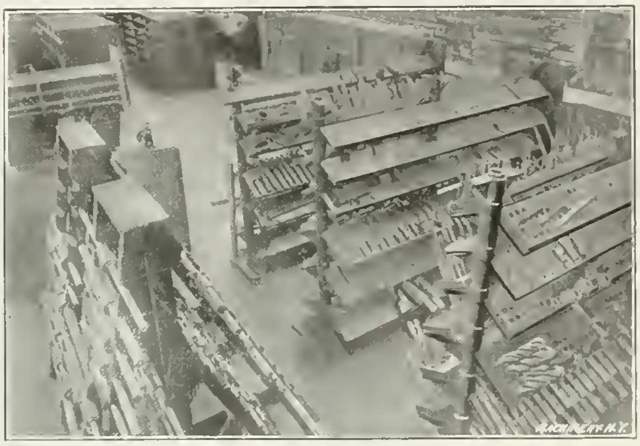

Fig. 1. General View of Toolroom, showing Racks and Tools

that give very good results, but the constructions are complicated. Hence, this new two-arc method should find favor among those accustomed to the more complex three-arc construction.

* * *

The energy with which the German manufacturers and engineering firms are acquiring business all over the world is well exemplified by the combination of twenty German machine manufacturers and engineering firms which are to es-

Fig. 3. Racks for Large Jigs

tablish a central office for the Far East at Shanghai, China. The office will be divided into different departments, each department representing a special line of machinery represented in the combine. A German engineer who has been a resident of China for more than ten years, and who is thoroughly familiar with conditions in the Far East, is to be the head of the office. Negotiations with customers will be carried on independently of the home offices. The combine includes two large German machine tool firms.

* * *

The first electric railway was built by Werner Siemens in Berlin, Germany, in 1879. This was of a rather experimental character, but furnished the nucleus from which all later developments have sprung. The first electric railway in America was built in Baltimore in 1885, and ran to Hampden, a distance of two miles.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—7

THE CINCINNATI PLANER CO.

By ETHAN VIALL*

Three of the largest Cincinnati manufacturers have plants in the Oakley industrial colony—the Cincinnati Milling Machine Co., the Cincinnati Bickford Tool Co., and the Cincinnati Planer Co. The two latter have moved their entire plants to Oakley, but only a portion of the former has been moved as yet.

The plant of the Cincinnati Planer Co. is of brick construction, 150 feet wide and 400 feet long, with a middle bay 56 feet wide running the entire length of the shop and over which

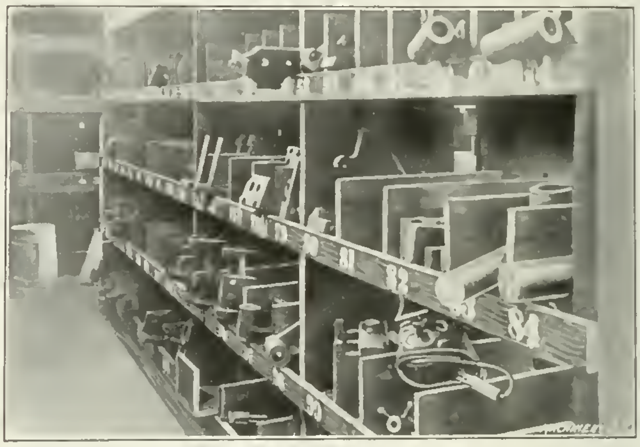

Fig. 2. Numbered Jig Shelves for Holding Jigs and Tool Sets

travels a 15-ton crane of the most modern type. The lighting is the best possible, as an unusually large amount of glass has been used in the construction, giving ample light even for cloudy days, while Cooper-Hewitt lights, at frequent intervals, are all that could be desired for night work. The machinery is motor driven by the group system for the most part, though some of the larger machines have individual motors, the current for which as well as for the lights, is furnished by the common power house of the colony described in

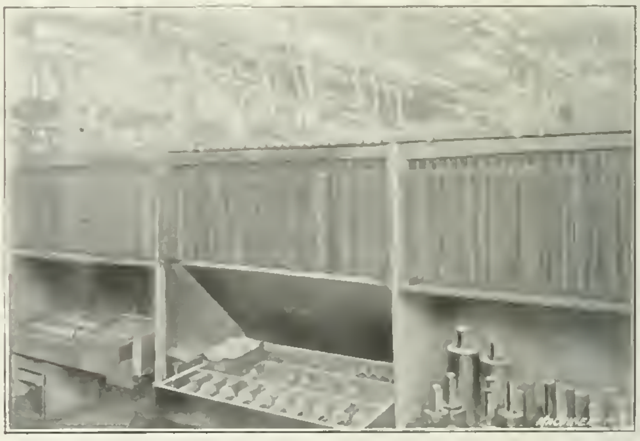

Fig. 4. Blueprint Racks and Gages

the June, 1910, issue of MACHINERY. An outside traveling crane at the end of the shop is so arranged that it can either unload a car directly into the casting yard or place the castings where the big shop crane can easily reach them.

The Floor Plan

The shop, as previously mentioned, has three bays, one central, and one on each side. At the rear of the shop in one of these side bays are located nearly all the lathes, while on the other side of the shop nearly all the planers are disposed. The larger planers for extra heavy work are in the central bay, and one of them is so set at an angle as to be able to accommodate very long work. On the same side as the lathes, only nearer the front of the building, are the gear cutters and milling machines, the corresponding space on the opposite side of

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the building being devoted to the radial drills. The front half of the building has practically no machinery, that part being left for extensions.

The Toolroom

The toolroom has every case, rack and convenience needed to make it of the best. Fig. 1 shows a few of the tool racks and cases; taps, drills and reamers are at the right, and large reamers and boring bars at the left. A point well worth noting is that drills, reamers and taps which are within certain

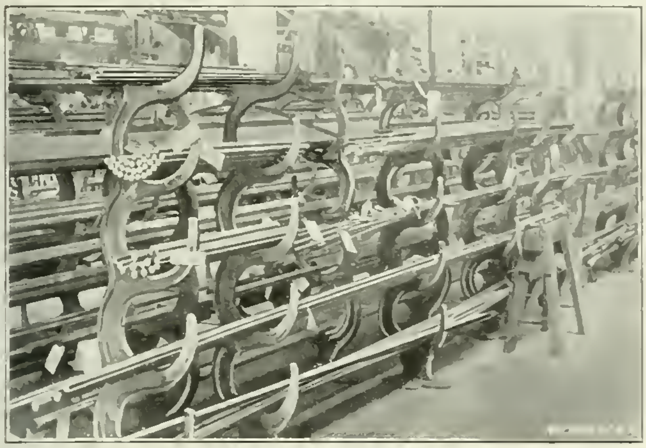


Fig. 5. Cast-iron Stock Racks

sizes, all have interchangeable shanks fitted to them, and in this way by using a driving socket of the correct size changes of tools in the spindle of the drill press may be made with a minimum loss of time. In this connection, there is another interesting feature; all machine taps are made 0.004 or 0.005 inch small so that when the holes are re-tapped with a hand tap it cleans up nicely and makes a good fit. All machine taps are fitted with straight shanks of a certain size, as just stated, so that the machinist has no trouble in distinguishing between the ones used by hand and those intended for the machines.

Stock that is being sent through the shop is first given a stock order number and a piece number which are put on one side of a red tag, which has on it, in addition, the name of the piece, the quantity to be finished, the number of the drawing and the date on which the lot was started. On the reverse side of this tag are given the various operations through which each piece must go, and in case it is a machining operation the job name is followed by the number of the machine on which the operation is to be done. This machine number is followed by the number of the jig shelf on which the tools used on the machine are stored.

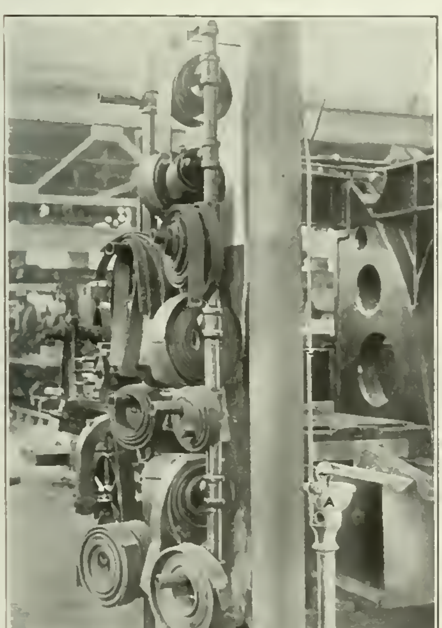


Fig. 6. Belt Rack and Drinking Fountain

A row of jig shelves is shown in Fig. 2, and in each is a set of tools and jigs for the job indicated by the number on the outside; and the set used for any particular operation is easily found by means of the jig shelf number on the stock card. Some of the large jigs are stored as shown in Fig. 3, and gages and blueprints as in Fig. 4. The blueprints shown in the engraving are all mounted on tin and are in compartments so as to be checked out the same as a tool, little hooks being screwed in just over each compartment on which to hang the checks.

Bar stock of all kinds is stored in convenient places in the shop on the cast-iron racks shown in Fig. 5, and in Fig. 6 is a belt rack made of pipe. At *A* in this engraving is a sanitary drinking fountain, which is one of many in the shop, and is a means of furnishing clear, cool, running water, to the men without the necessity of using a cup.

In Fig. 7 is shown a corner of the gear cutting department, with a Gould and Eberhardt machine at *A*, another at *B* and a gear cutter board at *C*, while at *D* is shown a first-class way to keep the gages used in setting the machine.

Large jigs, used when boring out the holes in planer beds for the bull wheel and pinion driving shafts, are mounted on three-wheeled trucks as shown in Fig. 8, so as to be easily moved to any desired location. In Fig. 9, one of these jigs

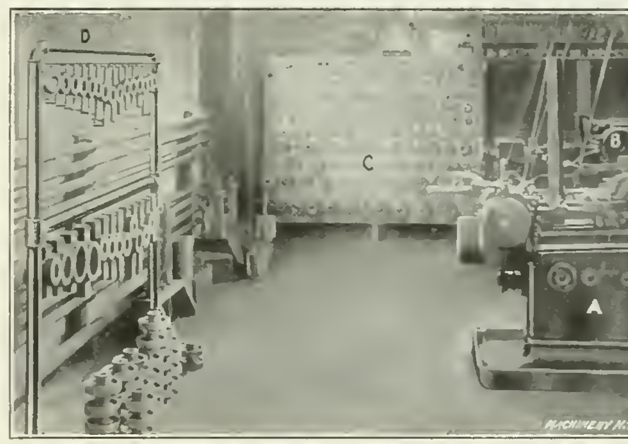


Fig. 7. Gear Gage and Cutter Racks

is shown in use. The jig itself is located in and clamped securely to the finished V's of the planer bed. The boring bars used in this, as well as in all other jigs, where it is possible to do so, are supported by guide bushings at both ends in accordance with the best shop practice.

Interchangeable Jigs for Housings and Beds

A very practical and ingenious set of interchangeable jigs is in use for locating the holes in planer housings and beds, whereby the holes are absolutely sure to line up properly when the two parts of the planer are put together. Fig. 10 shows one of these jigs ready to be placed on the base of a housing. The jig is located by placing the tongue blocks *A* and *B* in the grooves *C* and *D* and pushing it along until stop pin *E* comes in contact with the finished front, *F*, of the housing. Fig. 11 shows the jig in position. In use, of course, the housing and jig lie flat; they are placed as shown in order to be photographed more easily. Fig. 12 is the same jig ready to

Fig. 8. Large Jig Trucks

apply to the side of a planer bed, the locating being done by means of the tongue blocks which fit into grooves in the bed at *A* and *B*, and the stop *C* butting against *D*. Fig. 13 shows the jig in place.

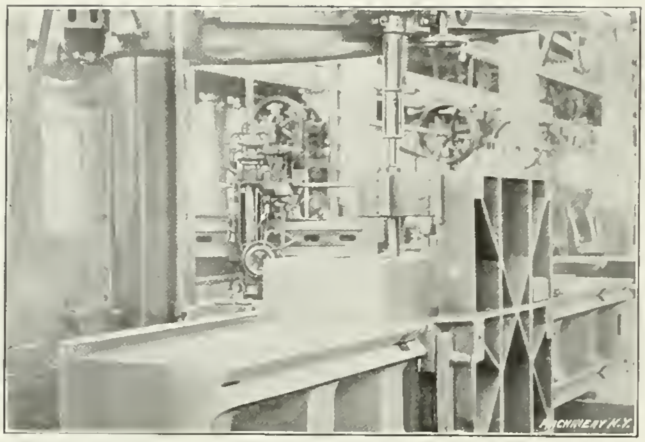


Fig. 9. Planer Bed Jig

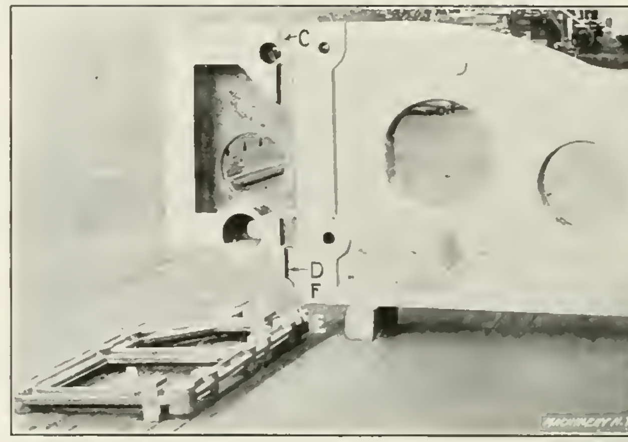


Fig. 10. Housing Base Jig

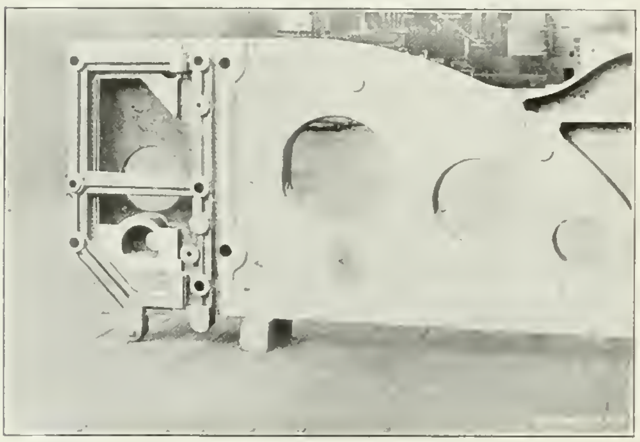


Fig. 11. Housing Base Jig in Place

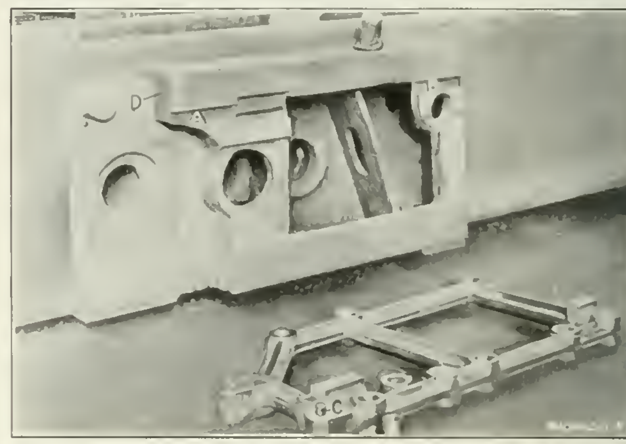


Fig. 12. Housing Base Jig ready to place on Bed

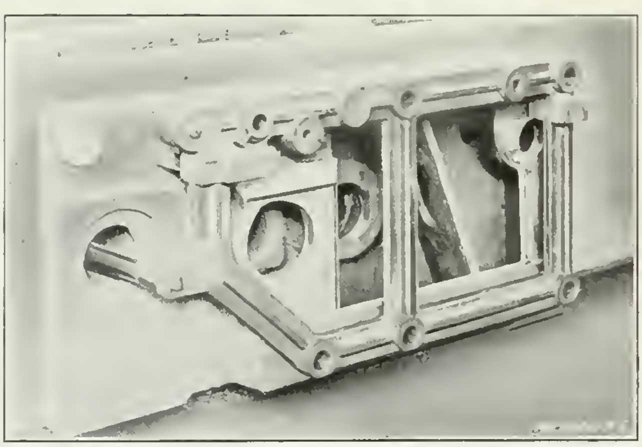


Fig. 13. Housing Base Jig in Place on Bed

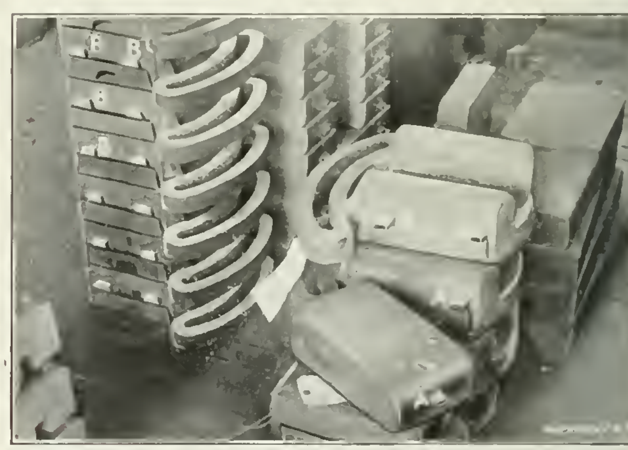


Fig. 14. Lugs on Castings for Convenience in Clamping

Fig. 15. Clamping Pieces on Planer by Means of Lugs

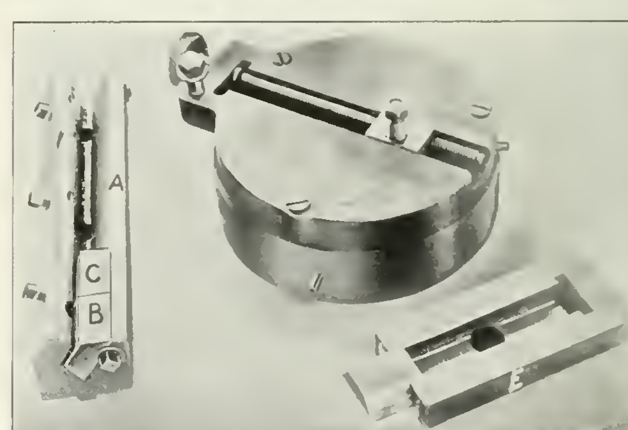


Fig. 16. Friction Blocks and Planing Jig

The use of small easily removed lugs on castings for the purpose of clamping while machining, is a feature that is not employed in other shops to the extent it should be. In numerous cases, this would save jigging or several settings. Fig. 14 shows several clapper boxes and blocks, planing lugs being shown at *A*, while at *B* they have been knocked off after the parts were finished. Fig 15 shows how these lugs are made use of in clamping down long and comparatively thin castings.

Small dovetail blocks used in planer frictions are planed in the jig *A* Fig. 16, two of the blocks being shown at *B* and

C. These blocks are cast approximately to shape, planed top and bottom and then placed in this jig where the bevels on both sides are planed. At *D* is shown one form of friction block in which these blocks are used, and another is shown

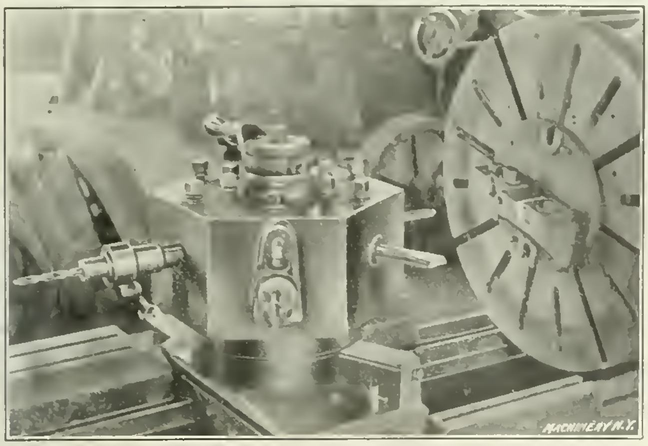


Fig. 17. Screw Machine Chuck and Tools for Friction Slides

at *E*. After planing, the blocks are drilled, bored, countersunk and tapped in a screw machine as shown in Fig. 17.

Balancing Pulleys

While pulleys of various kinds and sizes are turned as far as possible on the inside of the rim as shown at *A*, Fig. 18, yet in order to run well they must be counterbalanced. The standing balance is obtained by using the Bowsher balancing

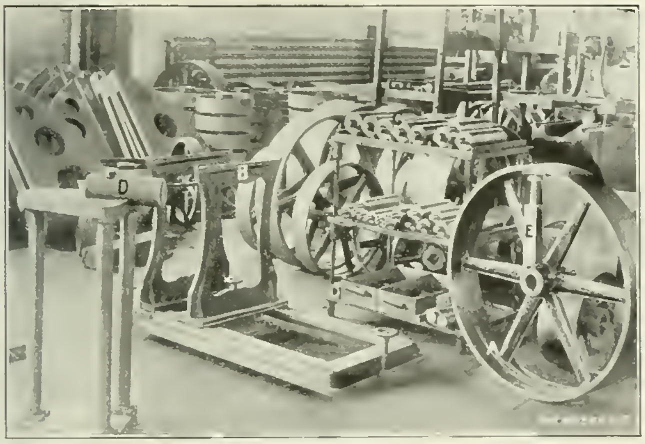


Fig. 18. Pulley Balancing Tools

ways *B* and riveting on pieces of iron where indicated. Specially ground mandrels on which to mount the pulleys are shown at *C* and a riveting stand for small pulleys at *D*; large pulleys, however, have counterweights riveted on by using the backing block shown at *E*, which consists of a post to brace against the hub and a heavy screw with a hardened head, slightly countersunk in the middle for the rivet head.

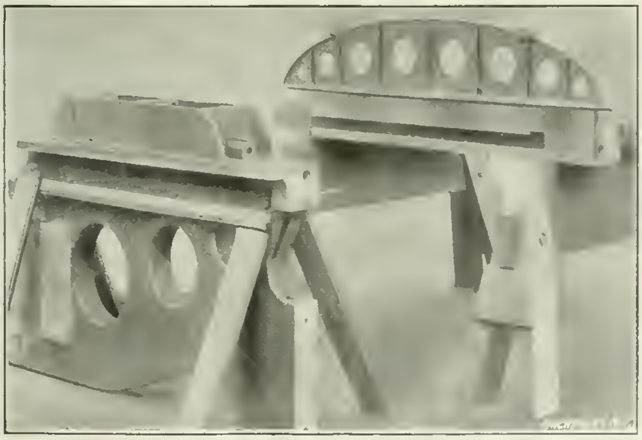


Fig. 19. Scraping Plate and Straightedge

Fig. 19 shows a master plate and a straightedge to which the housings and other parts are scraped.

Reservoir for Oil from Planer Ways

Oil from planer ways is collected, strained and used again as shown in Fig. 20. The plan pursued on old planers is to cut a hole near the ends of the V's as at *A*; from the bottom of these, tubes *B* are run to a small tank *C*, which has a screen in it to retain the dirt, the oil being drained through the stop cock *D* into the pan *E*, after which it is poured back into the oil pockets which are of the usual roller oiling type.

A Numbering Jig

Numbers are stamped evenly on crossrails by using the jig shown in Fig. 21, which has a thumb-screw on the back

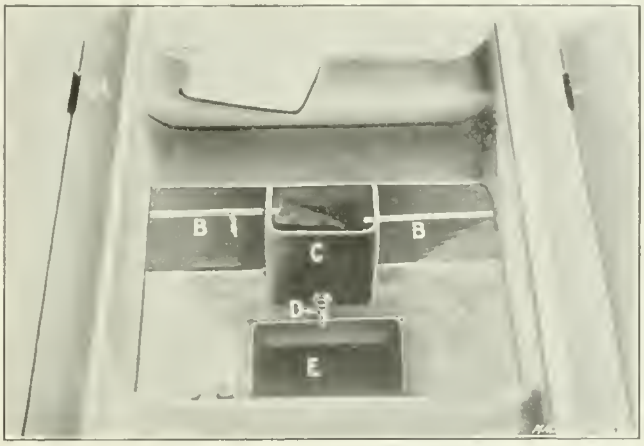


Fig. 20. Device for Saving Oil from Planer

to hold it securely in place. The numbers used have the sides ground so as to make a snug fit in the spaces for five figures and a large space for the "No." stamp.

* * *

ANNUNCIATOR FOR GEAR-CUTTERS

An electric annunciator is employed in the gear-cutting department of the King Machine Tool Co., Cincinnati, Ohio, to call the attention of the operator (who attends to several machines) when the gear blanks have been fully cut. The device for making electrical contact on the machines is simple, consisting of an arm attached to the index wheel, and a contact

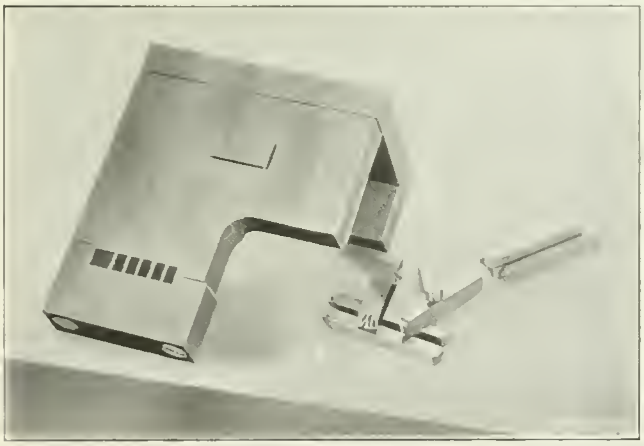


Fig. 21. Number Stamping Jig

finger mounted on the frame of the machine. This finger is engaged by the arm at one point in its revolution. The operator starts the machine cutting a blank with the arm standing just beyond the finger, and when it has turned all the way around contact is made. The annunciator rings and indicates the number of the machine requiring attention.

The device is so constructed that the electrical connection is maintained until the contact finger is straightened back into normal position; thus, should the operator neglect to attend to a machine on which the blank is finished, the annunciator will continue to ring until stopped by turning back the contact finger.

* * *

It is mentioned in the *Practical Engineer* that the Inner Farne Island has been provided with an automatic light-house, machinery having been installed which turns on the acetylene gas at dusk and turns it off at dawn. It is stated that the light-house will need attention only once every six months.

THE MECHANICAL ENGINEER AND PREVENTION OF ACCIDENTS*

The preservation of the lives and limbs of industrial workers is a more vital question than any other which the mechanical engineer meets in the industrial field. Accident clauses, wise and less wise, have been included in the laws of various states, but legal obligation to safeguard industrial workers has not alone succeeded in preventing avoidable accidents to any great extent. The subject of the prevention of accidents, however, is now coming to the front as a humanitarian consideration. It is the object of the author to initiate a discussion on the prevention of accidents by stating in detail the principles encountered as they have presented themselves to him.

In this matter the United States has lagged considerably behind Great Britain, Germany and France—which countries more than thirty years ago began to enforce, with excellent judgment, laws for safeguarding industrial workers. The statistics covering industrial accidents in the United States are incomplete, yet according to the Bureau of Labor, the yearly mortality from accidents, among adult wage-earners alone, is between 30,000 and 35,000. The non-fatal injuries inflicted are upward of two million a year. These are conservative figures for a single year, and when compared with the more thorough foreign accident records, it gives just cause to inquire why the United States should be so far behind in conserving the lives and health of the industrial workers; yet the figures given take no account of the accidents affecting women and children in the industries, so that the total would be much greater were these recorded.

The Mechanical Engineer and Accidents

From a study of the conditions of safety under which European and American industries are carried on, the author has come to the conclusion that the safeguarding of industrial workers cannot be attained entirely by legislative acts. The principles of safeguarding the workers should be as much a part of the education of the engineer as should those of efficiency in other directions. Many engineers enter into responsible control of industries with little or no realization of the dangers involved. The scientific study and the solution by the mechanical engineer of individual problems of safeguarding, and the instructing of employes, will do more than all other agencies to bring about satisfactory results. The prevention of industrial accidents depends largely upon the intelligent interest of engineers engaged as managers or designers. The attitude of the executive in such matters is all-important, and determines the policy of the whole plant. By proper supervision and precautions in all plants, and by the cultivation of greater care on the part of the operators, probably at least one-third of the annual accidents could be prevented.

As an example, it may be mentioned that in one plant which had a yearly average of 200 accidents, the result of the attention given to preventive measures reduced the number of accidents for the last year to 64. By the steps taken, the earning opportunities of the employes were in no case reduced. Of the 64 accidents during the last year, not one was due to the negligence of the employer, and in but one case was an accident due to the negligence of a foreman. In 25 cases the accident was due solely to the negligence of the person injured, and in 38 cases the occurrence was accidental and non-preventable in the most literal sense. The latter accidents evidently represent the unavoidable trade risk of this particular plant; yet the actual risk before safeguarding the machinery and instructing the employes in a thorough manner was six times as great as this non-preventable risk. This experience has been repeated in many cases.

The Causes of Accidents

In analyzing thousands of accidents with a view of devising remedies, the author found the following to be the chief causes: ignorance; carelessness; unsuitable clothing; inefficient lighting; dirty and obstructed work places; defects of machinery and structures; and the absence of safeguards. In current popular comment on the wastefulness of life and limb in industries, little regard is paid to the causes underlying accidents, but well-considered action must be based solely on this. Steam generators and other vessels under pressure, electric apparatus, railroads and elevators as contributing factors to accidents, have been omitted from the present consideration, because engineers have given a great deal of attention to these already. It is significant that it is chiefly in cases where property, as well as persons, is liable to injury that preventive measures against accidents have as yet been generally and efficiently elaborated.

Ignorance

In spite of ample facilities for the acquisition of some knowledge of mechanical principles, the author has found some superintendents, a number of foremen, many operators and not a few managing owners of smaller plants grossly ignorant of the possibilities for preventing accidents to themselves and others. Nothing but administrative vigilance in selecting employes and instructing them regarding their own special risks will prevent accidents due to ignorance.

Carelessness

Carelessness, sometimes combined with ignorance, sometimes due to sheer thoughtlessness or folly, stands highest as a cause of industrial accidents. Little can be done to shield the worker and those whom he sometimes involves from the results of his own carelessness. It is the author's experience

Fig. 1. Influence of Daylight on the Number of Accidents

that the bright and nervy American workman is usually the first in taking foolish and wholly unnecessary chances with his life and limbs—chances which in no way add to his efficiency or his earnings. The maintenance of strict discipline in the shops and the elimination of the dangerous employe is all that can be done in addition to a campaign of education throughout the shop.

Unsuitable Clothing

Accidents are sometimes caused by many machine parts which are necessarily exposed near the operator and with which he would never come into dangerous contact except for the use of unsuitable clothing. Ragged sleeve ends, loose ties, and open jackets of untidy machinists have, again and again, been wound upon seemingly small parts in motion and inflicted frightful and sometimes fatal injuries. Not a few survivors have to thank the inferior strength of the usual overall for their escape.

Inefficient Lighting

Inefficient lighting is the cause of numerous accidents. The author has observed that the maximum of accidents have occurred toward the close and beginning of each year, during the months of minimum daylight. The accompanying illustration Fig. 1 shows the seasonal distribution for three successive years of about 700 deaths annually, due to industrial accidents reported from 80,000 plants.

In shops, the intensity of artificial lighting at the cutting point of tools and over a limited area at the machine tool or bench is frequently far above actual requirements, while all around the operator a semi-darkness prevails which has a

*Abstract of paper read by Mr. John Calder before the American Society of Mechanical Engineers, February 14, 1911.

blinding effect, and is a source of danger. It has been found that the concentrated illumination, by means of shades, of ordinary 16-candlepower incandescent lamps at cutting tools in machines is often several times as intense as the ordinary daylight on the same parts. From the point of safety, the elimination of this excessive light on spots is required, and a more generally diffused light of less unit intensity should be substituted by the use of fewer but larger lamps, located to suit varying shop requirements, and reflecting from white walls and ceilings. The mechanical engineer, administering or designing plants, can do much to reduce the accident risk from this cause.

Dirty and Obstructed Work Places

Dirty and obstructed work places are closely allied to defective illumination. It is the duty of the management of every shop to see that the cleaning of floors and passages and the removal of waste are systematically provided for. Sometimes this condition is due to the employe himself; sometimes it is due to attempts to save floor space, thereby crowding machines and workers together without due regard to their safety. Almost all mechanical operations can be conducted under pleasanter and safer conditions than at present, as far as light and cleanliness are concerned.

Defects of Machinery and Structures

Apart from the question of specific safeguarding provisions, the author's experience points to the fact that machines or processes which are essentially dangerous because of defective design or arrangement, or from lack of repairs, are comparatively rare. It does not pay any employer to keep a defective tool in operation, nor is it in the interest of the employe to use imperfect apparatus. While defects of machinery contribute to some serious and a number of minor casualties, they do not do so to the extent commonly alleged.

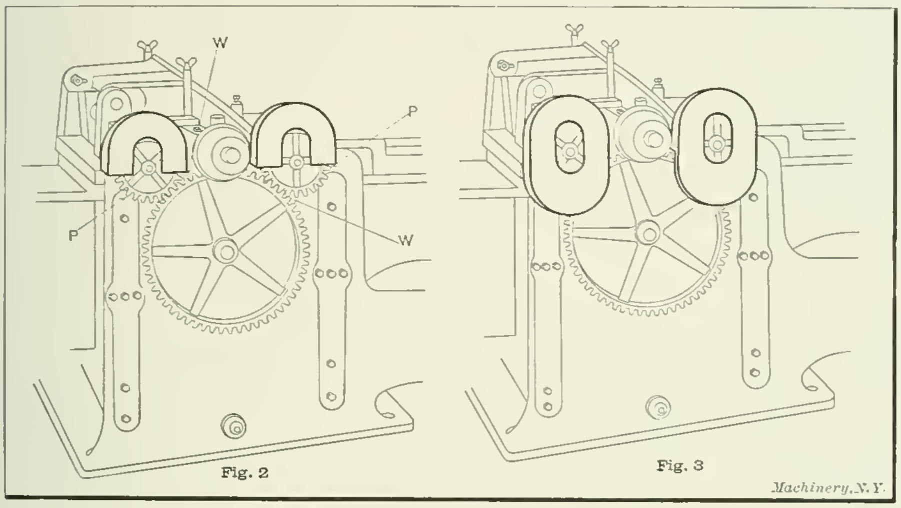
Absence of Safeguards

Absence of safeguards, although it is not the most prolific cause of accidents, closely concerns the mechanical engineer. In the eyes of the public and the non-technical investigator, this matter is of the first importance. In many cases of injuries to operators caused by the absence of a suitable safeguard, it will be found that it has been removed or rendered ineffective by the employe. In many cases some machines will be safeguarded in one part of the plant and not in another, due to the operation of the principle that what is permitted to be everybody's business is nobody's business. The provisions for safeguarding should, therefore, never be left to the initiative of a number of individuals in any one plant.

The contributions of the mechanical engineer to the safeguarding of machinery fall into two divisions: 1. Efficient safeguard which he designs as parts of machine tools and apparatus. 2. Safeguards which he may devise and supply as the mechanical engineer of a plant using apparatus capable of inflicting injury if permitted to remain as installed, or which cannot be intelligently protected until all related apparatus is in position and the operating conditions of the employe fully apparent.

The machine tool builders have already accomplished a great deal in the way of useful safeguarding, particularly in guarding against the dangers of gears in metal-working machinery. Sometimes, however, so-called "guards" are encountered which are not guards at all but rather delusions, indicating that the designer had appearance rather than utility in mind. This is illustrated in Fig. 2, where the pinions *P* have been covered on the top, which is the out-running and safe side, by semicircular flanged hoods, whereas the intaking and dangerous parts of the gears at *W* are unprotected and likely to grip the clothes and fingers of unsuspecting operators. Fig. 3 shows the proper way to protect the gears in the machine illustrated.

Many designers seem to believe that anything which looks like a cover for a part of a machine constitutes an efficient safeguard, but this is not true if no regard is paid to the actual direction of rotation or to reversal of motion, or to the likelihood of the guard being left off permanently. The real points of danger in daily practice must be studied before a satisfactory protection can be provided. Shafts and spindles, low pulleys, belts, gears, narrow clearances between fixed and moving parts, couplings, projecting screws, nuts and pins, etc., are all best protected by the machine tool builder when designing the machine. It is important that the guards for machines are so designed and applied that there be no temptation for the workman to throw them aside as cumbersome. To educate the employe to use caution and foresight about dangerous machines is difficult enough, and it should not be rendered more so by making him work with an impractical safeguard. A careful inquiry into the conditions under which an employe has to work should be made and the safety devices should enable him to work with the same efficiency as without the safeguard.



Figs. 2 and 3. Incorrect and Correct Application of Gear Guards

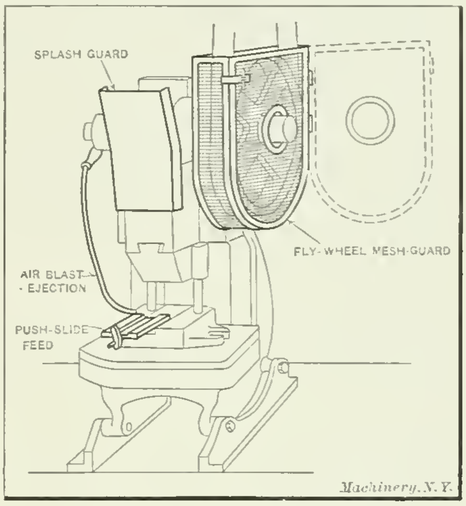


Fig. 4. Punch Press with Air Blast Ejector, Push-slide Feed and Flywheel Guard

When guarding equipment built in position, the manner of installation and the precise nature of the workman's duty around it must be taken into consideration. Protection against accident in power-generating machinery, for instance, is not secured, as is sometimes supposed, by merely guarding the dangerous moving parts. In power houses, for example, the edges of all stairs, platforms, ladders and gratings should have low fenders of metal on all sides so as to prevent nuts, bolts, tools and other small parts from rolling off into the machinery or striking the employes. In addition, a double metal railing not less than three feet high and not nearer than twelve inches to any moving part, should be provided at all dangerous places, such as crank and flywheel pits, and at the inside and outside edges of all stairs and elevated platforms.

Punches and Presses

Punches and presses are causes of frequent accidents. The mechanical engineer cannot be too careful in seeing that these tools are in good repair, particularly as regards the actuating mechanism. Automatic roll feeds, sub-presses, magazines, hoppers, gravity slides, etc., have done a great deal to eliminate the danger of feeding such presses by hand. The increas-

ing use of compressed air in mechanical industries permits of light pieces being blown off the die at the end of the operation by a cam-operated blast properly directed and timed as indicated in Fig. 4. The ordinary spring ejector serves the same purpose for heavier work. In Fig. 4 a convenient flywheel guard is also illustrated. Provision is made by means of a door for the tool-setter to move the flywheel by hand without detaching the guard. The work in this machine is fed in by a push-slide so that the operator does not have to place his fingers under the punch at all. In Figs. 5 and 6 are shown two forms of guards, consisting in the one case of a screen, and in the other of a bar, which are timed to descend on the operator's fingers, if these be in a position of danger, and force their withdrawal before an accident occurs through the descending punch.

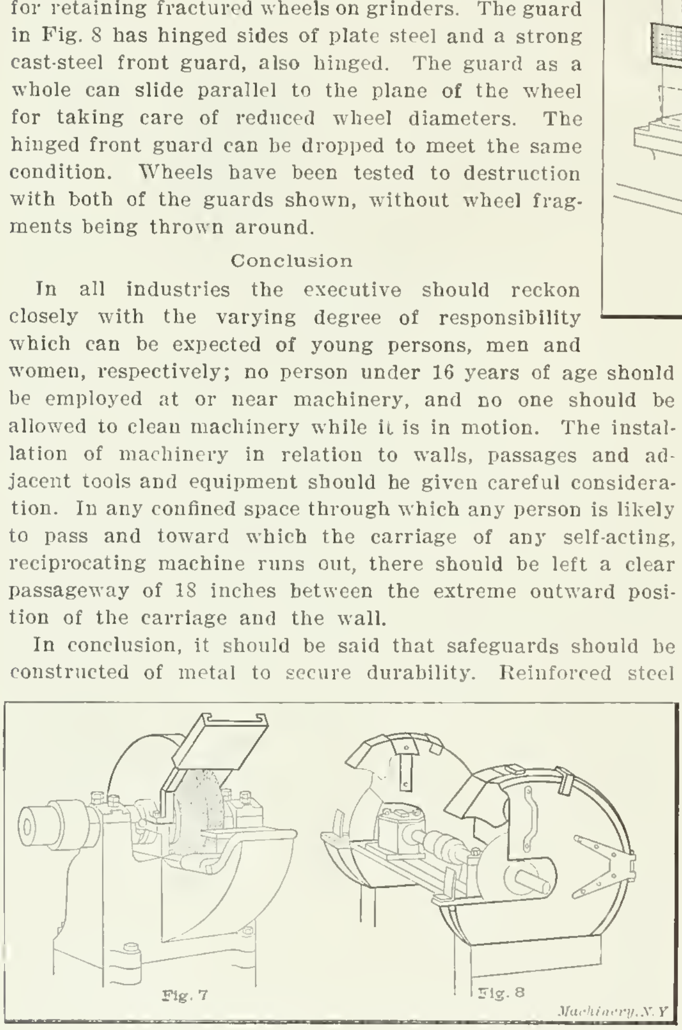
Grinding Wheels

Various methods are employed for confining bursting wheel fragments to a guard-casing or for rendering their velocity harmless. Figs. 7 and 8, show various forms of guards or armors, successfully used for retaining fractured wheels on grinders. The guard in Fig. 8 has hinged sides of plate steel and a strong cast-steel front guard, also hinged. The guard as a whole can slide parallel to the plane of the wheel for taking care of reduced wheel diameters. The hinged front guard can be dropped to meet the same condition. Wheels have been tested to destruction with both of the guards shown, without wheel fragments being thrown around.

Conclusion

In all industries the executive should reckon closely with the varying degree of responsibility which can be expected of young persons, men and women, respectively; no person under 16 years of age should be employed at or near machinery, and no one should be allowed to clean machinery while it is in motion. The installation of machinery in relation to walls, passages and adjacent tools and equipment should be given careful consideration. In any confined space through which any person is likely to pass and toward which the carriage of any self-acting, reciprocating machine runs out, there should be left a clear passageway of 18 inches between the extreme outward position of the carriage and the wall.

In conclusion, it should be said that safeguards should be constructed of metal to secure durability. Reinforced steel mesh work is preferable for all but the heaviest machinery, because it permits of easy inspection without detaching the safeguard. Warning and caution notices should be sparingly used and as brief as possible. They give possible legal protection against damage suits, but are practically worthless if no attempt is made to enforce them. Every executive and engineer will find it a valuable adjunct to the safety engineering of the plant to maintain in every department a record of every accident and also every "near" accident. An examination of these records without regard to legal compulsion will help more than anything else to remove speedily the causes of accidents and the present great reproach against our industries.



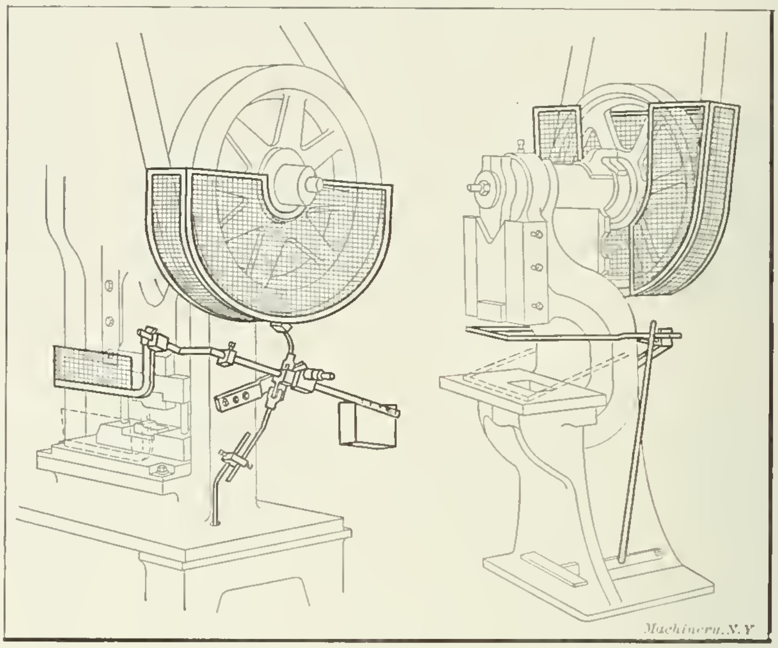
Figs. 7 and 8. Effective Guards for Grinding Wheels

* * *

It is a great deal easier to point out the shortcomings of the boss than it is to fill his boots from day to day.

LOCOMOTIVE CAB SIGNALS AND AUTOMATIC STOPS

An article in the *Bulletin of the International Railway Congress* for November, 1910, abstracted from a foreign source, gives some interesting information regarding the experiments made with cab signals and automatic stops in Germany. Experiments with such devices were first made in 1906, in which year the Prussian State Railways devoted considerable attention to systematic trials. Attempts were made to obtain audible signals, but in general it was not thought advisable to have the signals act as automatic stops. Some of the first experiments were made with sirens and horns set up at the side of the track and electrically operated. When the train gets within 1200 feet of the distant signal, it causes the horn to sound if the signal itself is standing at "caution," and the sound continues to be heard until the head of the train has passed 160 feet beyond the distant signal. These experiments are not yet concluded. One of the difficulties met with is that with some express trains the sound of the horn is not loud enough to attract the attention of the engineer.



Figs. 5 and 6. Punch Presses with Effective Safety Devices

On other roads experiments were made with an electric apparatus, using a brush contact. On approaching a distant signal the arrangement caused a visual signal in the form of a disk to appear in the cab. The results of these experiments were not satisfactory for the reason that the contact brushes were repeatedly damaged by the ballast or the other objects on the track, and sometimes at high speed the appliance failed to act. In another device so-called "slippers" were used on the locomotive, sliding on raised treadles, the lifting of the slipper causing a depression of a rod on the engine. This apparatus was designed as an automatic stop, but the connection to the brakes has been cut out, and it is used merely as a signalling apparatus. During snow storms, however, this device caused trouble because the treadles could not be moved into position and the signals became uncertain.

Other experiments were undertaken with a wireless apparatus by means of which signals were sent to a receiver placed on the locomotive from a sending station, the signals produced consisting of colored disks in the cab. Difficulties with this apparatus were met with on account of the fact that telegraph lines crossing the track, etc., would produce the same effects as the wireless wave from the sending station. Perhaps the best results have been obtained with a recording alarm, so operated that a bell will ring in the cab when a signal is overrun; to stop the bell from ringing the engineer must record the overrunning. This apparatus has been tried by five different divisions with good results. Absolute reliability has, however, as yet not been obtained with any apparatus, and the experiments will be continued and extended.

A METER FOR RECORDING THE FLOW OF GASES

The accurate measuring of the flow of gases passing through a pipe line is a matter of considerable difficulty, particularly when the pressure and temperature of the flowing gas varies from time to time, and the measuring instruments are required, nevertheless, to record the quantity of gas reduced to a standard pressure and temperature. For this reason the meter illustrated and described in the following will prove of especial interest. This device, known as the Thomas meter, is made by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and serves the purpose of graphically recording the quantity of flow of gases at any pressure and at any temperature, independent of the fluctuations of pressure or temperature to which the flowing gas may be subjected. The design of the meter is based upon a scientific principle ingeniously applied, and is, therefore, of more than ordinary mechanical interest.

General Design of Meter

A diagrammatical view of the meter is shown in Fig. 1. It consists of an electric heater *B* made of suitable resistance material, and placed across the passage of the gas in such a way as to heat all the gas passing through the pipe line of which the meter forms a part. The object of the heater is to raise the temperature of the gas to a higher exit temperature than that at the entrance. The temperature at either side of the heater is measured by the two electrical resistance thermometers *E*, acting in connection with an automatic regulating mechanism, as will be further explained later. The thermometers consist of screens made of nickel wire, which like many other materials changes its electrical resistance in direct proportion to the changes in temperature. This simple arrangement, properly connected and controlled, makes it possible to obtain a record of the gas flow, and to read it off directly on the dials of an integrating watt-meter or by means of the curve drawn by a recording watt-meter.

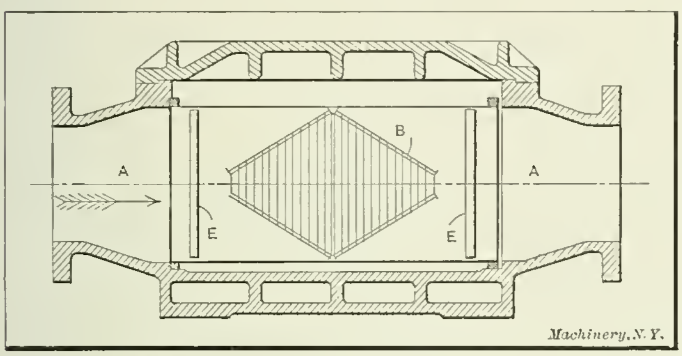


Fig. 1. Diagrammatical View of the Thomas Meter for Recording the Quantity of Flow of Gases

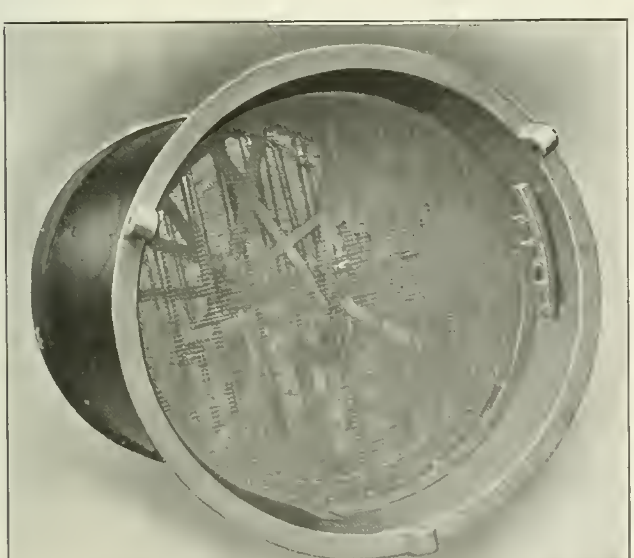


Fig 2. Meter Casing through which the Gas flows, showing the Resistance Thermometer and the Electricel Heater

The actual appearance of the various parts of the meter is shown in the halftone illustrations. In Fig. 2 is shown the meter casing through which the gas flows; in Fig. 3, the electrical resistance forming the heater of the meter; in Fig. 4, the screen of nickel wire which acts as a thermometer, and in Fig. 5, the switchboard and recording instruments of the meter.

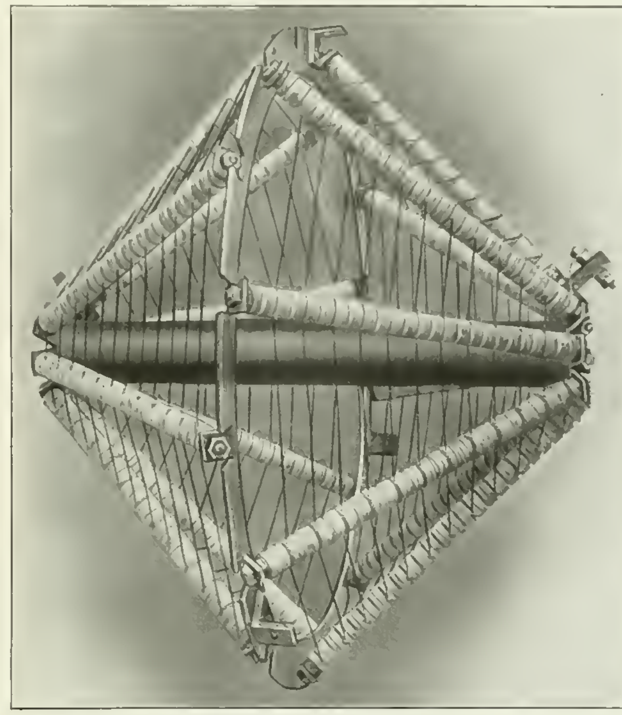


Fig. 3. Electrical Resistance forming the Heater of the Meter. By Means of this Device the Temperature of the Gas is raised Two Degrees as it flows through the Mater

Principle of Action of Meter

Suppose that gas or air flows at a uniform rate through a pipe *A* shown in Fig. 1, and that it passes on its way an electrical heater *B*. Suppose also that the heater gives off heat at a standard rate, which would be the case if the voltage across the heater terminals remained constant and if the resistance of the heater did not change. It is then evident that if the flow of gas and the liberation of heat are both uniform and constant, the temperature of the gas will be raised a certain number of degrees as it passes through the heater; and this temperature rise will remain constant so long as the conditions specified do not change.

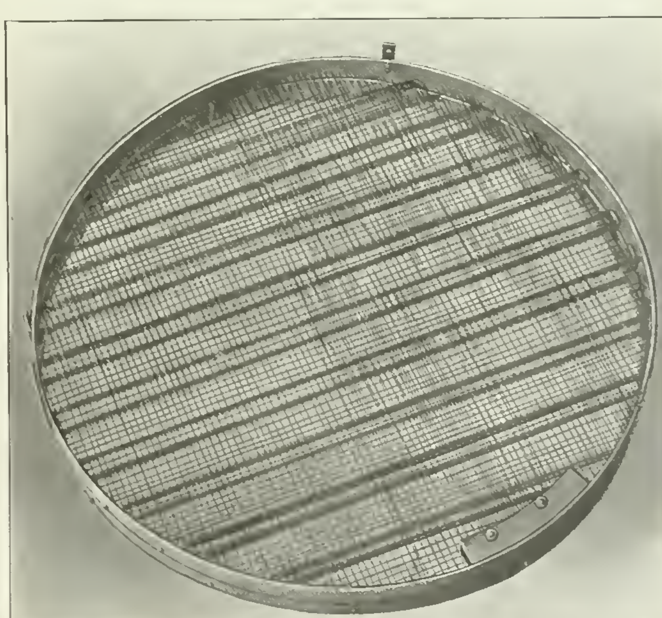


Fig. 4. Screen of Nickel Wire which acts as a Thermometer in the Thomas Meter

If now the rate of flow of gas is increased, but the rate of heat liberation remains constant then the temperature of the

greater amount of gas flowing through the meter cannot be raised as many degrees as the temperature of the smaller amount of gas, and the temperature difference between the entrance and exit of the meter will, therefore, be smaller. On the other hand, if the amount of gas decreases, the tem-

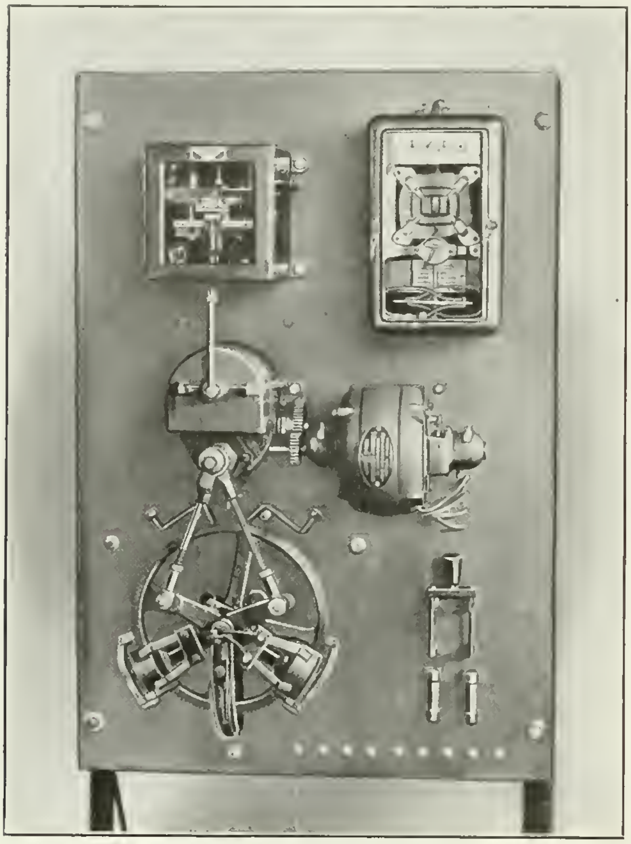


Fig. 5 Switchboard and Recording Instruments of the Meter

perature difference will increase. Hence, the temperature difference is an index of the rate of flow of gas so long as the rate of heat liberation is kept constant.

This principle was applied to the Thomas meter during its development, but while excellent for laboratory purposes, it was found to be impractical in the case of meters for commercial service, because a constant voltage can almost never be obtained. Hence the application of the principle outlined above is modified for the commercial meter. Instead of measuring a varying temperature difference, the temperature difference is kept constant, and the number of watts required to maintain this constant difference in temperature between inlet and outlet will vary directly as the quantity of the flow of gas or air. Hence, the amount of gas passing through the meter can be directly recorded by a watt-meter.

The difference in temperature between the inlet and outlet of the meter is 2 degrees F. This difference is maintained by the action of the nickel-wire screen resistance thermometers *E* in Fig. 1, by means of which the resistance in the electrical heater is controlled in a manner which will be described in detail later. As soon as the difference in resistance in the thermometers becomes greater or less than that corresponding to the desired 2 degrees temperature difference, the controller causes a small rheostat to operate, thereby restoring the balance between the thermometer resistances, this balance being attained only when the temperature difference given becomes 2 degrees. Thus, if the rate of flow of gas is increased, the temperature difference tends to decrease, and at once additional energy is introduced sufficient to heat the increased weight of gas, and *vice versa*.

It is apparent from what has been said that the accuracy of these meters is not affected by changes in the pressures of gas or air flowing through the pipe line, because the unit of measurement is that of weight rather than of volume. Neither does a variation of temperature of the incoming gas affect the accuracy of the meter, because it is a difference of temperature rather than a fixed temperature upon which the action of the meter depends. The possibility of measuring gas or air accurately irrespective of its pressure or temperature is the most interesting fact in connection with this device; and the meter can be used for gas or air at either high or low pressure and at either high or low temperature; and fluctuations of either will not affect the final reading of the instrument, which can be arranged to record the flow of air or gas at any desired standard of pressure and temperature. The determining factor, of course, is simply the specific heat of the gas, the flow of which is measured.

The apparatus is applicable to the measurement of gas or air, whether dry, saturated, or superheated. If water is carried along mechanically in the form of a fog or mist, this can readily be transformed into vapor by the introduction of heat from a small steam radiator, consisting of a coil of pipe, placed at the entrance to the meter. When water vapor is contained in the air a correction is required, owing to the fact that the specific heat of water vapor is twice that of air. This correction ordinarily, however, amounts to only about one-half of one per cent.

The specific heat of any given kind of gas appears to be nearly constant even when there are minor changes in the composition of the gas, because the constituents which vary from time to time are not those which have the greatest influence in affecting the specific heat.

Switchboard and Apparatus Used for Recording the Flow of Gases

The switchboard on which the instruments are mounted which make possible the measuring of the flow of gases by the method outlined, is shown in Fig. 5. A diagrammatical view of the heater, switchboard, recording instruments and connections is shown in Fig. 6. In the latter illustration the controller *G* is a galvanometer and Wheatstone bridge com-

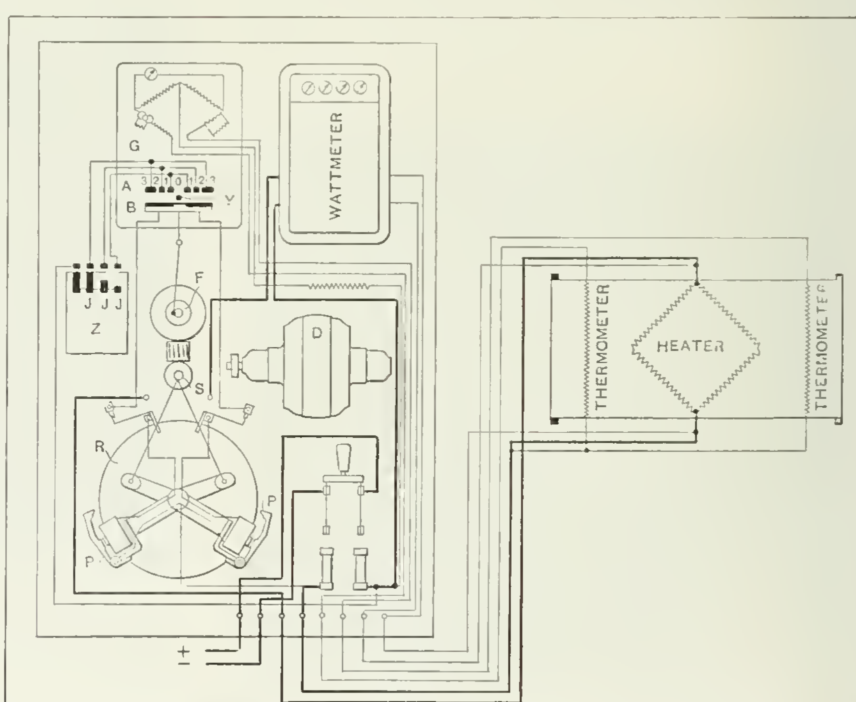


Fig. 6. Diagrammatical View of Heater, Switchboard, Recording Instruments and Connections

bined. The movable needle Y swings to the left or right of the zero position according as the difference in resistance of the thermometers is greater or less than that corresponding to the required temperature difference of 2 degrees between the inlet and outlet of the meter. A motor *D* of 1/8 horsepower

operates continuously, and by means of a crank F causes the bar B to move up and down, clamping the needle Y at the top of the stroke against the contacts A. The motor also drives at a slow but constant speed the contact drum Z and two eccentrics S which give to the rheostat pawls P a reciprocating vertical motion through small arcs along the edge of a ratchet wheel R on the rheostat shaft. On the drum Z are placed three segments J of different lengths corresponding to one, two or three teeth on the wheel R. If needle Y is clamped in position 1 at the right of the zero position, the pawl is engaged at such a time in its stroke as to increase the heater energy by one step of the rheostat. If Y is clamped in position 1 to the left of the zero position, the heater energy is decreased by one step. If it is clamped in position 2 to the right or left of the zero position, the heater energy is increased or decreased by two steps, etc. In any case Y is returned to the zero position, and the change in the heater energy is continued until it has come back to this point. When Y is at zero, no change takes place in the rheostat.

The watt meter in the upper right-hand corner of the switchboard shows the energy required to maintain the constant difference of temperature, and the dials are so graduated as to register the total cubic feet of gas or air passing through the meter at a standard pressure and temperature. The switchboard and recording mechanism can be placed in any convenient position as, for instance, in the office, thus permitting a constant observation of the flow through the pipe line.

Theoretical Basis of the Meter

As 3412 British thermal units are equivalent to one kilowatt-hour, it is a comparatively easy matter to give an equation showing the relation between the amount of gas passing through the meter and the electrical energy required to heat it 2 degrees F.

Let G = cubic feet of gas per hour,
S = specific heat per cubic foot,
T = temperature difference in degrees F.,
E = energy in kilowatts.

Then $G \times S \times T$ = the number of thermal units required. Or expressed in a different way

$$GST = 3412\,E$$

from which

$$\frac{GT}{E} = \frac{3412}{S} = K,$$

K being a constant dependent upon the specific heat of the gas. Since in this meter the temperature difference T is kept constant, it follows that $\frac{K}{T}$ is constant. Let $\frac{K}{T} = C$.

Then

$$G = \frac{KE}{T} = CE$$

Thus it is evident that the relation between the number of cubic feet of gas per hour and the energy in kilowatts is directly dependent upon the specific heat of the gas, which can be determined from the customary chemical analysis and the specific heat of the constituents of the gas; and a final record can be obtained directly in cubic feet, as stated.

NEW PLANT OF THE KEMPSMITH MFG. CO.

The Kempsmith Mfg. Co., Milwaukee, Wis., manufactures milling machines exclusively, and consequently a specialization of system and equipment has been employed throughout the entire plant, which would not be used in a general manufacturing concern. Problems peculiar to the needs of milling machine manufacturers had also to be solved.

General Layout of the Buildings

The buildings consist of the main factory, the power plant, pattern shop and office, as shown in Figs. 1 and 2. The factory proper is of the modern structural steel saw-tooth roof construction, with concrete floor and roof. It is a single room, 300 feet long by 250 feet wide. The pattern shop is 90 by 50 feet, and the power plant 100 by 50 feet. These buildings are of the modern girder steel type construction, and have concrete floors and roofs. All the factory buildings are absolutely fireproof. The office, as shown in Fig. 1, is in a separate building, and is of modern design and fully equipped.

The general layout was planned for convenience, a minimum amount of moving of the parts being necessary in the process of manufacture. The arrangement in the factory is such that these parts in their travel from one machine to another, make an automatic circuit of the shop from the machining department to the assembling, testing and shipping departments. The factory is under a double system of supervision. One superintendent looks after the manufacturing of the small parts, while the other looks after the large castings, assembling, testing and shipping departments. The machines are arranged in groups, all machines of one type being in a single group, driven by one motor. The motors are hung from the steel-roof trusses on frames made from I-beams which are fastened with U-bolts. This allows the shifting of the motors when necessary, and at the same time permits the mounting of the motors without cutting the steel work. The lineshafting is in no case very long, and because of the fact that in specialized manufacturing of this kind, machines can be in most cases in operation 75 per cent of the time, the group drive system is more economical than the individual motor drive. Only where machines are in intermittent and irregular service is the individual motor employed.

A rather unique feature in connection with the lineshafting, is the brackets that are employed to lower the shafting about three feet below the main beams. Bolting the bearing bracket on the horizontal members of the roof trusses would bring the shafting so high that the belts would be too long. Steel brackets built up of channel-and-angle sections are used to support the bearings, as shown in Fig. 7. Hyatt roller bearings are used throughout.

Milling machine castings as a rule are not very large, and it was proved that the single-trolley system with an electric hoist would handle the machines equally as well as the large traveling crane, which would be much more expensive both in first cost and maintenance. By referring to the illustration Fig. 2, it will be seen that the trolley systems are so planned that the work can be moved from one part of the factory to the other in a few minutes. This

Fig. 1. General View of the Kempsmith Mfg. Co.'s New Plant

feature is proving to be very successful. Electric hoists with a controlling device will elevate the largest machine with all its equipment fully boxed for export, and move it at a rate of five feet per second. A switching device is used to transfer the trolley with its load from one beam to another. The lathes, grinding, milling, and automatic machines, etc., are not used to machine the large castings, so do not castings are unloaded from cars directly into the storeroom, while the complete machines are removed to the finishing and polishing rooms, and from these to the shipping department. The finishing and polishing rooms are completely enclosed to keep the dust out of the remainder of the factory.

The tool-room, which is shown in Fig. 3, is centrally lo-

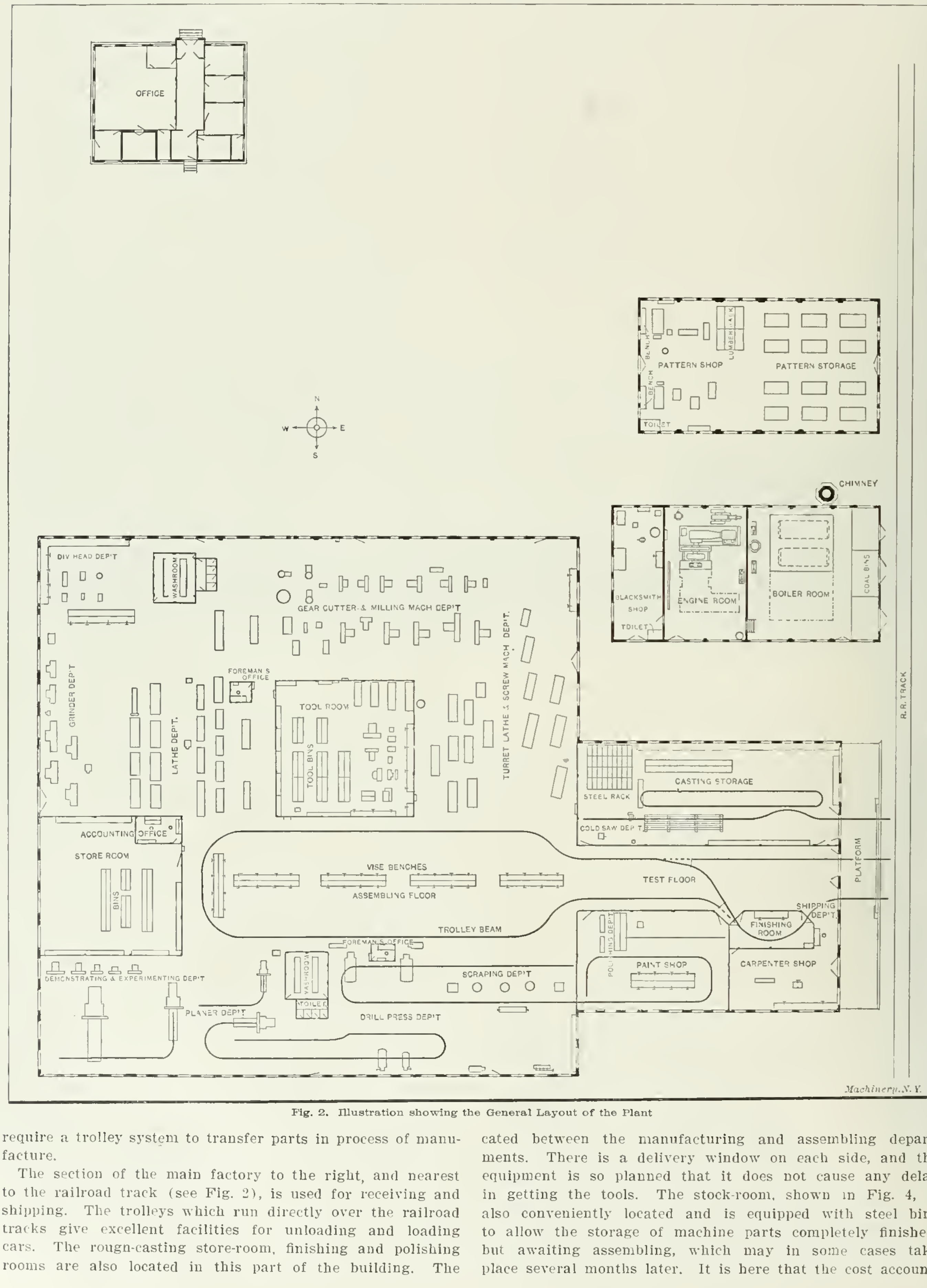


Fig. 2. Illustration showing the General Layout of the Plant

require a trolley system to transfer parts in process of manufacture.

The section of the main factory to the right, and nearest to the railroad track (see Fig. 2), is used for receiving and shipping. The trolleys which run directly over the railroad tracks give excellent facilities for unloading and loading cars. The rough-casting store-room, finishing and polishing rooms are also located in this part of the building. The cated between the manufacturing and assembling departments. There is a delivery window on each side, and the equipment is so planned that it does not cause any delay in getting the tools. The stock-room, shown in Fig. 4, is also conveniently located and is equipped with steel bins to allow the storage of machine parts completely finished, but awaiting assembling, which may in some cases take place several months later. It is here that the cost account-

ant, time-keeper and stock-keeper have their office. A complete record is kept of each part and operation, no matter how small.

The assembling floor, a view of which is shown in Fig. 5, is located between the large and small manufacturing departments. A row of benches extending along the center allows the assembling of machines on both sides. The trolley system makes a complete circuit of these assembling benches, and is in constant service in shifting the machines that are being assembled.

The foreman's offices are completely enclosed with glass and are elevated above the floor about a foot, which gives the foreman a complete survey of his department at a glance, without moving from his desk. He is not disturbed by the noise of the machines and small unimportant matters. In the southwest corner of the building provision is made for a row of Kempsmith individual motor-driven milling machines. These machines are to be used for demonstrating and experimental purposes. The equipment of this department will include a complete set of electrical instruments and automatic recording devices.

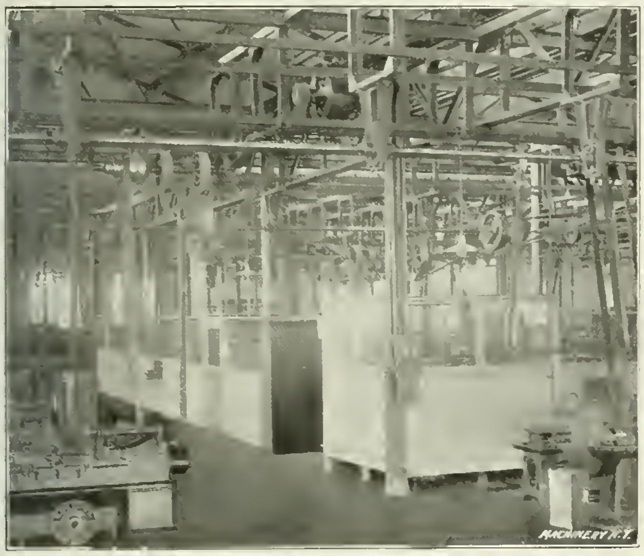


Fig. 3. View showing Foremen's Office in Foreground, and Tool-room in Background

Fig. 4. View showing Rough-casting Store-room to Left, Finishing Room to Right and Inspecting Floor in Center

Fig. 5. Assembling Floor and Benches, showing Overhead Trolleys

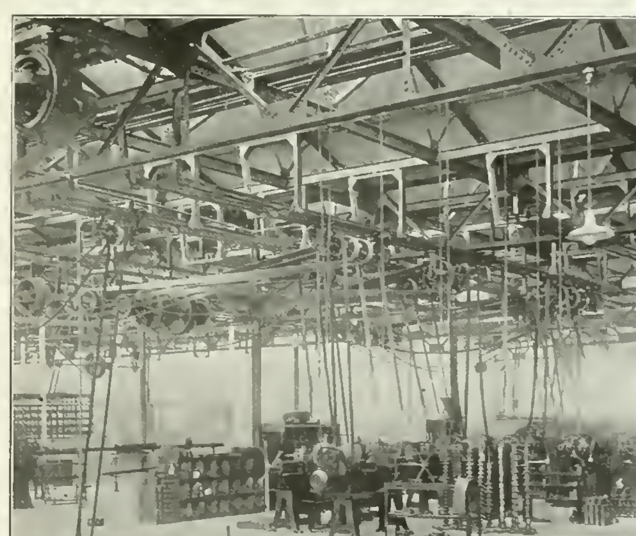


Fig. 6. Turret Lathe Department, showing Motor Group Drive

The office is a modern two-story building, finished in quartered oak. The first floor contains the general office, and private offices of the general manager, purchasing agent and sales manager. The second floor contains the drafting room and the offices of the engineering department. The basement is equipped for the convenience of the employes, and has a dining room, kitchen, laboratory and a schoolroom. In the school-room the apprentices have a weekly class under the supervision of an instructor from the Wisconsin University, who gives them personal attention. This is very helpful to the young men, and it keeps them alive to both their own interests and that of the company. They receive their regular pay during the time spent in the class. A modern telephone system is installed which gives connection to all departments and buildings.

Equipment

The boiler equipment consists of two 100 horsepower horizontal return-tubular boilers, made by the Milwaukee Boiler Co. The usual water columns, feed and blow-off connections, gages, injectors and safety valves are provided. A steam flue cleaner is also attached. The boiler feed-water pump delivers from a 200-horsepower Cookson open feed-water heater to the boiler. The feed-water heater, boiler feed pump and the vacuum pump are located in a space back of the boilers, ample room being provided.

The Webster system of heating is installed, the exhaust line from the engine being provided with an automatic back pressure valve, but live steam may also be used if required, this being automatically arranged for, through the pressure reducing valve. Thirteen thousand one hundred feet of pipe coil and cast-iron radiation is used. Steam is delivered from the boilers at 125 pounds pressure through extra heavy wrought-iron piping to the engine room.

The electric generating equipment consists of one 14 by 30-inch, 200-horsepower, 120-R. P. M. Vilter rolling-mill type Corliss engine, direct connected to one 150-K. W. 250-volt, compound wound, continuous current Crocker Wheeler generator. An automatic oiling system is provided. The engine is operated non-condensing, as exhaust steam is used for heating.

The switchboard consists of six panels of two-inch dull black

finished slate, mounted on pipe frame work of latest design, and is very handsome in appearance with its dull black instruments and polished copper switches. It comprises one generator panel, one spare generator panel, one balancer panel, one four circuit power feeder panel, two four circuit lighting feeder panels and one swinging voltmeter bracket.

All wiring between the generator and switchboard, and from the switchboard to the machine shop, pattern shop and office, is under ground, and is enclosed in a conduit system constructed of bituminized fiber, laid in concrete. All cables in the conduits are insulated with 30 per cent para-rubber compound, are lead sheathed, and consist of two or three conductors as required.

The motors are of the Crocker Wheeler and Allis-Chalmers makes, and are all shunt wound, with the exception of those operating the planers, which are heavily compounded. Liberal belt centers are provided allowing good belt contact and consequent cool operation of motor bearings. Allen-Bradley Co.'s motor starters are used throughout, and are mounted for each motor on a slate panel, which also contains an I. T. E. double-arm circuit breaker.

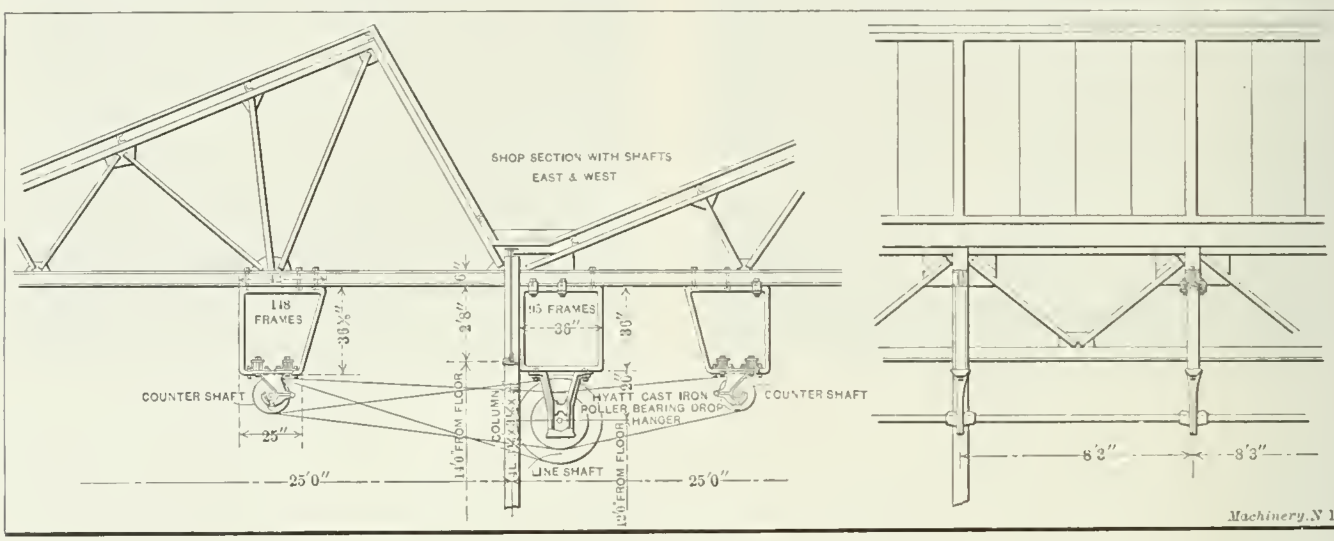


Fig. 7. Showing Location of Shaft Hangers and Roof Structure

The illumination of the machine shop, pattern shop and power house, was carefully planned and every consideration given to modern illumination engineering principles. Uniformity and economy were the prime objects desired, and they were accomplished by the installation of a unit system consisting of a shock absorber, conduit stem, Benjamin steel porcelain enameled reflector, and a 150-watt, frosted-bowl, tungsten Mazda lamp. These units were hung 25 feet apart, and 10 feet above the floor, the plane of illumination being 4 feet above the floor.

* * *

The melting of metals in vacuum is the ideal method, because oxidation is prevented and gases present in the metal are expelled from it. While it has long been known that the method of melting metals in a vacuum gave superior results in the final product, the method has been limited to very small quantities of metal due to the difficulty of carrying it out in practice. Metals which ordinarily are considered as brittle substances, and incapable of being rolled or drawn, can be produced, by melting them in vacuum, in a malleable or ductile condition. Examples of such metals are tungsten and tantalum, which in this way can be made in the form of wire, and are used to a great extent in the newly bought incandescent electric metallic filament lamps.

* * *

In the article on the Selden patent decision, in the February number, it was stated that the Association of Licensed Automobile Manufacturers has announced that the case would be taken to the United States Supreme Court for final decision. It appears that this was erroneous, as later reports state that it has been decided not to take this step.

A HOBBY—THE HUMAN SAFETY VALVE

By S. R.

The writer is employed in a large factory in a small village. Each year, in answer to advertisements for help, men from all over the country come to this factory to work. A few of these men will stay permanently, but many leave before long. The reason why they leave seems to the writer to be the lack of a "hobby." Every man, especially the man who works mainly with his hands, needs a hobby, and if the writer were consulted in the preparation of a dictionary, he would insist that the word "hobby" be defined as "the human safety valve."

It is generally conceded that from all points of view the most desirable place for a wage earner is a first-class shop in a small town. In the first place, this shop being located away from the source of labor supply, is likely to have a management which is much more inclined to a liberal policy, and which makes it a point to keep the men in times of business depression, rather than to go to the trouble of training a new set of men when work again becomes plentiful. In such a shop there is not as a rule, the hustle and rush that is found in the factories of a great city. In addition, rent is cheaper, food products are cheaper, and there are less chances to spend money. In short, living is cheaper. But, alas, the small town lacks opportunities for recreation, amusement and excitement, and this is where the trouble lies. That is why so many leave to return to their moving picture shows and fifty cent table d'hote dinners. This they call relaxation; they cannot stand the simple life.

The trouble is that they have nothing with which to occupy their minds. Time hangs heavy on their hands; in a word, they do not have a hobby. Why is it, however, that a man is willing to give years of time to learn a trade, yet is unwilling to avail himself of the opportunities to gather information that most surely will some time be of very great value to him? The old saying that "A little knowledge is a dangerous thing" is very much out of date; the fact is "Every little helps."

One need not have a college degree nor even anything more than the bare rudiments of most studies, before he will find that he is unconsciously making use of this knowledge in his daily work, and will want to learn more and more. It will grow on him and finally become a hobby. For a good many years the writer has ridden his hobby in the long winter evenings very much to his advantage. One year it was arithmetic, another algebra and geometry, and again machine design, always advancing by correlated studies. When study becomes irksome, the slide rule, shorthand, and the making of accurate free-hand sketches of machine parts is a good thing for a few evenings, just to "change the air." It matters little how one or where one acquires knowledge, but there is no way that will make it stick like "doping" it out for yourself, and then applying it.

ROUGH TURNING VS. ROUGH GRINDING OF CRANKSHAFT PINS

By H. C. PIERLE*

The manufacture of the crankshaft in the early days of automobile development was, without doubt, the hardest proposition automobile builders had to face. The machining of this one part was the cause of more lost sleep than any other part of the motor, not only to the automobile manufacturers, but also to the builders of machine tools who were asked to furnish equipment for this class of work. The line bearing of the crank never presented any serious difficulty; the stumbling block was the machining of the crankpins.

Five or six years ago, machining a crankshaft in the old way took a good deal of time. By means of special machine tools, such as crankshaft lathes and grinders, equipped with special fixtures, this time has been cut down considerably, and all the difficulties of machining have been overcome, so that the problem now is not how fast, but how much faster we can do them.

This question was naturally put up to the machine tool manufacturer, and brought up quite a discussion among the lathe and grinder builders. We will concede the fact that for finishing the pins there is no tool that can compare to the grinder, but Mr. Norton, in an article entitled "The Field for Grinding," which appeared in the January, 1910, number of MACHINERY, states: "There are cases where the least expensive way is to grind direct without turning, notably the greater part of crankshafts of automobiles and small gas engines." The R. K. LeBlond Machine Tool Co., as manufacturers of crankshaft lathes, naturally believe in rough turning, and this article of Mr. Norton's made us "sit up and take notice."

For this reason we wrote to several of the motor car and crankshaft manufacturers who have LeBlond crankshaft lathes in use, asking them for the average time for the machining operations on their crankshafts, and especially on the pins. We received replies from several of them, giving us the time and labor cost for the different operations—not the best time, but the average time as made by their own workmen in the shop. The results show that the lathe for roughing operations on crankshafts is still away ahead of the grinder.

We have no time on a crankshaft of exactly the same dimensions as shown by Mr. Norton, but we have on cranks that are somewhat similar. Our method of supporting the crankpin with a roller rest while doing the heavy filleting and cheeking work makes it just as easy to turn a crank with three center bearings, as with one, so there should not be any more time consumed in roughing the one than the other. The pins on the cranks taken as examples are all larger in diameter and greater in length than the crank shown in Mr. Norton's article, ranging from 1 5/8 inch to 1 7/8 inch in diameter, and about 2 inches long.

The following is a table giving time, cost of labor and actual cost for roughing four pins by turning, as compared with grinding only:

	A	B	Grinding
Rough turning four pins....	12½ min.	13 min.	20 min.
Cost of labor per hour......	$0.30	$0.30	$0.35
Labor cost for rough turning.	$0.0625	$0.65	$0.1165

The time and cost designated as "A" is the average given by two motor car manufacturers who make only one kind of crank. The time given by B is the average time of two crankshaft manufacturers who make many different styles of crankshafts for the trade. This probably accounts for the slight variation in the time.

Mr. Norton in his article states as follows: "The greatest economy is usually obtained by the combination of grinding with very rough turning." To bear him out in this assertion, the following table gives the time of finish grinding a crank after rough turning, as compared with his time of finish grinding after rough grinding.

	Turned Rough	Ground Rough
Finish grinding four pins.................	15 min.	20 min.
Cost of labor per hour......................	$0.30	$0.35
Labor cost for finish grinding.............	$0.0875	$0.1165

* Address: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

This makes the average cost of finishing four pins by the rough turned method 15¼ cents, and the cost of finishing four pins by the rough grinding method 23 3-10 cents.

There are several other matters outside of the labor cost which have to be taken into consideration, such as cost of wheels, handling, cost of machines, labor, etc. In roughing out pins on a grinder, the wheel wears rapidly especially on the corners, making it necessary to true it up at short intervals. It is very essential that the fillets be kept near the radius specified, and as the wheels wear more rapidly at the corners, it is necessary to take off enough at the periphery of the wheel to get the proper radius at the corners. This condition is more in evidence when the pins are oval or egg-shaped in the drop-forged cranks, due to the dies being worn and the greater depth that it is necessary for the wheel to go down to get to the proper diameter. Nine-tenths of the drop-forged cranks have heavy fins left by the trimming press, which have to be removed.

The LeBlond lathe is equipped with a cheeking tool used for this purpose, and this operation is included in the time of rough turning. One can readily see that rapid wear and cost of wheels forms an important item in crankshaft manufacture. High-speed steel at $1.00 per pound is far cheaper than grinding wheels.

There is always more or less lathe work to do on every crankshaft, such as chasing of threads, turning of flanges (with which about 50 per cent of crankshafts are equipped), cutting off and recentering, etc. All this with the roughing, can be done in one department and when finished sent to the grinding department with only one handling. After rough grinding, the crank is sent to the lathe department for the above operations, and then back to the grinding department, making it necessary to handle the product twice. With thousands of cranks, this is quite an item of expense.

Next, there is the difference in the first cost of the two machines, and the resultant interest charges and depreciation. Considering that three lathes will do the same amount of roughing that four grinders will do, as the results in the foregoing tables show, it is a great deal cheaper to rough turn than rough grind; the help for this work is also cheaper. As one superintendent writes, "Another item in favor of the lathe work is that we have no trouble whatever in getting crankshaft men for the lathe at 30 cents per hour, while on the grinders we must pay 35 to 37½ cents per hour to get good men, and they are hard to get at that."

* * *

VALUE OF EXPORTS OF TYPEWRITERS

It is interesting to note that during the past year typewriters were exported from the United States to the value of nine million dollars, in round figures. During the same period the total export trade in metal working machinery amounted to only about seven and a half million dollars, while the total export trade in structural iron and steel amounted to about seven million, the total trade in electrical machinery to about seven and a half million, and that in steel rails to about ten million dollars. In other words, the total volume of trade of typewriters—devices insignificant in size as compared with machines—exceeded considerably the trade in either metal working or electrical machinery, and was very close to the total value of the trade in steel rails. Another interesting comparison is that made with the export of sewing machines, which were exported during the past year to the value of about eight million dollars.

* * *

Three thousand patents have been issued up to the present on airships and devices for them, and about ninety patents are issued every month on devices for rapid rising, safe alighting and stability when in motion. It is estimated that 10 per cent of the successful flights depend on the machine, 15 per cent on the motor and 75 per cent on the man. The man of indecision, poor judgment and weak nerves, or slow judgment, is as much out of place on an airship as a defective motor. All the patents granted so far on devices for increasing the stability of an aeroplane have not overcome the necessity of an aviator's having good judgment and experience.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

AN UNUSUAL CURLING DIE

The punch and die illustrated and described in this article completely forms the curl in the forked lever shown in Fig. 1 and also indicated in position in the die at *P* in Fig. 2. This piece is known as the "ribbon-reverse weighted lever" of the Remington typewriter. It is the usual practice in most cases to form the curl of such a piece in two or three operations. The first operation usually starts the bend, and the curl is

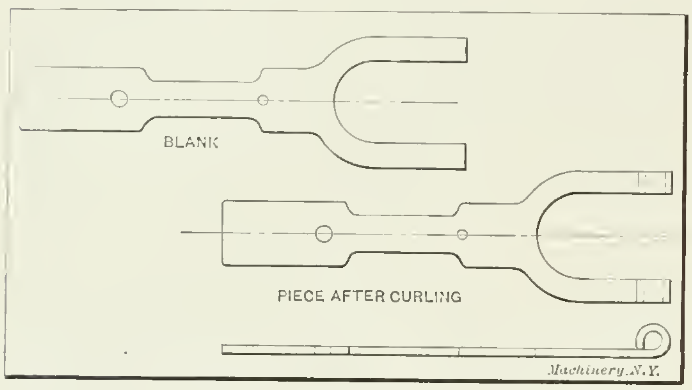


Fig. 1. Piece to be bent and Finished Product, shown Full Size

finished in the second or third operation by being formed around an arbor. However, in the present case the eye is completely formed in one stroke of the press in a vertical-acting punch and die.

In Fig. 2, *Y* is the base of the die made of cast iron; to this base are attached the other working parts, the principal one being the clamp or jaw *G*. This jaw is provided with a nest for holding the piece to be operated upon. It rocks on

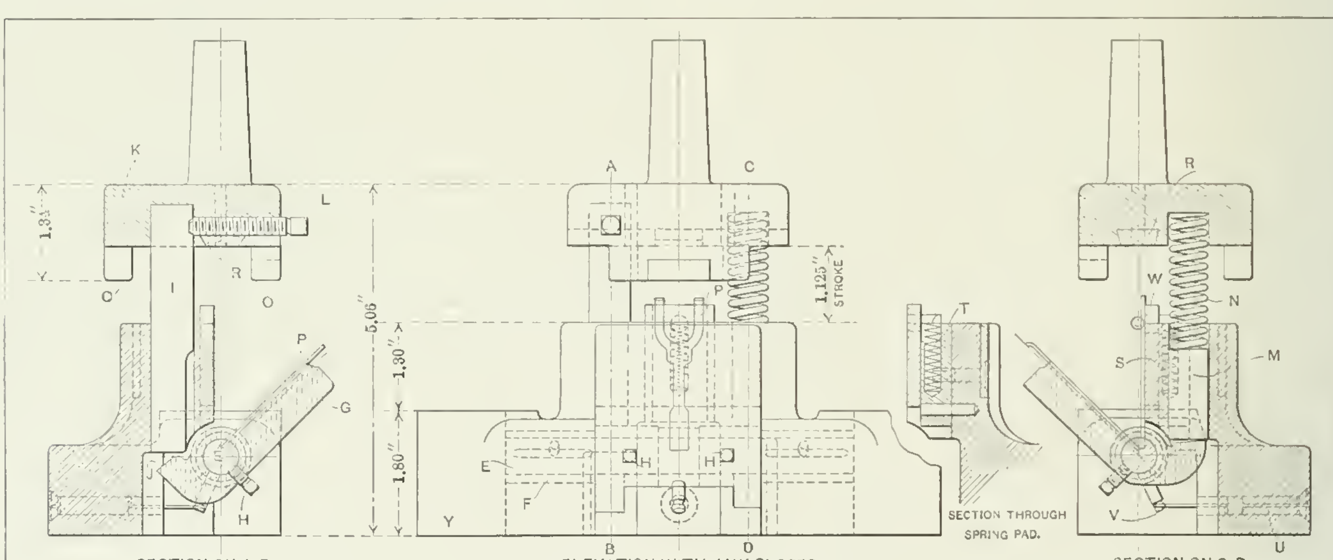


Fig. 2. Curling Die for Typewriter Part shown in Fig. 1

the shaft *E*, the ends of which turn in hardened and ground bushings *F*, which are provided to protect the base from excessive wear. The bushings are provided with oil holes as indicated. The jaw is not fitted tightly to the shaft, that is, the shaft is not a drive fit in the jaw, but is fastened to it by two small set-screws *H*. This feature allows the jaw to be adjusted at exactly the correct angle, and also permits of easy and quick dismounting in case of repairs.

When the press starts its downward movement, the action-pin *I* bears against the lug *J* on one end of the jaw *G*, causing the latter to swing up into a vertical position. The action-pin is secured in the tool-steel plunger *K* by the set-screw *L*. At the opposite side of the plunger, and bearing against an opposite lug of the jaw *G* is a short plunger *M* actuated by spring *N*. This plunger is provided for equalizing the pressure on *G* and for preventing excessive torsional or twisting strain.

A further downward movement of the ram causes the ears *O* on the plunger to engage and bear against the front or outside of the jaw and the rear of the base, thus holding the jaw securely in the upright position and preventing it from springing back. A hardened and ground bearing plate of tool steel is provided in the rear of the base, where it engages lug *O*, to prevent excessive wear. The grooved former *R* next comes in contact with the top of the work and starts the curl. It continues its downward movement until the end of the stroke, when the eye is finished. The supporting pad *W* is depressed in the meantime, sliding in the block *S*. On the up stroke of the press the pad is returned to its normal position by the spring shown at *T*. The jaw is released by the raising of the action-pin *I* and falls back by gravity into the position shown to the left in Fig. 2. It is aided in falling back by the spring *U*, secured to the back of the base and to the stud *V* at the bottom of the jaw. In the view to the right in Fig. 2 the finished curl is indicated by dotted lines.

On account of the extreme ease of loading and the rapidity of action of this punch and die, as well as on account of its unique construction and the economical production made possible by its use, it will no doubt prove of interest to many mechanics.

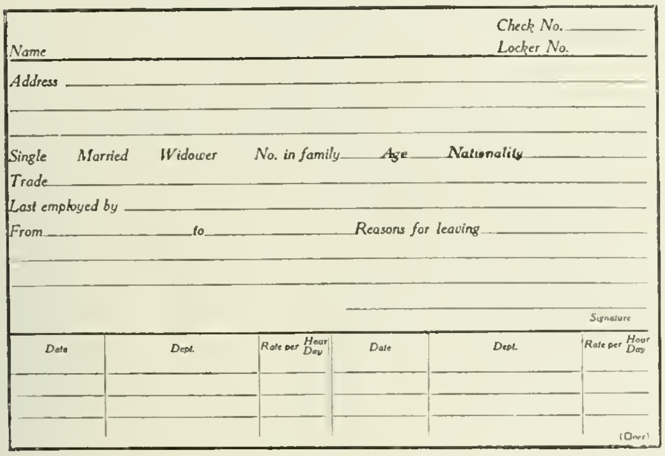
DESIGNER

EMPLOYMENT CARDS USED IN WORCESTER POLYTECHNIC INSTITUTE

The accompanying illustrations Figs. 1 and 2, show the card used at the Washburn Shops of the Worcester Polytechnic Institute for keeping a record of the employes. Although our shops are not large, employing only about fifty mechanics, the same problems of employment are presented as in other industries. While most superintendents have arranged some method of record keeping, I do not remember having seen any information regarding this in the pages of MACHINERY. It will be noticed that not only does this card enable the office to have available definite information regarding each employe, which is accessible for instant reference, but that the card is a receipted bill in full for all charges, when for any reason he severs his connection with the Shops. Not only does this record assist in direct employment problems, but it also renders assistance when answering other firms relative to former employes who may have applied to them for employment.

The front of the card, Fig. 1, indicates data which is typewritten upon the provided lines, when the applicant enters

the employment of the Shops. During his employment this face of the card is to the front in the index file. The reverse face, Fig. 2, is completed when for any cause whatever he ceases to be employed by the Shops, and bears the employe's


Check No.
Name Locker No.
Address
Single Married Widower No. in family Age Nationality
Trade
Last employed by
From to Reasons for leaving
Signature

Date	Dept.	Rate per Hour Day	Date	Dept.	Rate per Hour Day

(Over)

Fig. 1. Front Face of the Card, used when Applicant enters the Employment of the Washburn Shops

signature as well as that of the department foreman. The card is then filed with this face out, thus showing that the term of employment is finished. The data shown on the card is that common to any employment department, and gives the

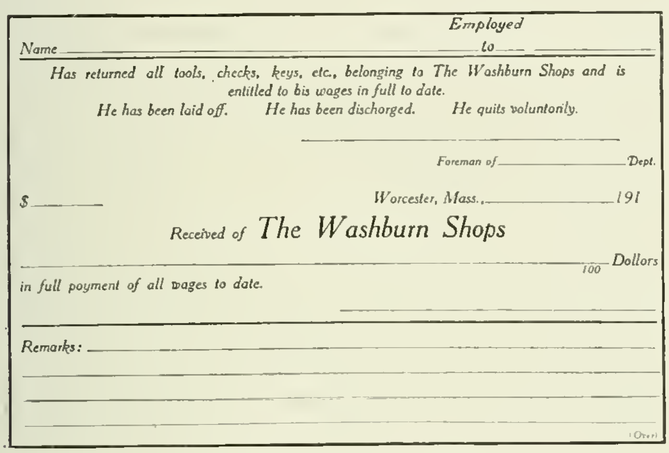

Employed
Name to
Has returned all tools, checks, keys, etc., belonging to The Washburn Shops and is entitled to his wages in full to date.
He has been laid off. He has been discharged. He quits voluntarily.
Foreman of Dept.
$ Worcester, Mass., 191
Received of The Washburn Shops
100 Dollars
in full payment of all wages to date.
Remarks:
(Over)

Fig. 2. Reverse Face of the Card, used when Employe severs his Connection with the Shops

superintendent a complete record of his employes, easily accessible. This is in direct line with the modern methods of shop management and modern business methods.

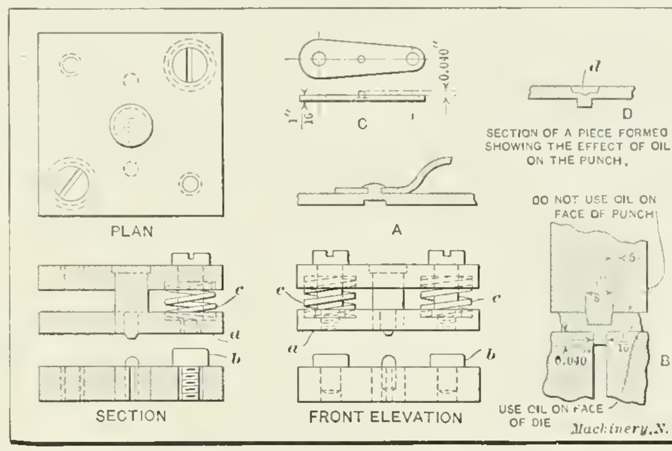
Worcester Polytechnic Institute. H. P. Fairfield

PUNCH AND DIE FOR FORMING RIVETS

A cheap and efficient way of riveting pieces together is sometimes accomplished by making the rivets solid with one piece—that is, forming the rivet from the piece itself, and punching a hole in the other part which is to be riveted to the first part. The manner in which the pieces are riveted together is shown at *A*, in the accompanying illustration.

The punch and die used for forming the projection or rivet for attaching a spring to a piece is shown by the three views in the accompanying illustration. It consists of a punch and die, attached to a sub-press die by means of cap-screws which are located in the punch-holder and die-holder respectively. The stripper-plate *a* does not come in contact with the stock, except when stripping it from the punch. When the punch is acting on the blank, the stripper-plate rests on the studs *b*. The reason for having the stripper-plate work in this manner, instead of resting on the stock, is to strip the stock from the punch, after it has been lifted out of the die by the punch. This prevents the work from clinging to the die, which would be the case if the stripper-plate rested directly on the stock when the lug was being formed. The height of these studs *b* should be greater than the thickness of the stock plus the length of the projecting lug, and they should be located directly under the tension springs *c*, so as to obviate any tilting tendency.

An enlarged view of a section of the punch and die with the stock in position is shown at *B*, where the dimensions used for forming the projecting lug on the piece shown at *C* are given. A good grade of lard oil should be used on the face of the die, but no oil should be used on the punch. If oil is used on the punch it will form a small dent *d* in the piece, as shown at *D*. The punch should be given about a five-degree taper on each side so as to facilitate stripping. A five-degree taper is about right for cold-rolled steel. The hole in the



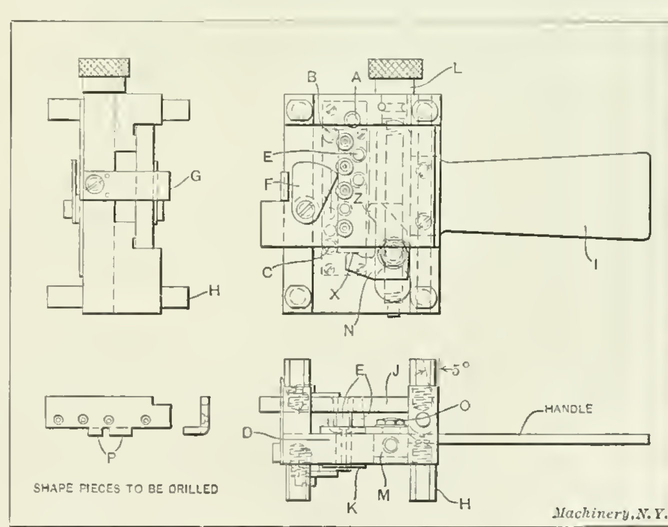
Punch and Die used for Forming Rivets

die is made perfectly straight and smooth. This method of forming a rivet without having the stripper-plate rest on the stock, bends the stock a slight amount, but not enough to cause any great inconvenience. D. A. C.

ADJUSTABLE DRILLING AND COUNTERBORING JIG

The jig shown in the accompanying illustration was designed in a shop where the writer was until recently employed, for drilling and counterboring different widths of pieces as shown to the left in the illustration. As there are many points in this jig which may be of interest to readers of Machinery, the writer will endeavor to describe them in the following:

There were some sixty different widths of pieces and the jig was designed to be adjustable for all of them. The drilling



Adjustable Drilling and Counterboring Jig having Some Novel Features

is done from the bottom of the jig and the counterboring from the top. The end of all the pieces is located against the pin *A*, and the side of the piece with the ears *P* is located against the pins *B* and *C*. As the position of the lugs varies in pieces of different lengths, several holes are provided for the pin *C*, the pin being placed in the hole suitable for the particular piece being operated on. The work is laid on the bottom of the jig and when the leaf *J* is brought down, the work is

clamped by the pin E. A swinging cover F is provided on both the top and the bottom of the jig to cover over the bushing not used in drilling the pieces of shorter lengths. The spring latch G is clearly shown and needs no further explanation. This jig is provided with separate and detachable feet H and also with handle I for convenience in handling.

A point to be remembered in the design of handles for jigs is that they should always be placed so that they come at least one inch above the drill press table, even if it is necessary to make the feet exceptionally long, as otherwise there is not sufficient room under the handle for convenience in manipulation, and there is also danger of the jig being tilted if the hand cannot freely pass under it.

An important point regarding the leaf J which is often overlooked is the angle of five degrees at the back. It is seldom necessary for the leaf of the jig to lie back flat or in a horizontal position when open, but it should nevertheless be inclined slightly from the perpendicular, so that it will stand open without being held. A casehardened piece K is provided around the bushing to prevent the drill from marring the body when it "misses fire," that is, when it "misses" the hole. When worn, this part may be easily replaced.

We now come to the most interesting part of the jig—the adjustable clamp. This consists of several parts, L, M, N, and O. The screw L on which the trunnion plug M is held rests in the body of the jig, passing through a hole in each side. A groove is cut in one end of this adjusting screw L, and a 3/32-inch pin passes through the jig close to the side of it, preventing the screw from pulling out and allowing the trunnion plug M to be adjusted longitudinally across the jig. The trunnion block M carries the clamp N which is secured to it by a nut and washer O, and when the screw L is turned, it carries the clamp N along the surface of the jig. When the point X of the clamp N starts to bear against the end of the work, the clamp revolves on the trunnion and the point Z is brought against the edge of the work. One-half turn of the screw L loosens the clamp sufficiently to allow the work to be removed. It will be plainly seen that the position of the clamp can be varied. This clamp will hold pieces of any length within the limits of the jig by simply adjusting the screw L. This is as good an example of an adjustable jig as the writer has seen for some time.

New Haven

METHOD OF LAYING OFF LINES FOR LETTERING

In making drawings where there are a large number of details which require the making of a material list, or a list of operations, it is a tedious job for the draftsman to lay off the lines for the lettering. To overcome this difficulty the following method was devised, which not only relieves the tedious operation of laying off the lines, but also results in a considerable saving of time. This device consists in the making of forms from stiff cardboard with lines ruled on them at a distance apart equal to the height of the lettering. The columns are also ruled off, and are printed in as shown in Figs. 1 and 2. Reading from the left of the material list, Fig. 1, the first column gives the number of pieces required; the second column gives the name, or the shop number of the part; and the third column gives the size of the material used in making the part. Reading from the left, the first column in Fig. 2, gives the number of pieces required; the second column gives the name, or the shop number of the part; the third column gives the order of operations; the fourth column gives the number of the jig or die used for performing the operation; and the fifth column gives the size of the stock or pattern number.

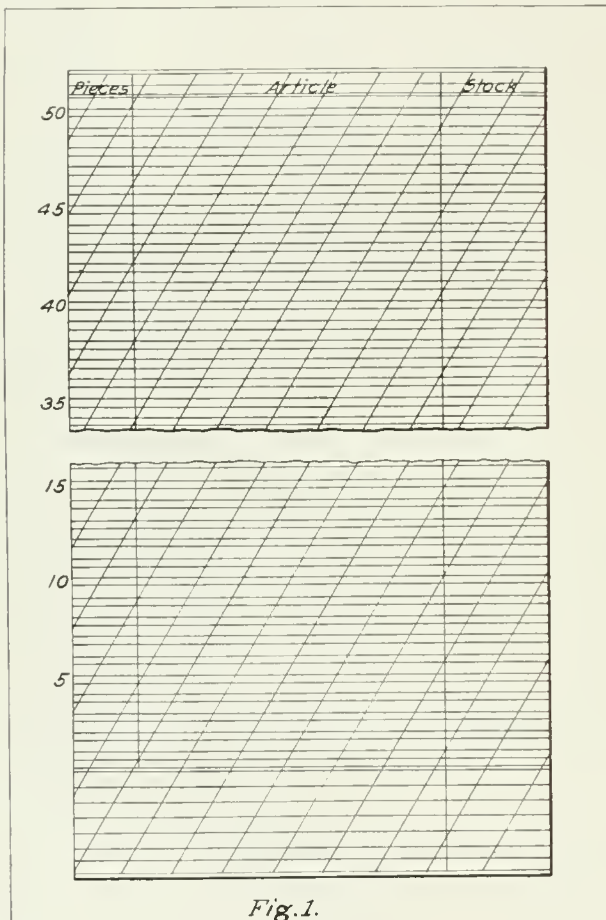


Fig. 1. Form used in Laying off Lettering for Material List

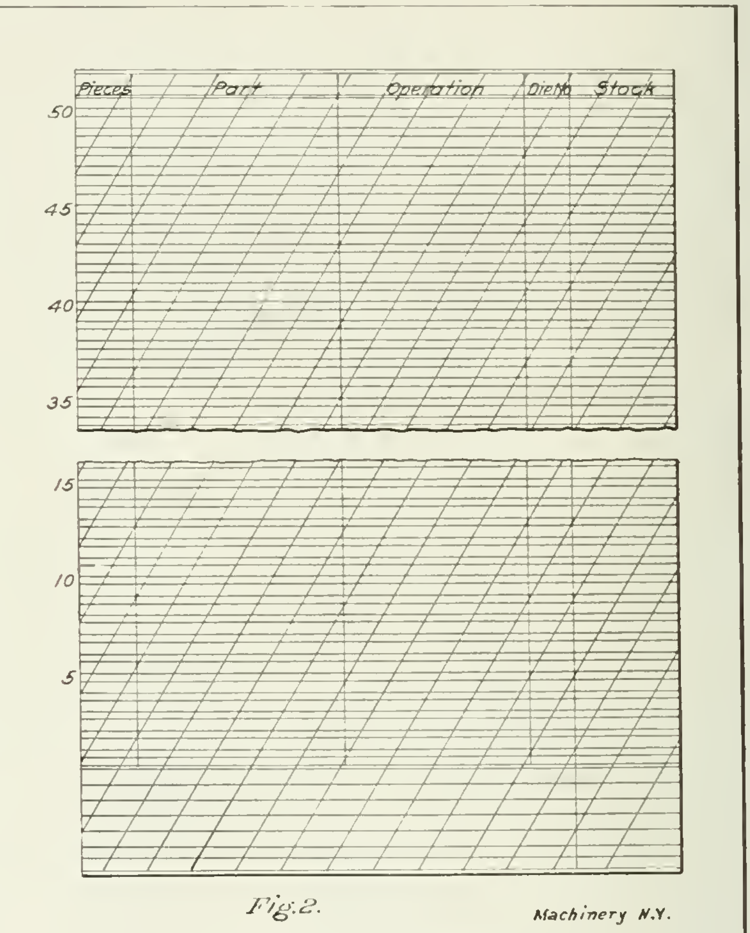


Fig. 2. Form used in Laying off Lettering for List giving Order of Operations

The oblique lines shown in Figs. 1 and 2 serve to keep the slant of the letters uniform. The space at the bottom of these forms is used for the name of the machine, the drawing number and other details. These cards are made out for 50 detail numbers, which is about the longest list that is really necessary. Every fifth line is numbered, beginning at the bottom, the reason for which will be explained later.

To use these forms, a space is left at the right-hand corner of the drawing, and when the tracing has been finished the card is slipped under it, and the list filled out, using the lines

on the form as guide lines for the lettering. If the number of items or lines of lettering required are counted before the lettering is done, it is an easy matter by referring to the numbers at the edge of the form, to start the list in the correct place, so that the last item will occupy the last line above the space reserved for the name and other information given in the title on the drawing. The list is then ruled off, drawing the lines a short distance below the lettering.

Fig. 3 shows a part of an operation sheet completed. Here the title, the name of the part and the number of the pieces

Pieces	Part	Operation	Die No.	Stock
2	Pedals	Part & pierce	385	3/16"x1"x22"
		1st Form	386	
		2nd "	387	
1	Front Leg	Part & pierce end holes	223	5/8"x1"x1/8" angle
		Pierce wide side	493	5'9" long
		" narrow side	285	
		Notch	224	
		Offset ends	419	
		Form	225	

THE BLANK M'F'G. CO.
AURORA ILL. № E319
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Machinery NY

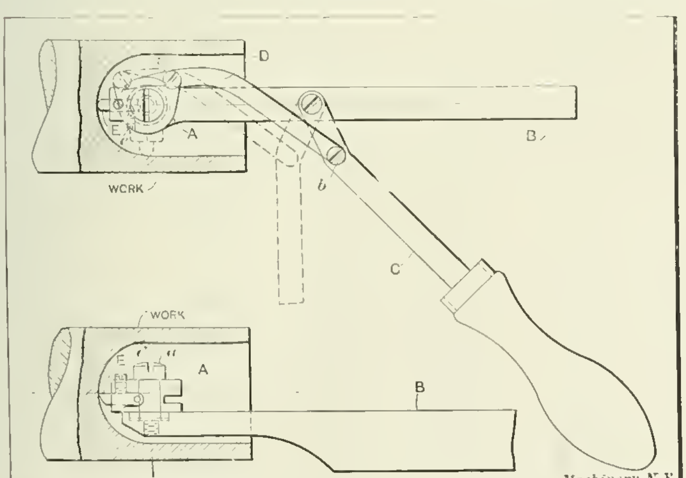
Fig. 3. Part of an Operation List Completed

are underlined, which makes them stand out more plainly. The various operations to be performed on each part are enclosed with a bracket to avoid any possible misunderstanding. When revisions are made, a note is added at the bottom of the card, as shown at the lower left-hand corner in Fig. 3. Another advantage of this method, is that the lists are easily kept of a standard form, and those who use the blueprints become familiar with them, which avoids confusion.

Aurora, Ill. E. J. G. Phillips

TURNING TOOL FOR BALL SOCKETS

The accompanying illustration shows a simple tool which can be used for turning ball sockets or other internal spherical work. This device consists mainly of the tool-holder *A*, which is held to the holder *B* by the fillister-head screw *a*. The turning-tool holder *A* is operated by the handle *C* through the connecting-link *D*, which is held to the tool holder and



Turning Tool for Ball Sockets or Other Spherical Work

handle by two fillister-head screws *b* and *c*. The turning tool *E* is held in the holder *A* by the headless screw *d*, and is adjusted outwardly by the cone-pointed screw *e*.

In operation, the shank *B* of this tool is held in the toolpost of the lathe, and is brought in line with the center as shown. Then the tool *E* is set to the desired radius and the lathe carriage advanced bringing the tool into the hole in the work to the desired depth. When in this position the handle *C* is turned to the left, thus forcing the tool-holder carrying the turning tool *E* to the right. The movement of the tool when turning a socket is clearly illustrated by the full and dotted lines. The dotted lines show the position of the lever at its extreme stroke, or in other words, when the radius is completed. Turning tools of various lengths are used for turning different radii.

Philadelphia, Pa. John L. Zanzinger

A BORING FIXTURE FOR THE LATHE

On a certain machine that we were building there were several different brackets in which the distance from the base to the center of the hole was the same in each case, but the brackets were not all of the same shape. About twenty-five of these machines were to be built, so a fixture was made as shown in Fig. 1 for boring the holes. A discarded lathe was brought up from the basement, the cross-slide removed and the fixture fastened to the slide of the carriage. The reason for using the lathe was that our boring machines were all busy on large work. To hold the fixture to the carriage a pin was driven through it and into the slide of the lathe, thus holding the fixture, so that it was approximately

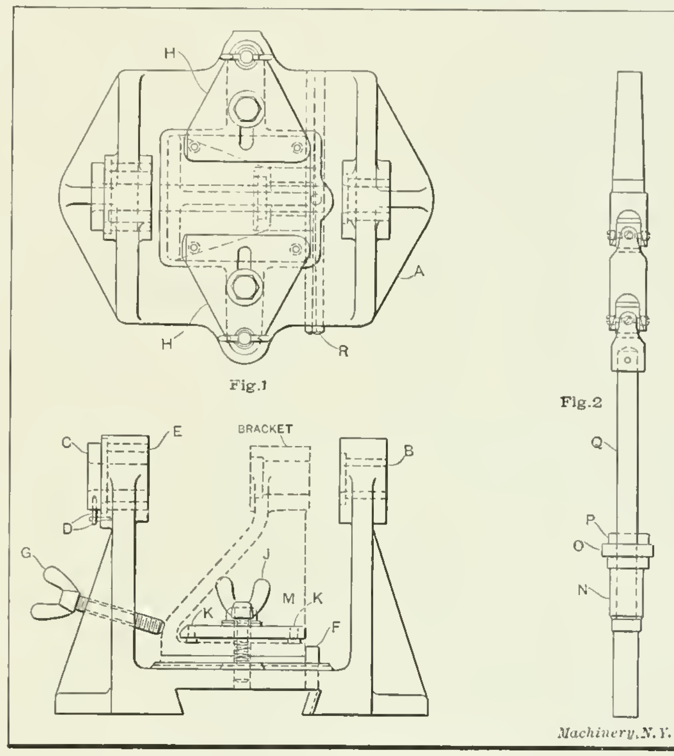


Fig. 1. Fixture used on the Lathe for Boring out Brackets. Fig. 2. Boring-bar used in Connection with the Fixture shown in Fig. 1

in line with the lathe centers. It was not entirely necessary that it should be exactly in line, as the universal joint in the boring-bar, Fig. 2, would take care of any variation.

This fixture is of simple design and is made of cast iron. The frame *A* is well ribbed and holds the bushings *B* and *E*. The bushing *B* is the smaller of the two, being a good fit for the boring-bar, and is forced into the fixture. The bushing *E* is also forced into the fixture, but the hole in it is large enough to clear the stop-collar *O* on the boring-bar. *C* is a bushing which supports the boring-bar and is held in the bushing *E*. It is kept from turning by the two pins *D*, one of which is driven in the fixture and the other in the shoulder of the bushing. A slot 3/4 inch wide by 1/4 inch deep is cut in the bottom of the bracket and a key is held in the fixture to fit in this slot, thus holding the bracket in line with the center.

The bracket is held against the stop-pin *F* by the wing-screw *G*. The clamps *H*, one of which is placed on each side of the fixture, hold down the casting to the base of the fixture, and have two bearing points which are made by driving shouldered pins *K* into them. These pins hold the casting down in a better manner than a perfectly flat surface would. The clamps are held down by wing-screws *J*. These clamps have an elongated slot cut in them, so that they may be pushed back out of the way to facilitate the removal of the casting. Coil springs are placed under the washers *M* held on the wing-

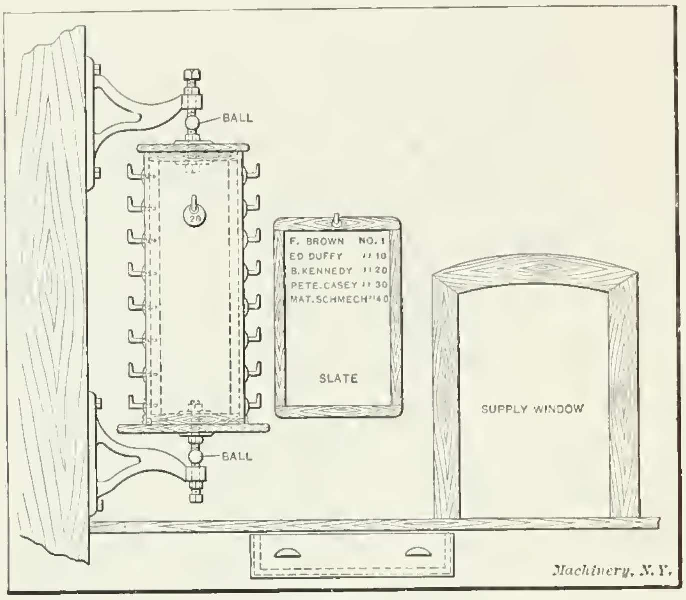
screws J, so that they always keep the clamps tight up against the washer, and thus facilitate their being pushed back.

The boring-bar, Fig. 2, is also of simple design and is made from a good grade of tool steel. N is a combination reamer and counterbore, and O is a stop-collar for limiting the depth of the counterbore. The counterbore and stop-collar are held on the boring-bar by the key P which fits in a slot cut in the bar Q. The ordinary feeding arrangement of the lathe was used for boring out these castings. This boring-bar is held on the lathe centers and driven by an ordinary dog.

Bristol, Conn. WALTER J. OLDROYD

CONVENIENT CHECK HOLDER FOR THE TOOL-ROOM

The accompanying illustration shows a very convenient check holder for use in the tool-room. It will hold 1000 or more checks conveniently, and is placed near the window of the tool-supply room. The check holder proper consists of a wooden cylinder 6 inches in diameter by 24 inches long, with a circular plate fastened to each end. Two balls are held



A Convenient Check Holder for Use in the Tool-room

between the cap-shaped ends of the screws shown, thus facilitating the rotating of the cylinder. There are 100 hooks screwed into this cylinder, which is sufficient for holding 1000 checks.

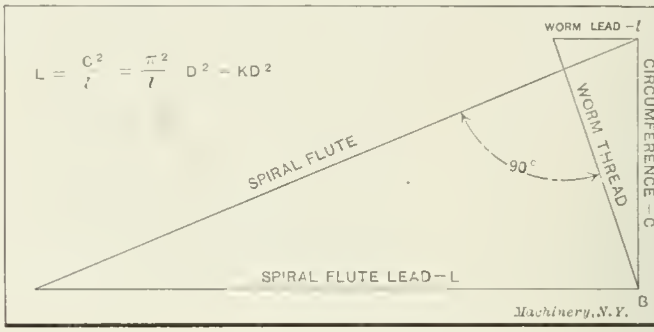
The use of this check holder is as follows: Each man is allowed ten checks, which are not given to him, but are placed on one of the hooks, and his name and number are written on a slate which is shown to the right in the illustration. Now when this man calls for a tool his check is taken from the hook, and put in the place that the tool occupied, and when he returns the tool, the check is taken out and replaced on his hook. This avoids the inconvenience of a man having to carry his checks around with him, and also prevents the liability of losing them. Of course, it is an easy matter when a man leaves the works to erase his name from the slate and substitute the name of the man taking his place and number. J. W.

DETERMINING THE LEAD OF SPIRAL FLUTES IN WORM HOBS

When relieving hobs by hand filing as is done in most shops that are not equipped with a relieving attachment for one of the lathes, the following table gives a quick method of obtaining the lead for which to gear the milling machine, to cut the spiral flute at right angles to the worm thread. If, however, a relieving attachment is available the lead should be figured out by a method suitable for this relieving attachment.

To find the lead L, simply square the outside diameter and multiply by the constant found in the table. An example will serve to illustrate: Consider a triple threaded worm hob with 4 threads per inch and 1¾-inch outside diameter. It is desired to find the lead for cutting the flutes so that the outside cutting edge is square across the worm tooth. First, square the outside diameter, $(1.750)^2 = 3.062$ inches. Then multiply by 13.16, the constant found in the table for a triple threaded worm of ¼ inch pitch. This gives 40.3 inches as the flute pitch.

To proceed with the cutting, refer to the tables furnished with the milling machine and select gears for the lead nearest



Development of Spiral Flute for Given Worm Pitch

to 40.3 inches and find the angle to which to set the milling machine table for this lead and a diameter of 1¾ inch. This done, all the information necessary to finish the job has been found.

The values in the tables were obtained as follows: In the engraving, which represents the surface of the worm hob unwrapped or developed, l equals the lead of the worm; C, the circumference; and L, the lead of the spiral flutes. Here are two similar triangles from which $\frac{L}{C} = \frac{C}{l}$ which reduces to $L = \frac{C^2}{l}$. Substituting πD for C gives $L = \frac{(\pi D)^2}{l}$. Taking D^2 out, leaves $L = D^2 \frac{\pi^2}{l}$. The value of the expression $\frac{\pi^2}{l}$ can now be calculated for the various single, double, triple, etc., worms, which results are here tabulated.

CONSTANTS FOR DETERMINING THE LEAD OF SPIRAL FLUTES IN WORM HOBS

Pitch of Worm, Inches	Type of Worm			
	Single	Double	Triple	Quadruple
3	3.29	1.64	.....	.....
2	4.93	2.47	1.64	.....
1½	6.58	3.29	2.19	1.64
1¼	7.90	3.95	2.63	1.97
1	9.87	4.93	3.29	2.47
1/2	19.74	9.87	6.58	4.93
1/3	29.61	14.80	9.87	7.40
1/4	39.48	19.74	13.16	9.87
1/5	49.35	24.67	16.45	12.34
1/6	59.22	29.61	19.74	14.80
1/7	69.09	34.54	23.03	17.27
1/8	78.96	39.48	26.32	19 74
1/9	88.83	44.41	29.61	22.21
1/10	98.69	49.35	32.90	24.67
1/12	118.44	59.22	39.48	29 61
1/14	138.17	69.09	46.06	34.54
1/16	157.91	78.96	52.64	39.48

The expression $L = \frac{C^2}{l}$ may be useful otherwise, as it shows the relation between the lengths of the leads of two spirals (strictly speaking helixes) which are at right angles to each other on the same diameter. G. V. ANDERSON

Walpole, Mass.

[The author chooses the outside diameter of the hob in preference to the pitch diameter for reasons of convenience both of measurement and of backing off the teeth by hand for clearance. It is assumed that the difference in cutting action of hobs fluted at right angles to the worm thread at the top of the teeth and to the thread at the pitch line is of little importance.—EDITOR.]

THE SYSTEMATIC SCRAP-BOOK

In the January issue of MACHINERY, "Designer" takes exception to the writer's article which appeared in the November number, in which a system for the systematic compilation of a scrap-book was described. Especial exception is taken to the index described in connection with the scrap-book. The writer acknowledges some merit in the method employed by "Designer," but believes he has failed to grasp the scope and unlimited expansibility of the system described in the article in question.

"Designer" has described a method employed by himself, for saving the valuable information which comes to him through the medium of MACHINERY, and to this extent we will acknowledge the simplicity of same, although his method is not without its drawbacks even in caring for the pages of MACHINERY. He states that where there is a page on which are articles on two or more subjects, the page is cut up and the different articles pasted on blank pages, each under its correct heading. What if these different articles occurred on the same leaf in such a manner that one could not be cut out without destroying the others? It would then be necessary to file the page under one of the articles and to file blank pages referring back to the others. This would necessitate looking twice before finding the reference, and as the book increased in size, more and more trouble would be experienced from this source. If "Designer" desired to preserve pages from some publication of larger size than MACHINERY, it would be necessary to begin another book, and so *ad infinitum*. In course of time, then, if he desires to look up some particular subject, he will commence in one book, look through all the pages filed under that guide and, not finding what is wanted, take up the next book and so on, perhaps not finding just what is wanted after looking through them all.

Compare this method with that of looking at a card, found in a moment's time under its proper heading or sub-heading in the index, whereon will be listed *all* the articles pertaining to the topic sought, giving directly the page numbers of the various books wherein those articles occur. It will be remembered that in the writer's system all books were numbered to facilitate indexing; the word "books" as used above includes any text-book, bound volume of magazines, scrap-book or catalogue owned by him. As to the time required to keep up the card index, the writer will index an article under his system in less time than "Designer" can insert a page under the proper guide.

The card index system previously described can hardly be classed as "elaborate" or "laborious," as such a system applied to various requirements has proved to be a time-saver the world over. "Designer's" method will work very well for one book, but it must be remembered that the system described and used by the writer covers an entire library and is unlimited in its applicability and expansibility.

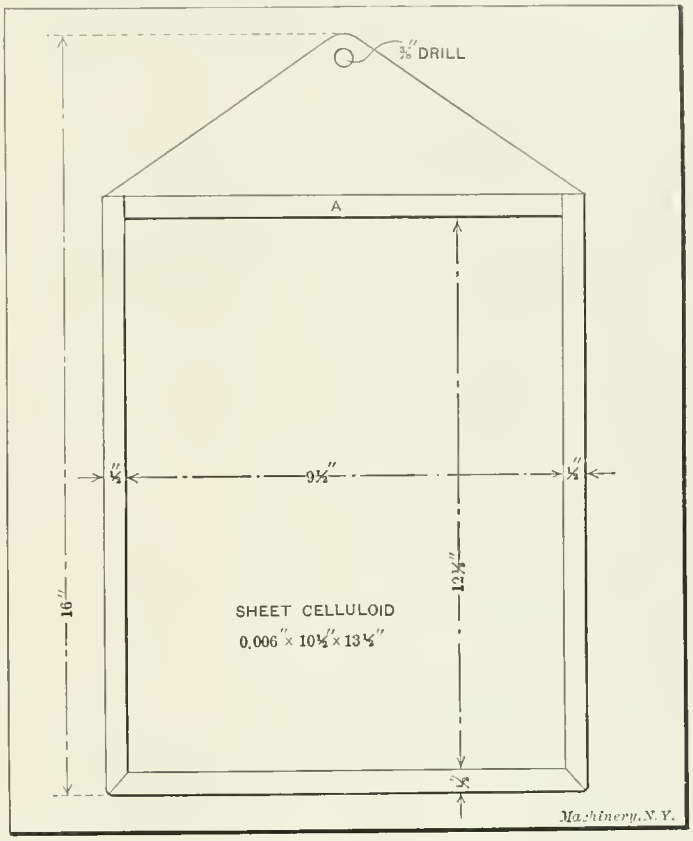
Muskegon, Mich. R. E. ASHLEY

MOUNTING BLUEPRINTS FOR SHOP USE

In the December number of MACHINERY J. B. & Co. ask for an efficient and cheap method of mounting blueprints for shop use. This, I understand, refers to blueprints which are sent to the shop for some certain job, and at the completion of which are returned to the drafting-room; not those which are held as reference prints and which remain permanently filed in the shop.

In our shop, for instance, when we want to send a print of a jig to the tool-room, it is mounted in the holder shown in the accompanying illustration. This consists of a sheet of white transparent celluloid, about 0.006 inch thick, a little larger than the print, and a piece of sheet tin, the edges of which are crimped over, holding the celluloid firmly on three sides; the top is left open for the insertion of the sheet. The top edge of the celluloid has a strip of tin *A* crimped over it also, to protect it from tearing. A hole is drilled in the tin at the top, by which the frame may be hung. As several sizes of prints are used it is necessary to have holders for each size.

No treatment of the print, such as shellacking, etc., is necessary; it is simply slipped into the frame behind the celluloid, which effectively protects it from grease and dirt, and as thin celluloid is very transparent, the figures can be plainly read. The frames can, of course, be used over and over again, and will last for years, so that, exclusive of the first cost, the expense is very slight. The celluloid can be easily cleaned of grease and dirt which may collect on it.



Frame for Holding Blueprints

The suggestion offered by the editor, of using strawboard of suitable thickness, to which the prints are pasted, is one which is widely used and serves very well, but the prints should be shellacked on the front as they soon get dirty if handled much.

Prints as large as 18 by 24 inches have been put in holders like that shown in the illustration; but these holders are more often used for such sizes as 6 by 9, 9 by 9 or 9 by 12 inches. DESIGNER

SOME SUGGESTIONS FOR INDEXING BOOKS

In an article entitled "Some Suggestions for Indexing Books," which appeared in the January number of MACHINERY, Mr. Myers elaborates extensively upon what seems to the writer to be a fantasy; he suggests a reform in indexing which would itself speedily require revision. A change in the present method used in the majority of cases would not be criticized, but the improvement should be in the manner of assemblage, and not in the plan. As Mr. Myers mentions, the commonly-accepted system appears to be based on common sense; it is concise, and, when properly used, of the greatest simplicity. The engineer who has recourse to handbooks and trade catalogues does not need an illustration of a set-screw, stud, or tap-bolt to locate a reference.

The application of the pictorial method to the Carnegie hand-book, was not a very good example, as the proposed index could not be as useful as the present index sheets of this book. The heavy condensed type used in marginal style for key-word finding, and the various miscellaneous indented notes directly following, with leaders to the page number, is a commendable arrangement. Allowing that a pictorial index might be satisfactory for a small trade publication, it is difficult to see where it could be usefully employed in index-

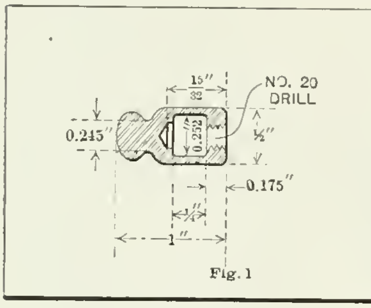
ing "Kent" or "Trautwine," or a volume of MACHINERY'S data sheets. This would be emulating the ancients in the use of hieroglyphics to a superlative degree, and the result would be one of absolute perplexity.

Current practice in general offers matter classified principally under the name of the article or topic; such classifications are useful in an assemblage of the subject matter. Referring to "Kent," we find "machine screw taps" indexed under "Machine" and "Taps;" similarly "helical springs" comes under "Helical" and "Springs," and so on. This gives a sufficiently simple arrangement, and one which it would be difficult to improve upon.

Los Angeles, Cal. L. R. W. ALLISON

A RECESSING OPERATION IN THE AUTOMATIC SCREW MACHINE

A screw machine operator frequently runs across some interesting jobs in different shops. The writer has always made it a rule to keep a memorandum of these jobs, so that they may be referred to when setting up a machine for other parts of a similar character. It is also a good plan to keep a record of errors, because what often seems to be the best method, proves to be a failure in practice. This is particularly true



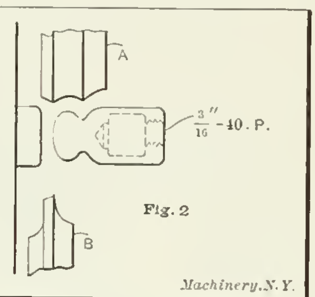


Fig. 1. The Piece to be made

Fig. 2. Arrangement of the Circular Tools

of screw machine work, as there are so many different methods of tooling some parts that it is difficult to determine which is best.

The piece shown in Fig. 1 was made by a cash register concern some time ago, and it gave plenty of trouble before it

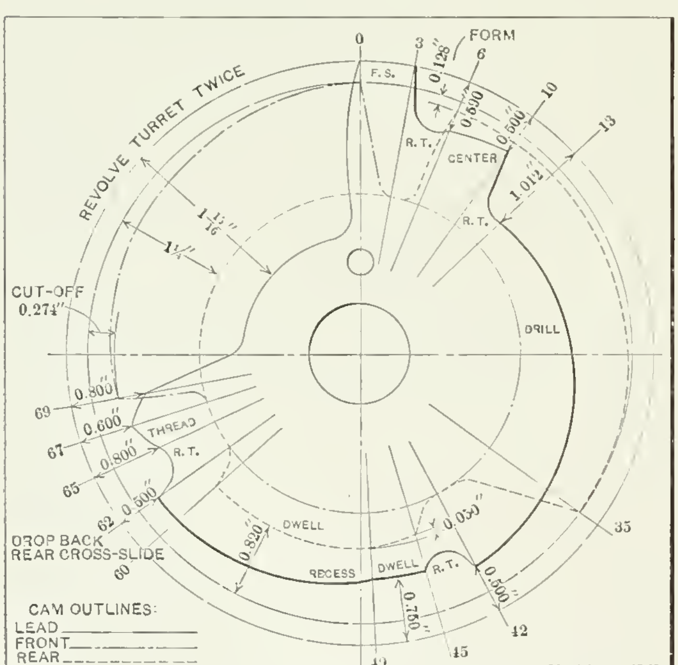


Fig. 3. Cams used in making the Piece shown in Fig. 1

was made successfully on the automatic screw machine. This piece was made from machine steel ½ inch in diameter, in a No. 0 B. & S. automatic screw machine. In considering the speed, we find that for forming we can run the stock at about 80 feet per minute, and thread at 30 feet per minute. This gives us 611 and 603 revolutions per minute respectively, but by referring to the table in the B. & S. book we find that the nearest spindle speed is 663 revolutions per minute.

The recessing is performed with a B. & S. standard swing tool, which is the tool usually selected for this class of work. The recessing cutter is first fed at right angles to the spindle by the cross-slide, after which it is fed forward by the turret. The feeds given in the following were found to be sufficiently light, and the tools stood up well without continual sharpening.

The method of setting the circular tools on the machine is shown in Fig. 2. The circular form tool *A* is located on the back-slide, and the cut-off tool *B*, on the front-slide. The form tool operates while the hole is being drilled; this is practicable, because the smallest diameter to be found is 0.245 inch, while the diameter of the drilled hole is 0.161 inch. The surface speed of the drill is only 28 feet per minute, as the machine spindle cannot be run faster on account of threading. Some operators prefer a high-speed drilling attachment for this kind of work. The order of operations for making this piece is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	13	3
Form 0.128 inch rise at 0.001 inch feed	(128)	(29)
Revolve turret	13	3
Center 0.090 inch rise at 0.005 inch feed	18	4
Revolve the turret	13	3
Drill 0.512 inch rise at 0.004 inch feed	128	29
Revolve the turret	13	3
Recess 0.050 inch rise at 0.0028 inch with rear cross-slide	18	4
Recess from turret 0.250 inch rise at 0.0051 inch feed	49	11
Drop back rear cross-slide	9	2
Revolve turret	13	3
Thread in	9	2
Thread out	9	2
Cut off 0.274 inch rise at 0.002 inch feed	137	31
Revolve turret twice	(26)	(6)
Total number of revolutions to make one piece	442	100

With this layout a piece is made every 40 seconds, which means a gross production of 900 pieces in ten hours. The cams for this piece are shown in Fig. 3, and consist as usual of the lead, front-slide and back-slide cams.

By referring to Fig. 3 it will be noticed that the rear-slide cam has a lobe from 45 to 60 on the cam circle. The use of this portion is as follows: At 45 the recessing tool is brought into place by the lead-cam, the rear-slide cam moves forward 0.050 inch feeding the recessing tool in to take the depth of chip required. Then from 49 to 60 the form cam has a dwell while the recessing tool moves forward; the allowance from 60 to 62 is made to withdraw the back-slide before withdrawing the swing tool. S. N. BACON

A HANDY KNIFE SHARPENER

While the knife should be used sparingly upon tracings for erasing purposes, it is in many cases necessary. In order to make a really good job when scratching out with the knife, it is very important to have the blade in first-class condition; otherwise it tends to drag up more of the surface of the cloth than is desired, and if the part scratched out has to be reworked upon a poor looking job is the result.

The writer has used a "stunt" which will be worth trying: Take a strip of suitable emery cloth about ¾ inch wide and 5 inches long, and fasten it with four small tacks to the top face of the drawer, which is invariably provided in a drawing table, usually on the right-hand side.

After having oilstoned the blade to be used for scratching-out purposes, all that is necessary for keeping the blade point in good condition is to open the drawer about 2 inches and draw the blade a few times across the emery cloth, and an exceedingly keen edge can be maintained for many months without further oil-stoning. Q. E. D.

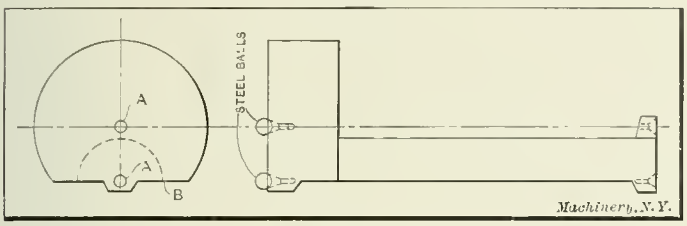
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TESTING THE WORK CENTERS OF AN ECCENTRIC PIECE

A short time ago a little problem came up in our shop which I thought might be of interest to the readers of MACHINERY. It was required to test the work-centers *A* of the eccentric piece shown in the accompanying illustration, in relation to a flat side *B*, at right angles to the centers.

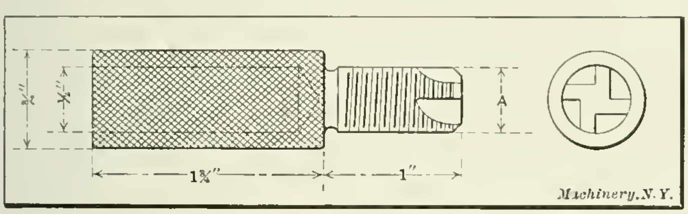


Two steel balls of the same diameter were clamped in the centers, so that a scale placed against them would be tangent to their diameters. By this means it was an easy matter to test the centers *A* with relation to the flat side *B*.

Detroit, Mich. FRANK I. TOWER

TOOL FOR CLEANING THE THREADED HOLE IN CIRCULAR TOOLS

The tapped holes in the circular tools used on the Brown & Sharpe automatic screw ma hines sometimes become clogged with chips and dirt, thus preventing the insertion of the screw. It is not advisable to clean out these holes with a tap, as since the tools are hardened, it would soon put the

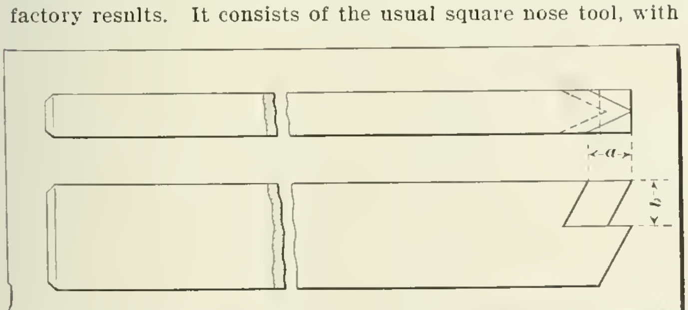


tap "out of business." A tool which can be used for this class of work is shown in the accompanying illustration. This is a piece of tool steel, knurled on the handle, as shown, and threaded. Grooves are filed in the forward end of this tool, after which it is hardened. The dimension *A* is made to suit the threaded holes in the circular tools for the various machines. F. W. RANDALL

New Haven, Conn.

HIGH-DUTY SPLINING TOOL

The accompanying sketch shows a splining and key-seating tool, which the writer has used for some time with very satisfactory results. It consists of the usual square nose tool, with



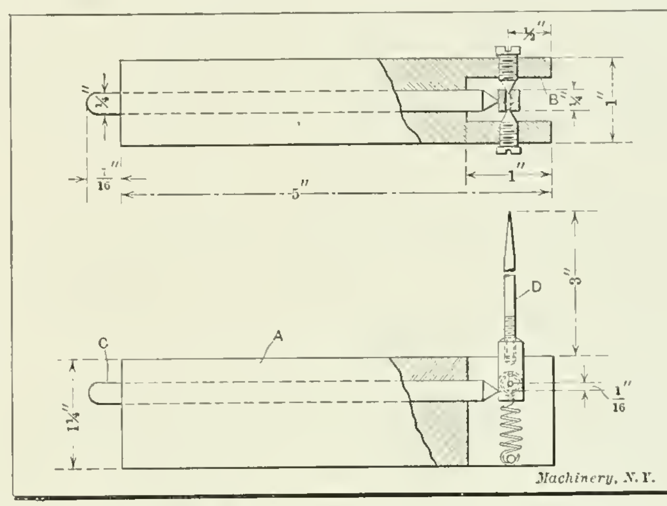
the front part ground V shape, thereby forming two portions to the tool. The V part divides the cut into three sections, one being taken by the V, and the other two by each of the corners of the lower square section. The chip being thus divided, less power is required for taking the cut, and a better job is produced. The side clearance of the V acts on the back chip in a precisely similar manner to the groove or top-rake of a twist drill; and so the square point in following the V, has a tendency to cause the chip to coil up, guiding the chips to both sides.

In practice, *a* is always made at least twice the depth to which the cut is to be made, for if the tool were to enter the full depth of a cut the back chips would tend to clog. Observing this caution, no difficulty will be experienced.

This is a tool which will meet the general desire for "hogging" service, for experience has shown that it does not chatter, and will therefore stand more severe service than the ordinary square tool. CHIPS

INDICATOR FOR TRUING WORK

The accompanying illustration shows a very simple indicator for truing work in the lathe. The body *A* of this indicator is made from a piece of 1¼-inch by 1-inch machine steel 5 inches long. It is slotted at *B*, and an indicator needle is held in a square block, as shown. This square block is held by two



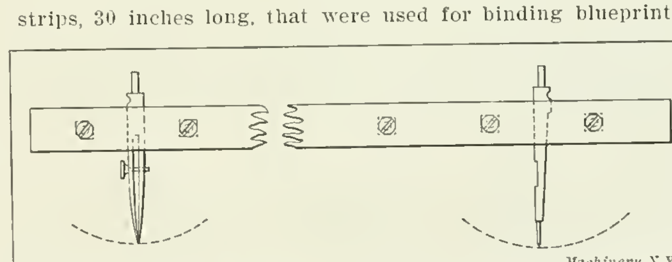
cone-pointed screws, thus allowing the needle to swivel. A coiled spring is attached to the block holding the needle, to steady it and hold it against the cone-pointed rod *C*. The rounded end of this rod bears against the periphery of the work, and any irregularity or eccentricity of the work is shown by the deflection of the needle *D*.

Joliet, Ill. REX MCKEE

BEAM COMPASS

The accompanying sketch illustrates a beam compass that was made on an occasion when such an instrument was needed badly and there was none in the draftsmen's outfit.

We had in the office a number of ⅞ by 3-16-inch hardwood strips, 30 inches long, that were used for binding blueprints,



and also a box of 1/8-inch button-head screws with square nuts that were used for the same purpose. Holes were drilled in two of these strips about three inches apart and the parts of an ordinary compass were clamped between the two strips by means of the screws, as shown in the engraving.

An adjustment of several inches could be had by swinging the pen and needle point (shown by the dotted lines) without loosening the screws. In the absence of a better instrument this proved very satisfactory. A. N. P.

* * *

Japanese lacquer is not a lacquer in the ordinary meaning of that word, but rather a varnish, being analogous to the spirit varnishes containing shellac.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

MAKING BLUEPRINTS FROM BLUEPRINTS

Designer.—I would like some information on the making of blueprints from another blueprint. I have tried to do this but have not been able to get satisfactory results. I believe that there is some chemical by means of which the original blueprint can be treated so as to make it possible to obtain a good copy. I would be pleased if any reader of MACHINERY who has been able to satisfactorily make blueprints from other blueprints, would describe the process.

A PROBLEM IN SHEET METAL DRAWING

H. W.—I would like to ask through the columns of MACHINERY how to make a rectangular shell from open-hearth steel plate (No. 20 gage). The shell is 5 inches long by 4½ inches wide by 6 inches deep. It is also necessary to have a ⅜-inch flange all around the box. The corners are required to be fairly sharp. How many drawing operations are required, and what difference in depth could be made in each successive drawing operation? Also, what formula could be used for determining the size of the blank?

SIZE OF EXHAUST FAN

J. P. McC.—What size exhaust fan is required to exhaust the emery dust from a No. 2 B. & S. surface grinder, a B. & S. No. 3 cutter grinder and an emery wheel stand with two 10-inch by 1¼-inch wheels; all are dry grinders. The dust would have to be drawn or blown about 40 feet.

Answered by Brown & Sharpe Mfg. Co., Providence, R. I.

A.—We would recommend an exhaust fan of about the capacity of the No. 00 "Monogram" exhaust made by the B. F. Sturtevant Co., Hyde Park, Mass. The inlet for this exhauster is 4¾ inches in diameter and the outlet 4⅛ inches. To get the best results we would recommend placing the fan as near the machines as possible. If it were hung on the ceiling just over the machines, it probably would give the best results. Let the 40 feet of piping necessary be on the outlet side of the fan. The inlet pipe to the fan should be made full size and the branches from it for the respective machines should not enter the main pipe at right angles but should enter it at an angle of about 45 degrees inclining toward the fan. It is best to avoid all sharp bends, using curves instead of ells when making bends. We think that if a fan of the size mentioned is run at a speed of 3000 to 4000 R. P. M. it will give you all the draft necessary.

FORGING WRENCH JAWS

C. R. C.—How can wrench jaws be satisfactorily drop forged on a steam hammer? In our blacksmith shop we have always forged open-end wrenches by hand, which is a rather inefficient method. Cannot this work be done a steam hammer with cast-iron dies? It is proposed to forge only the jaws in this manner. No drop hammer is available.

Answered by James Cran, Plainfield, N. J.

When the number of wrenches to be made is too great to be done economically by hand, and still too limited to justify the expense of sinking steel dies, to say nothing of other necessary equipment, an ordinary steam hammer equipped with cast-iron dies answers the purpose very well. Cast-iron dies, however, to give satisfaction in the making of forgings, must be made in a somewhat different manner from regular tool-steel drop-forging dies, inasmuch as there must be no sharp corners in the impressions; nor should the dies be made to throw out surplus metal in the shape of a "flash," as is generally done in drop forging, but should be so constructed, when the shape of the pieces to be made will permit, that the forging will be without a "flash." Open-end wrenches are of a shape suitable for forging in this manner, whether they are to be S-shaped, have the head at an angle of 15 or 22½ degrees from the handle, or are perfectly straight. Forgings without "flashes" are made in what is generally known as "open dies," that is, the impressions are much wider than the forgings to be made in them and are so arranged that one impression reduces the stock to the required thickness, and another to the shape and width, by changing the work from one impression to the other as each successive blow of the hammer is struck. This will be better understood by referring to Fig. 1, in which upper and lower steam hammer dies for forging open-end wrenches are shown. The size of stock to be used for wrenches made in the manner described, should be as nearly as possible equal to the width and thickness of the wrench head when finished; the stock may be somewhat larger, but should never be smaller.

The forging is carried out as follows: The heated stock is placed edge up in impression *A* and receives a blow which partly shapes it. It is then placed in impression *B* for the next blow, which reduces it in thickness. This procedure is continued—striking a blow in each impression alternately—until from six to twelve blows have been struck, according to the size of the wrench and the weight of the hammer used. The forging is thus reduced to approximately the shape shown in Fig. 3. To reduce the neck to about two-thirds of the thickness of the head, which is generally considered to be about

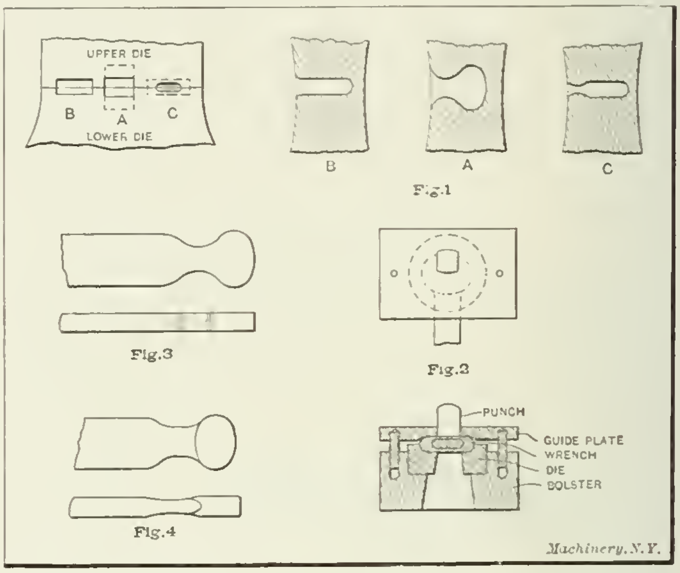


Fig. 1 Fig. 2 Fig. 3 Fig. 4

the right proportion, it is struck one or two blows in impression *C*, bringing it to about the shape shown in Fig. 4, which completes the forging process as far as the head is concerned.

The opening for nuts or bolt-heads can be made in various ways, preferably by milling, as that leaves them perfectly straight and smooth. Should a milling machine not be available for the purpose, a punch-press may be used, or the opening can be made under a steam hammer by using dies and punches as shown in section in Fig. 2. The cast-iron bolster could be used for all sizes, but the dies, the punches, and the guide plates would have to be made to suit each size of wrench, and interchangeable so that they would fit the bolster. It is important that punches to be used in connection with a steam hammer be short so that when they are driven through the work they will not come in contact with the lower die, and that they be slightly tapered from the face up, to prevent them from sticking in the work, should the head get battered out of shape. Both die and punch should be of tool steel, say from 60 to 75 point carbon, hardened and tempered. The writer has found that by drawing the temper of punches and dies to be used in this manner a little further than if they were to be used in a punch-press, the best results are obtained. The guide plate pins may be made of machine steel. The cast-iron forging dies will give longer and better service if they are hardened. This does not call for any elaborate process, as is generally supposed. It is done by heating the faces to about the same temperature as is required for hardening tool steel, and then coating them with pulverized raw borax, which is allowed to "cook" until it ceases to bubble. They are then placed, face up, at the bottom of the quenching tub, and allowed to remain without being disturbed until perfectly cold. Drawing the handles of wrenches to size is too ordinary an operation to call for comment.

"INS AND OUTS OF GEAR HOBBING"—A REPLY

By RALPH E. FLANDERS

The comment of Mr. Percy C. Day on the article entitled "Ins and Outs of Gear Hobbing" is intelligent and friendly, and it further emphasizes certain important points which it seems worth while referring to again.

The reason for choosing a 21-tooth gear for the experiments was very simple. It was possible to make blanks for these gears, 6-pitch, out of a 4-inch bar of steel, that being the largest diameter of stock within easy reach of the experimenter. There is nothing unfair, moreover, in choosing a small pinion and a 14½-degree angle, for the user of a gear-hobbing machine has a right to expect that he will be able to cut a pinion of that number of teeth and that pressure angle. Hobbing machine manufacturers do not warn prospective customers that such gears cannot be cut satisfactorily on the machine. It would seem that they should at least see that their customers use proper hobs. The hob was the product of one of the best toolmaking firms in the country and was sold without any warnings as to its limitations. If the hob has limitations, the purchaser has a right to know it, and he should thank any article or reports of experiments that will put him on his guard. Let him get assurance that proper correction is made in his hob for interference.

In regard to the matter of the looseness of the machine, I must not be understood as saying that the machine was really "slack" in its adjustments. It was simply set up so as to run freely, in the same way that machines are often adjusted in the average machine shop. The point is that generating machines (gear-shapers included) must be adjusted more carefully and closely than an ordinary drill press or shaper, if the most accurate results possible are to be obtained; and the hobbing machine in particular, as distinguished from other generating machines, must have unusual care taken in this respect, as well as in its fundamental design. This is owing to the fact that its generating mechanism has to carry *the whole strain of transmitting the cutting power.* In this respect it is at a disadvantage as compared with any other gear generating machine I can call to mind, whether made for spur, bevel, or any other type of gearing. The intermittent cutting strain is a serious disturbing factor in the generating action, unless great care is taken to avoid it.

This matter of the necessity for careful adjustment, as I freely confessed in the article, was a new thought to me, and was the principal personal result of the investigation. No doubt Mr. Day, with his better practical experience, knew it already. If he considers that ignorance in this matter vitiates the entire experiment so far as the symmetry of the teeth is concerned, it will surely be a most instructive and valuable undertaking if he will carry out the experiments under more nearly ideal conditions, and will report his results to the readers of MACHINERY. Will Mr. Day do this for us?

The result of the experiments on my own mind was the conviction that the torsional strain, back-lash and play is of far greater moment in the production of unsymmetrical teeth than the centering of the hob teeth can possibly be.

* * *

TIME REQUIRED FOR CLEANING BOILER TUBES

In the January, 1911, number of MACHINERY, engineering edition, an article appeared entitled "Method of Handling Boiler Tubes in the Canadian Pacific Shops." In this article it was stated that by the use of a tube rumbler made by Joseph T Ryerson & Sons, Chicago, Ill., the cleaning of 300 tubes required, on an average, from 10 to 48 hours, the variation in time depending upon the condition of the tubes. We have been informed that this statement is incorrect and that in the shops mentioned it takes, on an average, only 5 hours to clean 300 tubes, and only in the most extreme cases would a time corresponding to that given in the previous article be required. In some extreme cases it has been impossible to loosen the scale except by resorting to the use of a hammer.

*Address: Fellows Gear Shaper Co., Springfield, Vt.

A FRIENDLY VIEW OF THE HOBBING PROCESS

By J. E.

A great deal has been published of late concerning the bad points of the hobbing process in its relation to the production of spur gears. The methods of dealing with the question have varied, but have in the main been along a similar line—that of an extreme case—and the authors have neglected to consider practical conditions before drawing their conclusions, thus leaving wrong impressions. To one who has made a study of the hobbing process under practical conditions, this misleading information stands without solid foundation and should be vigorously contradicted.

The hobbing process is one of the methods for producing spur gears, which is theoretically correct, and which like all other processes of the kind, must be modified to a certain degree to place it on a practical basis. These modifications must necessarily be made with care, and a thorough knowledge of the principles involved is required. Such modifications are not, however, limited to the hobbing process, but are common to all processes of generating interchangeable gearing of the involute system. It is not necessary to mention them here, as they are well known to those interested in toothed gearing. Of the many articles that have appeared on this subject, probably that which has caused the most commotion is the one by Mr. R. E. Flanders entitled "Ins and Outs of Gear Hobbing," which appeared in the January number of MACHINERY, and it is in answer to his article that this is written.

To one who has seen and cut gears for a variety of purposes, from those used for automobiles to those for cream separators, which in every case are giving as good satisfaction as a commercial product can well be expected to give, the statements set forth as facts in the article referred to would seem to require no further comment, were it not for the fact that many will accept them as true conditions. The first point that is brought up is the mysterious "hooked" tooth. Did anyone ever see or hear of a pair of gears that would run with exactly the same action when reversed on one another? The statement is ventured here that such a pair of gears has yet to be made. They are certainly not produced under any system of generating or cutting in general use. Mr. Flanders advances the theory that hooked teeth are caused by the "long complicated mechanism by means of which the movements of hob and blank are connected." He also alludes in his summary to this handicap of the hobbing machine which, he claims, is due to a fundamental fault in its design.

Have we a gear generating machine that has as direct connection and simple mechanism as this same hobbing machine? It has no reciprocating slides, no rocking shafts, no intermediate indexing mechanism, no cutter-withdrawing or clapper-box arrangement, none of which is absent in machines working on the principles of any of the generating systems. On the contrary, the motion of the gear-hobbing machine is continuous and uniform.

The fact that the machine which Mr. Flanders used in his tests was not properly adjusted accounts for the conditions found in the case of Blank 1, as it is well known that a milling cutter of the hob type will not give good results unless the slides and work are well supported and free from "looseness." An unfair comparison is also made with the Fellows gear shaper, leaving one to assume that this machine will produce gears that are perfect; but the gears cut on this machine are not put through the same tests as are tabulated in the table accompanying Fig. 8. The matter of looseness and play in the mechanism of the machine used in the tests should not be taken as a serious defect of the hobbing principle, but as a defect in that particular case, which could be corrected by proper adjustment or by proper care in design.

In regard to the hob, it may be said that the distortion due to hardening, is so small, when the tool is properly made and handled, as to be negligible, and no reputable manufacturer of hobs would send out one that showed distortion affecting in any serious degree the accuracy of the gear. Each

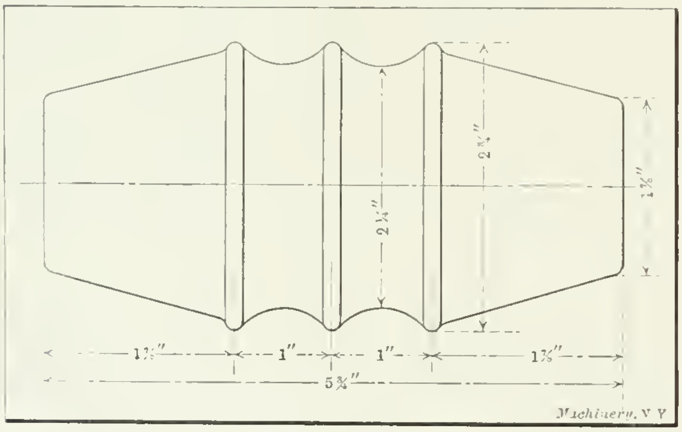
tooth has but a very small effect on the shape of the tooth generated, and since any distortion must be very small, we need fear little from this source. Possibly the cases Mr. Flanders cites relate to home-made hobs, which is not a proper condition on which to base conclusions. When made under proper conditions, by men experienced in the manufacture and treatment, the spur gear hob as made to-day needs no apologies. The interference of warped surfaces which need to be exaggerated in order to be noticeable even in extreme cases, is not a condition that is encountered in hobs used for cutting spur gears, as in no case is the angle greater than 10 degrees.

It will probably be of interest to Mr. Flanders to know that hobs made with straight flutes are made with a thread section that will produce the correct tooth form, and not with the same section that is used when they are fluted helically. It should also be noted that the standard makes of hobs have provision for the correction necessary for tooth interference and under-cutting. The fact that it is possible to produce good commercial gears from solid stock by one cut and at a rate that no other machine has yet equalled is the evidence that will decide whether the hobbing machine is to be delegated to the scrap pile or not. All conditions other than those referred to by the writer mentioned, point to the time (if it has not already arrived) when, for spur and spiral gears, the hobbing machine will be accepted by those who are at present doubtful about its making as good a showing as is claimed for the Bilgram and Gleason generators and the Fellows gear shaper. If we examine any process with the idea of picking flaws, we can generally find them. The writer has had the good fortune of having designed machines of both types, and knows from close study the faulty points as well as the good ones, and has found similar conditions with any machine, based on any principle.

* * *

LUCAS BABBITT HAMMER

Until lately the common form of babbitt hammer with handle was provided in the shop of the Lucas Machine Tool Co., Cleveland, Ohio, for use wherever a babbitt hammer should be used as a driver to avoid bruising finished work. When Mr. Lucas saw one of his men using a babbitt hammer head without a handle he promptly asked the reason—a habit he has whenever anything out of common comes to his attention in the shop—and was told that the men generally preferred the babbitt hammers without handles for most uses. A mold



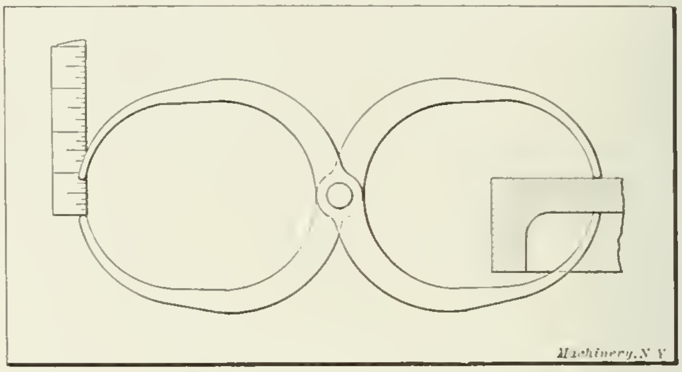
Lucas Babbitt Hammer

was made for casting a babbitt slug of the form shown in the illustration. The slug weighs about nine pounds, and is tapered at the ends to counteract in a measure the mushrooming action and thus prolong its effective life. The principal feature of novelty is the two finger grooves about the middle. These give a good hold where the slug balances in the hand. If one end is used more than the other the mushrooming throws it out of balance and so the grooves tend to make the men use both ends alike in order to keep the slug in good balance. The cost of handles is saved and the change is otherwise an improvement generally appreciated in this shop.

CALIPERING OVER A FLANGE

By GEORGE W. BURLEY*

In some of the recent issues of MACHINERY several methods of measuring the thickness of a web behind a flange by means of ordinary outside calipers have been given. There is one method, however, which has not been dealt with, and which, in the opinion of the writer, is equal to any of those which have already been considered. This involves the use of a pair of double-ended calipers, as shown in the accompanying illustration. The two ends of the calipers are made exactly alike and the four points are therefore all at the same distance from the center of the joint. To give accurate results the points should just touch when the calipers are closed.



Method of Calipering Over a Flange

The method of using the tool is as follows: The legs of either end are placed over the flange and set down so that they bear lightly on the two sides of the web. The distance between the leg points at the other end is then obtained by taking a measurement with an ordinary rule, as indicated in the engraving. This distance is also the distance between the leg-points at the end behind the flange, and, consequently, the thickness of the web. Thus, by the use of calipers of this kind, a single measurement only has to be taken, and there is no need of punch dots, packing or blocking, or screw adjustments.

* * *

OUTFIT FOR TESTING TOOL STEEL

In order to test the cutting qualities of various grades of tool steel, the O. K. Tool Holder Co., of Shelton, Conn., has fitted up a heavy-duty lathe for the purpose of ascertaining the power and time required for taking various kinds of cuts with tool steels of different brands. The testing outfit consists of a geared-head motor-driven lathe, the power required being read off on a watt-meter. The tests have been conducted especially to ascertain the qualities of the steel used in the tool-holders made by the company, which steel is imported from England.

So far, the tests have been made with the tools held in the ⅝ by 1¼-inch holder, and as much as 25 H. P. has been consumed for cuts taken with a single-point cutter in some of the tests. The cutting speeds and feeds used in these tests are of interest. Nickel steel (3½ per cent) containing 0.40 per cent carbon was reduced 1 inch in diameter with a cutting speed of 75 feet per minute, and a feed of 0.025 inch. Cast iron has been cut with a speed of 165 feet per minute and 0.1 inch feed, reducing the diameter 9/16 inch; in one case 10 pounds of metal was removed in one minute. A cut 15 inches long, with a cutting speed of 175 feet per minute, was taken in three minutes on a bar of machine steel 3-¾ inches in diameter. During the three minutes 16 pounds of metal was removed; that is, at a rate of 5-1/3 pounds per minute. In one case a piece was finished at a cutting speed of 385 feet per minute, removing 1/16 inch of stock, the length of time to cover 15 inches along the work being one minute.

In addition to the watt-meter giving the exact power consumed at all times, a device for indicating the speed of the cut and a scale for weighing the chips removed are included in the testing outfit.

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NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

ROCKFORD VERTICAL MILLING MACHINE

A design of vertical milling machine which is an interesting example of modern construction, has recently been brought out by the Rockford Machine Tool Co., Rockford, Ill. This machine, shown in the accompanying views Figs. 1 and 2, is of the type having a compound table rigidly supported on a horizontal slide or extension cast integral with the column. With this construction, the table is not adjustable vertically, as with a machine of the column-and-knee type, and of corresponding head have a vertical adjustment on the column and are counterbalanced to relieve the bearing of uneven strains. This bearing on the column is fully as large as that of the knee on a machine of the column-and-knee type, and of corresponding size, while the weight of the head is much less. As the top of the table is 30 inches from the floor, or approximately the same height as a planer pattern, castings or other parts to be machined, can be conveniently handled by the operator. This machine is provided with 12 speed variations for the spindle, and with 12 changes of feed, in either direction, for the table, saddle, and spindle-head. In addition, there is a rapid traverse for all feeding movements, which increases the general efficiency of the machine.

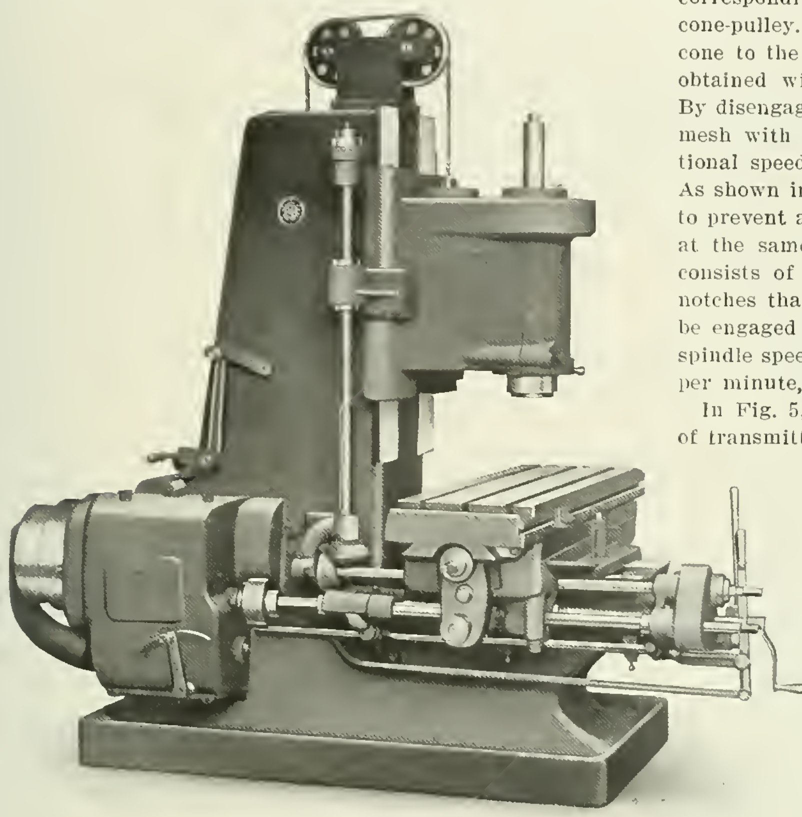


Fig. 1. Vertical Milling Machine, built by the Rockford Machine Tool Co.

The drive to the spindle is from a three-step cone-pulley, attached to the rear of the column, as shown. Nine of the available speed changes are obtained through back-gears, and the remaining three are high speeds, with a direct drive, for use with small cutters. The method of obtaining the nine geared changes is indicated in Fig. 3, which is a longitudinal section of the column in a horizontal plane. On the shaft *A*, which connects through bevel gearing with the vertical spline shaft *B*, there is a sliding clutch *C*, the position of which is controlled by hand lever C_1, Fig. 4. The vertical lever D_1 controls the position of the three sliding gears *D*, and when this lever and the gears are in a neutral position, a direct drive to the spindle may be obtained by the engagement of clutch *C* with a corresponding clutch cut on the end of the shaft carrying the cone-pulley. In this way a direct high-speed drive from the cone to the bevel gears connecting with the vertical shaft, is obtained with three variations from the steps on the cone. By disengaging clutch *C* and moving gears *D* successively into mesh with three corresponding gears on shaft *E*, three additional speed changes are obtained for each step on the cone. As shown in Fig. 4, the two levers C_1 and D_1 are interlocking, to prevent any conflicting combination of gears being engaged at the same time. This locking device is very simple, and consists of a segment-shaped projection on lever D_1, having notches that engage the clutch lever, so that clutch *C* cannot be engaged unless gears *D* are in a neutral position. The 12 spindle speeds thus obtained, range from 13 to 200 revolutions per minute, in geometrical progression.

In Fig. 5, which is a cross-section of the head, the method of transmitting the power from the vertical spline shaft *B* to the spindle, is shown. The driving pinion is made from a steel forging, and the large gears from steel castings. The spindle gear is provided with large bearings, as shown, which relieve the spindle of all side strains. The spindle has a vertical adjustment of 6 inches, which is effected by the handwheel shown to the right in Fig. 2, the movement being transmitted through worm gearing to the pinion *F*, Fig. 5. The spindle is a crucible steel forging, and it is provided with adjustable taper bearings to compensate for wear.

The construction of the feed-changing mechanism is shown by the sectional view, Fig. 6. The drive to the feed-box is through a spur gear which meshes with a pinion on the back-gear shaft *E*, Fig. 3. The feeds are engaged and reversed by a clutch *G*, mounted on the upper

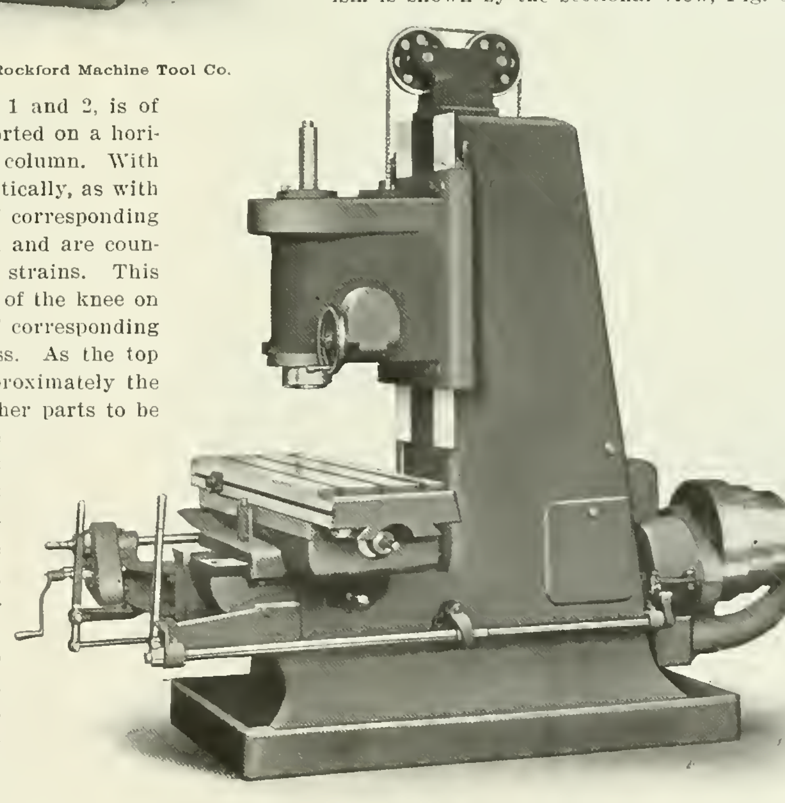


Fig. 2. Another View of the Rockford Milling Machine

shaft, which is the highest-speeded shaft in the box. The lever for operating this clutch is conveniently placed in front of the machine, and connection is made as indicated in Fig. 1. The power from the clutch-shaft is transmitted through slip-gears *H* at the left. Two pairs of these gears are used, which are reversible, thus giving four changes. Three changes for each position of the slip-gears are obtained by the sliding

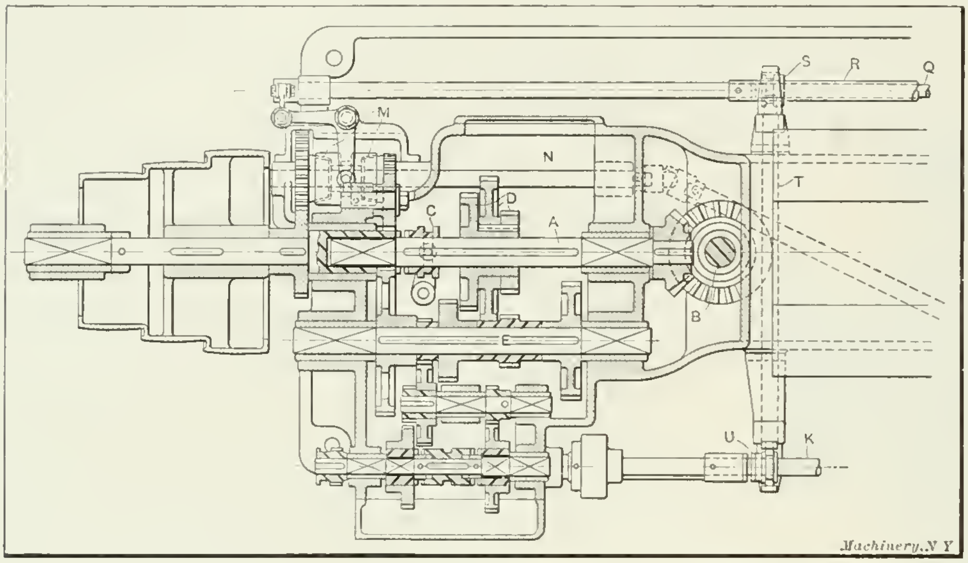


Fig. 3. Section through Column in Horizontal Plane, showing Change-gear Mechanism

gears *J* on the lower shaft. The position of gears *J* is controlled by the lever J_1 Fig. 4, and the changes are effected by engaging these gears with one of the three gears on the feed-shaft *K*. The twelve feeds thus obtained range from $\frac{3}{4}$ inch to 17 inches per minute, and the feeding movement is transmitted from shaft *K* to the table, saddle, and the head, as desired. The friction coupling *L* on the feed-shaft will drive any feed, but it will not transmit sufficient power to break the feed gears or other parts, in case the saddle should be fed against the column, the table nut against the end of the saddle, or the feeding movement otherwise positively stopped by some rigid obstruction.

One of the noteworthy features of this machine is the rapid power traverse, which enables the table and head to be adjusted quickly to any desired position. The control and operation of this rapid traverse will be understood by referring to Figs. 2 and 3. The power is obtained direct from the cone-

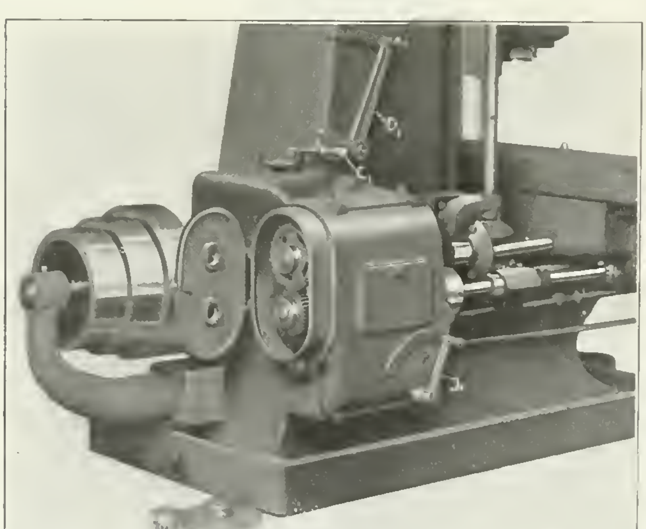


Fig. 4. Detail View showing Driving Cone, Feed Box and Speed and Feed Control Levers

shaft by spur gearing, and it is transmitted through a reversible clutch at *M* to shaft *N*, which connects through an angular shaft and universal joints to the feed train in front of the machine. The lever for controlling the position of reversing clutch *M*, and also that of clutch *U* on the feed-shaft, is conveniently placed in front of the machine on the right-hand side, as shown in Fig. 2. This controlling lever has a very simple interlocking arrangement which makes it absolutely impossible for the feed mechanism and the rapid traverse to be engaged at the same time. With the lever in the position shown, the rapid-traverse clutch *M* is locked in a neutral position, and the clutch *U* of the feed-shaft is engaged. This lever is pivoted and has a lower projection engaging a rod *Q* which passes through hollow shaft *R* and connects with collar *S* by a key which extends through a slot in the hollow shaft. This sliding collar *S* is connected by a yoke with the cross-shaft *T* which, in turn, connects with clutch *U* on the feed-shaft. It will be seen that when the operating lever is moved outward, clutch *U* will be disengaged, and the lever, which in its inner position engages a slot in the supporting bracket, can be moved to the right or left, thus engaging the reversible clutch *M* and applying the rapid traverse. The direction of the traverse will, of course, depend upon whether the controlling lever is swung to the right or left. When it is desired to again connect the feed, this is accomplished by pushing the lever into engagement with the slot previously referred to, which cannot be done without replacing traversing clutch *M* in a neutral position.

All movements of the table, saddle, head and sleeve are indicated by graduated collars reading to 0.001 inch, and the longitudinal and cross movements are equipped with automatic stops. All slides are fitted with taper gibs that are adjustable endwise to compensate for wear. The saddle slide is double-

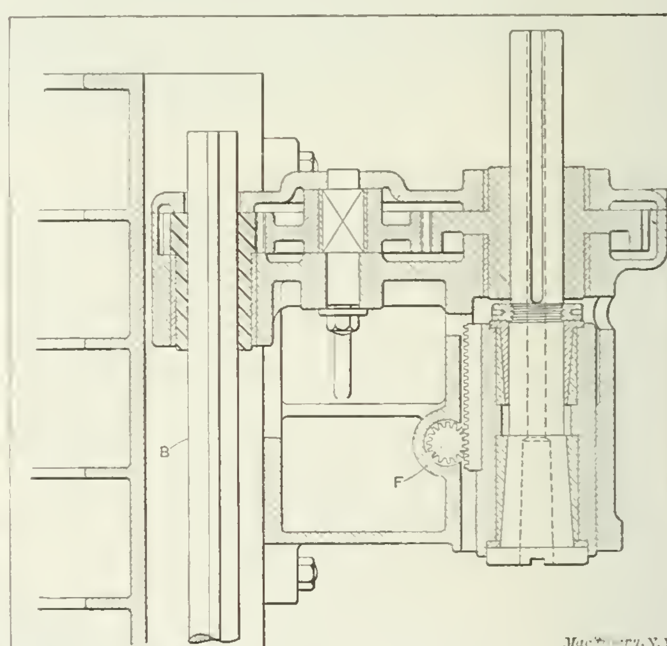


Fig. 5. Cross-section of Spindle and Head

gibbed, there being a taper gib on the inside of the right-hand bearing, thus insuring perfect alignment when feeding under heavy cuts. All shaft bearings are provided with wool-felt oil retainers, and there is also very efficient means for oiling the driving shafts and feed-box. All the bearings are connected by groups of soft brass tubes 5/16 inch in diameter, with oil cups having hinged covers. Two of these cups can be seen on top of the feed-box in Figs. 1 and 4.

The general dimensions of this machine are as follows: Distance from the center of spindle to column, 15 inches; maximum distance from table to spindle, 24 inches; minimum distance from table to spindle, 3 inches; diameter of spindle

at taper, 4 inches; diameter at upper end, 3 inches; working surface of table, 14½ by 48 inches; total length of table, 56 inches; feed to table, 32 inches; vertical movement of head on column, 21 inches; width and length of head bearing on column, 19 inches by 25½ inches; minimum and maximum

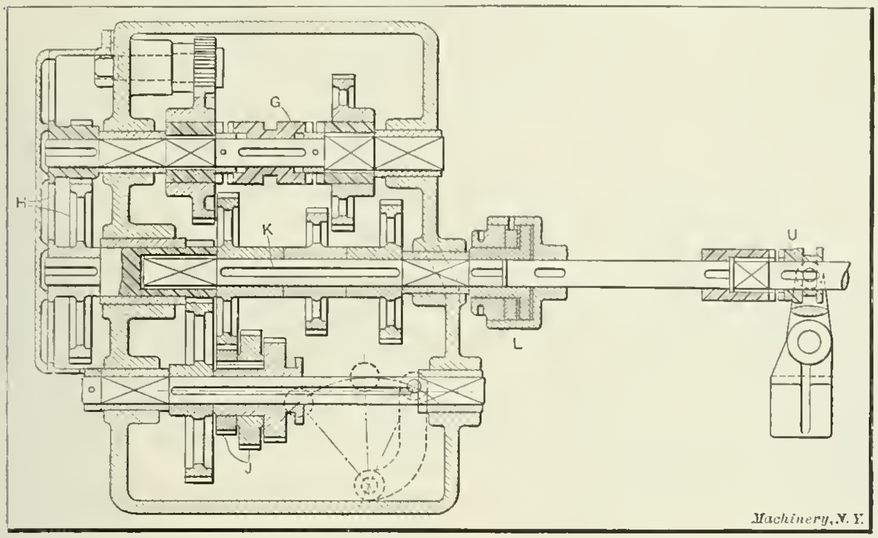


Fig 6. Sectional View of Feed-box

diameters of steps on cone, 12 and 15½ inches, respectively; width of driving belt, 4 inches; and net weight of machine, 6800 pounds.

FELLOWS GEARLESS VARIABLE-SPEED TRANSMISSION

The Fellows Direct Power Transmission Co., Los Angeles, Cal., has recently placed on the market a unique type of gearless variable-speed transmission which is herewith illustrated and described. Fig. 1 gives a diagrammatic representation of this gear. The driving shaft *A*, which may be directly connected to the engine, has a crank *B* which rotates with the shaft and transmits the power through the connecting rod *C* to a lever *D*, and thence to the grip ring *E*, as will be explained.

A bell-crank *F* is attached at its lower end by a pin *G* to a fixed point on the machine, while at its angle it is connected through two levers *H*, to the before-mentioned lever *D*. This

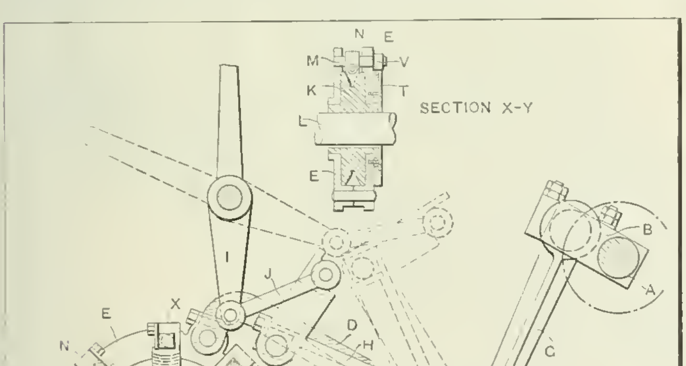


Fig. 1. Diagrammatic View of the Fellows Gearless Variable-speed Transmission

provides a toggle movement for the reciprocating connecting rod *C*, giving a varying amount of oscillation to the grip ring *E*, depending upon the location of the bell-crank *F*. This latter may be shifted, as shown by the dotted lines, by means of the lever *I* connecting with *E* through the link *J*. By proper adjustment of this lever *I*, any oscillation from zero up to the limit of the machine may be obtained without the necessity of shutting down the engine or throwing off the load.

The grip device consists essentially of a grooved steel disk *K*, keyed on the driven shaft *L*. A pair of grip-ring rocker-plates *E* are mounted on each side of the grooved disks and are free to oscillate on bosses. Near the rim of these rocker-plates are eight equidistant pins *M*. These pins have square central portions, on which are mounted dogs or wedge-blocks *N*, these being held in place by plates *O*. The inner ends of these wedge-blocks are turned to an arc of a circle, whose radius is somewhat greater than their distance from the pin *M*, the reason for which will be explained. These dogs fit into the V of the grooved steel disk *K*, previously mentioned, having a line contact with it. In their normal position these dogs *N* are radial, and just touch the groove of *K*; but if they are swung slightly in either direction they will grip the latter, as the radius of their turned ends is greater than the point on which they are swung. The driven shaft can thus be revolved in either direction as desired, by swinging the wedge-blocks in the proper direction. This can be done without shutting down the machine, by means of the shifter *Q* which engages with the crank-pin *R*, the latter, in turn, connecting through a crank to a segmental gear *S*, oscillating the shift-plate *T*. This shift-plate *T* has projections *U* which lie directly under collets *V* on the small pins *M*. The sidewise movement of the shifter *Q* thus swings the wedge-blocks in one direction or the other. This

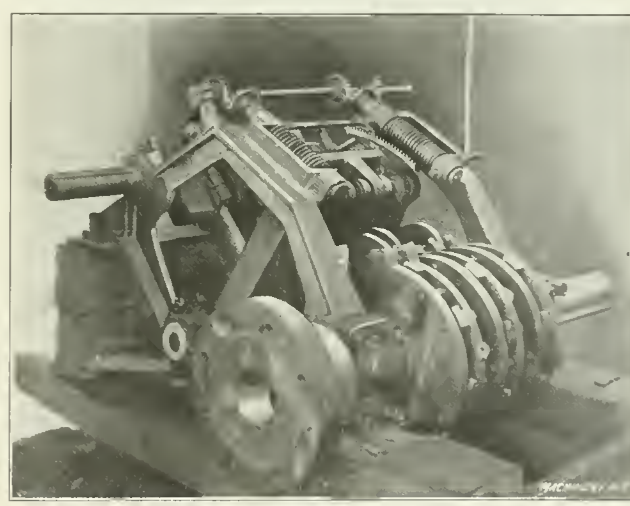


Fig. 2. A Fellows Gearless Variable-speed Transmission as applied to a Gas Engine in the Oil Fields

shifting may take place without interrupting the oscillation of the rock-plates, as the grooved shifter permits a continuous movement of the pin *R*.

This type of transmission has been compared to that of a street car controlling mechanism to which it bears a very close analogy; the shift-block *Q* corresponds to the reverse lever of the controller, and the lever *I* corresponds to the various notches of the controller box.

In operation it is customary to use at least three of these transmissions mounted in a set, in order to secure absolute continuity of rotary movement. This is illustrated by the halftone, Fig. 2, which shows this form of transmission applied to gas engine operation in the oil fields, where it is claimed that the results have been very satisfactory. This type of transmission can take its power either from a constant-speed electric motor, or from any form of internal combustion engine, and the makers claim that it will deliver from 97 to 98 per cent of the power imparted to it.

This type of transmission has been successfully applied to gasoline railroad section cars. One particular car cited operates on seven horsepower, has all speeds in both directions, and can carry its load and haul trailers on any grade

LARGE DUPLEX VERTICAL MILLING MACHINE

A large duplex type of vertical milling machine has recently been designed and built by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., especially for the McClintic-Marshall Construction Co., to be used in milling the faces on the gates for the Panama Canal. This machine, a view of which is shown in Fig. 1, is also arranged to handle large structural work, etc. It is equipped with two columns, each of which is independently driven by a 20-horsepower motor having a speed ranging from 450 to 1350 revolutions per minute. The motion is transmitted from the motor through a pinion and intermediate gear to the large driving gear mounted on a horizontal shaft at the side of the upright near the base. This horizontal shaft connects through bevel gearing with a vertical spline shaft which drives the spindle through worm gearing, as shown more clearly in the detailed view Fig. 2.

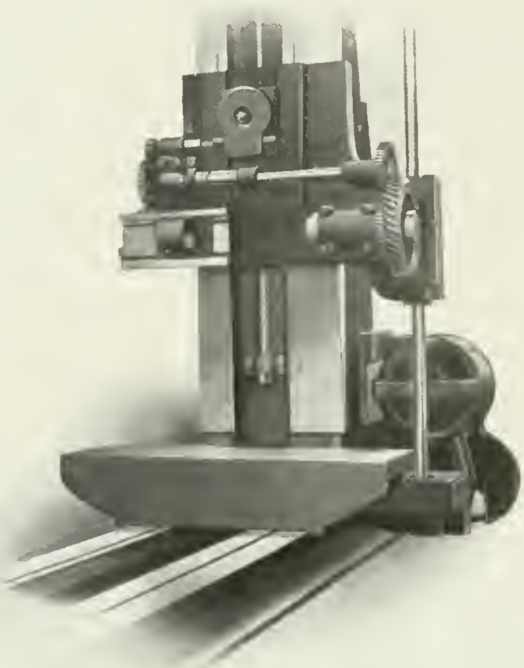


Fig. 2. Detail showing Drive to Spindle and Feed Mechanism

The worm-wheel is equipped with a bronze ring, and the driving worm is of hardened steel. Both the wheel and the worm are encased for continual lubrication, and the latter is fitted with roller thrust bearings. The bearings for both the worm and wheel are cast solid with the saddle. The spindle of this machine is 6⅝ inches in diameter; it is fitted with a No. 7 Morse taper and revolves in a bronze-bushed capped bearing. As the engraving shows, an outboard bearing is provided which has a transverse adjustment. This bearing is fitted with a taper bushing which is cylindrical on the inside and has a taper external bearing with adjusting nuts, to compensate for any wear which may occur.

The spindle saddle has square lock-gibbed bearings on the upright, and the adjustments for alignment are on one shear of the column face. The saddle is counterweighted as shown, and it has a fast vertical adjustment actuated by power and controlled by a conveniently located lever. The power for this traverse is obtained from the vertical spline shaft, which extends to the top of the column as shown, and connects, by means of a horizontal shaft, with a lead-screw located in the center of the column. A reverse movement for the rapid traverse of the saddle is obtained by a double train of bevel gears which connects the vertical spline shaft with the intermediate horizontal shaft at the top of the column. Interposed between these gears there is a Carlyle-Johnson friction clutch, by means of which engagement for upward or downward movement of the saddle is obtained.

The drive for the feed motion is taken directly from the cutter spindle, which carries a large spur gear just inside the driving worm-wheel, meshing with a second spur gear which is mounted on the horizontal shaft seen extending across the saddle in Fig. 2. This shaft connects, in turn, through change gears, with another horizontal shaft just above it that transmits the feeding movement to a nut revolving about the vertical lead-screw. This lead-screw remains stationary except when the rapid traverse is engaged, and it has a top and bottom bearing to permit of its always being maintained in tension. With this construction only one feed is available at a time, but a sufficient number of change gears is furnished to give feeds ranging from 0.035 to 0.321 inch per revolution of the spindle. The engagement or disengagement of the feed is effected by a clutch, as shown, which is controlled by a lever located just back of the saddle.

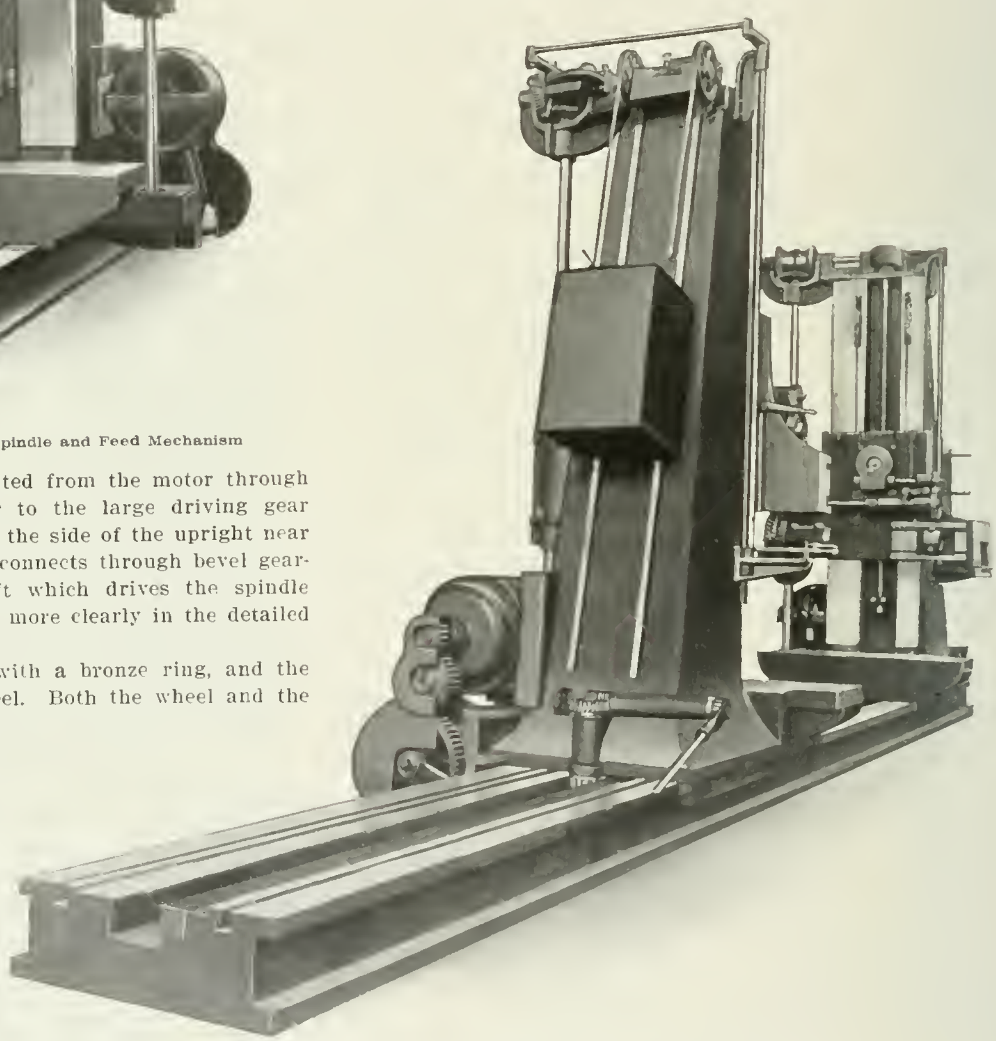


Fig 1. Large Vertical Milling Machine built by the Newton Machine Tool Works, Inc.

This machine has a capacity for cutters having a maximum diameter of 13 inches and a length of 39¼ inches, while the minimum capacity for length is 25¼ inches. The minimum distance from the work support to the center of the spindle is 10½ inches, and the maximum distance is 8 feet, 4½ inches. A base for supporting the work is attached to each column and the columns each have 12 feet of hand adjustment on the bed. The bed is made in three sections, the intention being to mount one upright on each end-section, with the intermediate section between them, when an extension is necessary for especially long work. This machine is also manufactured in smaller sizes to meet ordinary requirements.

ROCKFORD UNIVERSAL JIG AND THREE-SPINDLE TAPPING MACHINE

The universal jig illustrated by the three accompanying views is an interesting design, built by the Rockford Drilling Machine Co., Rockford, Ill., to meet the special requirements of a customer. As the casting for which the jig was designed required tapping operations on every side, it was necessary to so construct the jig that the work could be quickly placed in the various positions.

To obtain a universal adjustment, the double-trunnion type of construction was employed, the work being attached to a bracket mounted on trunnions in an outer frame that, in turn, has trunnions in the supporting stand. As the three illustrations indicate, this construction enables the work to be placed in any required position. To positively and quickly locate the casting for tapping the different holes at the correct angles, each of the swiveling frames is provided with an indexing plate containing as many holes as are needed for locating the work in the different positions required. These holes are engaged by indexing pins, one of which is in the outer frame and the other in the supporting stand. In this way the casting is held for the various operations, without the necessity of using supporting blocks, and it can be quickly and accurately adjusted to different positions with little effort on the part of the workmen.

When the casting is placed in the jig, it remains in the same position with relation to the inner work-holding bracket, until all the operations are completed. This jig is mounted on four casters, each of which is equipped with a ball-bearing to minimize the friction, so that the jig and work can be readily moved to any desired position beneath the drill spindles.

A three-spindle, combined drilling and tapping machine that is a special design built by the Rockford Drilling Machine Co. for use in conjunction with the universal jig, is shown in Fig. 2. As will be noted, the heads with which this machine is equipped differ considerably in size, thus enabling a variety of tapping operations to be performed. The heads are all provided with the makers' tapping attachment, and they are similar in construction to those used on the regular 14-inch, 20-inch back-geared, and 23-inch back-geared drilling machines built by this company. This machine is equipped with a special base, upon which the jig and its work is mounted. It has a tapping capacity ranging from 3/16 to 1¼ inch.

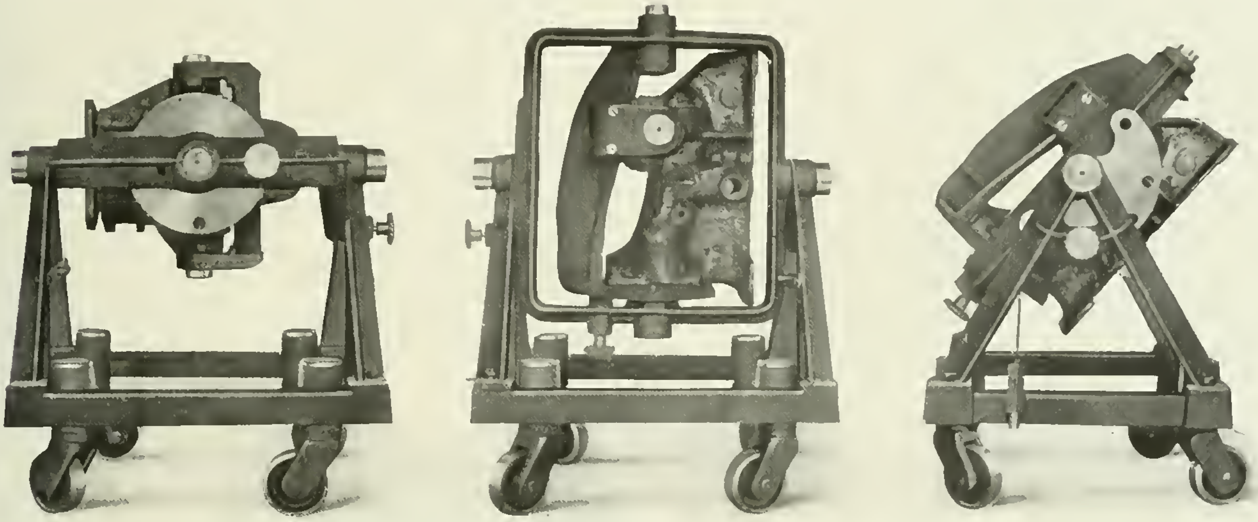


Fig. 1. Jig with Universal Adjustment, built by the Rockford Drilling Machine Co.

Fig. 2. Special Three-spindle Tapping Machine

WOOD & SPENCER STANDARD DRILLING AND REAMING JIG

A standard drilling and reaming jig, designed for handling a wide range of work, has been placed on the market by the Wood & Spencer Co., of Cleveland, O. This jig is so designed that it may be quickly operated for clamping or releasing the part being machined. It is equipped with a lower sliding member that serves to clamp the work by holding it against the top part of the jig. This sliding member is actuated by a hand lever that is connected to a shaft on which is mounted a double-threaded worm, as shown in the sectional view, Fig.

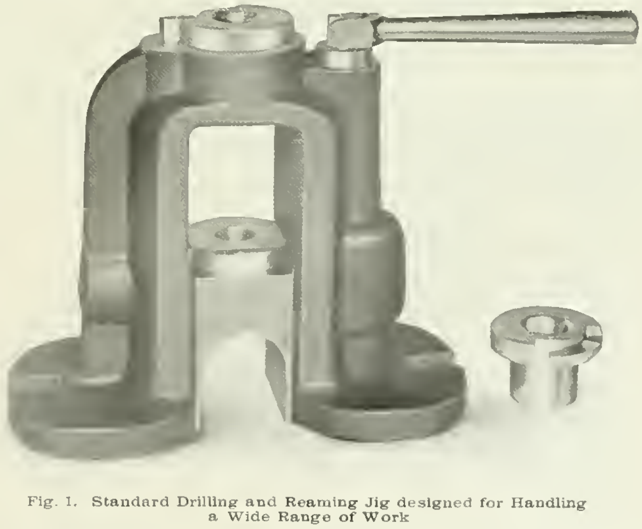


Fig. 1. Standard Drilling and Reaming Jig designed for Handling a Wide Range of Work

2. The worm engages teeth cut in the side of the sliding member, and being double-threaded, gives a rapid adjustment.

The average piece to be drilled can be fastened or released by a quarter-turn of the clamping lever. As this lever is free to swivel on its shaft, it can readily be placed in the most convenient position. For comparatively large jigs, a single-threaded worm is used in order to obtain greater clamping power. The liner bushing *A* is shaped on its under side to suit the work, but the bore of this bushing is kept standard, so as to interchange with all the slip bushings that belong to any given size of jig. These slip bushings, as shown more clearly in Fig. 1, are held in position by what is practically a bayonet lock, there being a pin in the jig body having a projecting end that engages a half-flange on the bushing. The sliding member contains a regular bushing as shown, or it can be equipped with work-holding blocks of special shape when necessary. These jigs are made in eight sizes and lengths, and are furnished with or without bushings.

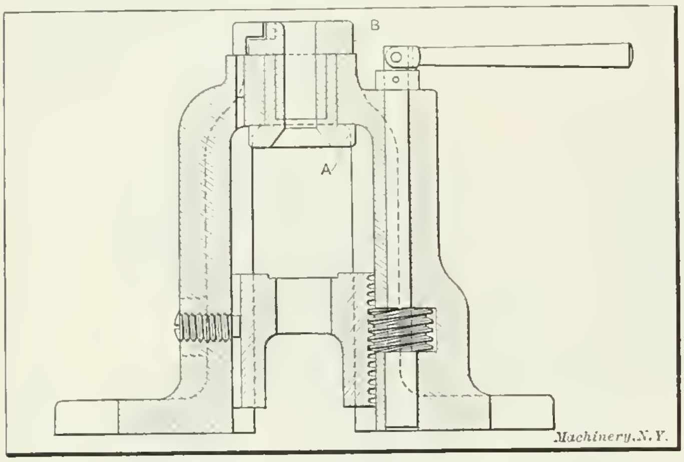


Fig. 2. Sectional View of Wood & Spencer Jig

STEPTOE CRANK-SHAPER WITH SPEED-BOX AND MOTOR-DRIVE

The John Steptoe Shaper Co., of Cincinnati, O., is now building the crank-shaper illustrated in Fig. 1, which is equipped with a self-contained motor-drive and a speed box for giving the necessary speed variations. The motor used is a 3-horse-power constant-speed type, having a speed of about 1200 revolutions per minute. The drive from the motor to the speed box is through a small pinion on the motor shaft, which meshes with a large gear on the speed box shaft. Four changes of speed are obtained in the speed box and this number is doubled by the back-gears, giving eight changes in all. The machine can be started or stopped by means of a clutch which operates in the hub of the large gear. This clutch can be operated with little effort on the part of the workman, as one-pound pressure on the clutch lever gives 128-pounds pressure on the ring.

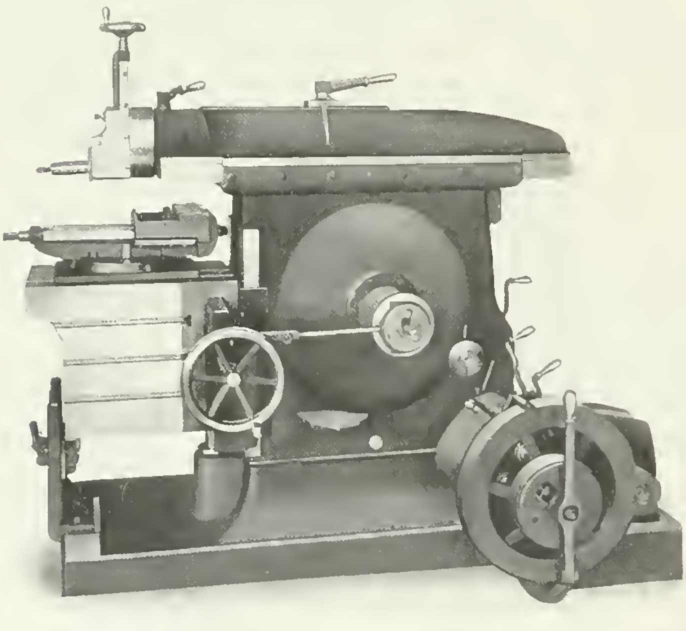


Fig. 1. Twenty-four-inch Motor-driven Back-geared Crank-shaper, with Speed-box

The gears and the clutch mechanism are fully enclosed by guards as shown, thus avoiding the possibility of accidents. All the bearings in the speed boxes are equipped with ring oilers which keep the shafts constantly flooded with lubricant. The proper distribution of the oil over the entire bearing is insured by spiral oil channels in the shafts. The speed box is so designed that no clutches are used, and there are no gears running idle on the shafts. The arrangement is such that when one gear is shifted into position the other is shifted out, so that the wear is reduced to a minimum and all unnecessary noise eliminated. All gears are keyed to their shafts and they are only subjected to wear when in actual operation.

Where the driving shaft from the shaper enters the speed box, a large bushing is provided which enters the column of the shaper and also the speed box bearing. The advantage of this construction is that any strain that might come from the speed box is taken directly by the bushing and not by the driving shaft. This bushing is provided with ring oilers, both in the column of the shaper and in the speed box. The intermediate shaft in the shaper is also provided with ring oilers which can be readily removed or replaced at any time should this be necessary. The speed box is supported by means of a heavy brace that projects from the base of the shaper. The motor is set on a sub-base which is cast integral with the base. This construction gives the motor a very solid foundation and eliminates any vibration when the machine is running, thereby preventing chatter marks on the work which is being planed.

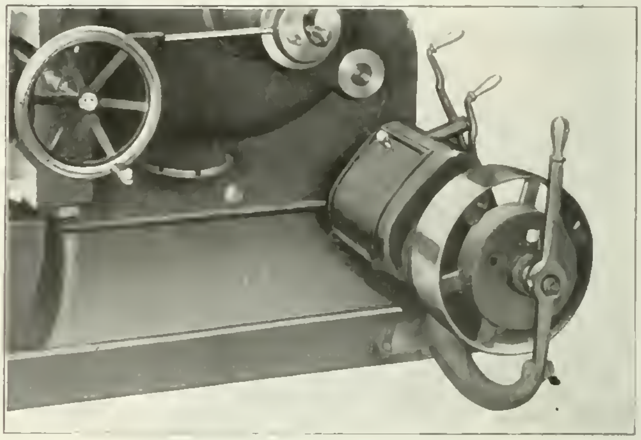


Fig 2. Back-geared Crank-shaper with Speed-box and Clutch Pulley

ROCKFORD SPECIAL DRILLING, TAPPING AND TURNING MACHINE

A special machine by means of which the pump stand casting of an ordinary agricultural force pump may be finished at one setting of the work has recently been built by the Rockford Drilling Machine Co., Rockford, Ill. The casting is illustrated in Fig. 2, which also indicates the operations required. There are fourteen operations in all, including drilling, boring, facing and tapping or threading. Formerly this work was done, principally, in the upright drill press. The castings are now placed, as they come from the tumbling mill, in this special machine which finishes them ready for the paint shop and assembling floor. The time required for the completion of the fourteen operations indicated in Fig. 2, is about five minutes per casting, whereas the time required by the method of machining formerly employed varied from 40 to 50 minutes per casting.

This machine is driven by three belts operating on pulleys *A*, *B* and *C*, from which the power is transmitted through gearing and shafts to the various spindles. Each spindle is

provided with suitable clutches so that it can be immediately disengaged when the operation for which it is intended, is performed. Automatic knockouts are also provided for the feeds wherever necessary.

The function of the various parts is as follows: The multi-spindle head *D* is for drilling four holes in the base *d*, Fig. 2; the square bar *E*, driven by the right main spindle, is for tapping the internal hole *c*; the auxiliary head *F*, at the front, is for drilling and tapping the two holes in boss *f*; the left spindle *G* is for boring, facing, and threading end *g*; the angle and vertical spindles *H* are for drilling and tapping holes *h*; and the hole *i* in the casting is drilled and tapped by a spindle in the rear that is not shown in the illustration.

One of the interesting features of the machine is the 4-spindle auxiliary-head *D* located in front of the right main spindle. The adjustment of the spindles on this head is controlled by the small hand lever seen at the top. By moving this handle forward or backward, the diameter of the circle in which the holes are drilled, is increased or diminished, the construction making it possible to secure an instantaneous adjustment of the four spindles. This head is driven through gearing from shaft *I* which, in turn, is rotated by a belt operating on pulley *C*. The feeding mechanism for head *D* is located at *K* and derives its power through a chain drive and gearing, as shown.

Shaft *I*, in addition to driving drilling head *D*, transmits power to the angle and vertical spindles *H*, through bevel gearing. The square tapping-bar *E* is driven by the right-hand spindle, and it is reversed when withdrawing a tap, by engaging a clutch, controlled by handle *J*, with a reverse gear on the right. The feeding mechanism for tapping-bar *E* is located at *L* and is driven through gearing from the right spindle. The drive for spindle head *F*, to which is attached a 2-spindle auxiliary head for drilling and tapping the holes in boss *f*, Fig. 2, is transmitted from the left-hand driving pulley *A* through a train of gearing and shaft *M* which may be disconnected from the driving train by operating a clutch controlled by lever *N*. This head is mounted on a dovetailed slide, and it can be adjusted longitudinally when necessary. The left-hand spindle for performing the tapping, boring, and facing operations on end *g* of the casting is driven through gearing by pulley *A*. This pulley also drives the back spindle, previously referred to, which is for machining hole *i*. The movement of this back spindle is controlled by shifter *O* which connects with a friction clutch, and the spindle is adjusted by a handwheel. The angle and vertical spindles are also adjustable along their supporting base, the adjustment being effected by means of the handwheel and screw shown.

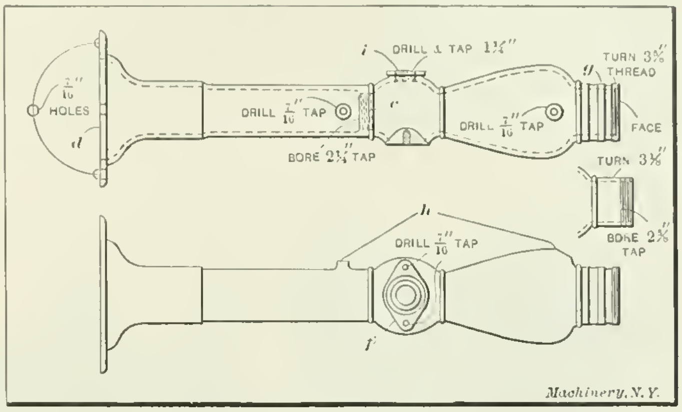


Fig. 2. Pump Casting upon which Fourteen Operations are performed in Special Machine shown in Fig. 1

The pump casting is held, while being machined, in a fixture of simple design, in which it may be quickly clamped or released. As will be seen, the entire control of the machine is from the front, and the various spindles have sufficient adjustment to permit the machining of the different sizes of castings required for the line of pumps made by the concern for whom the machine was constructed.

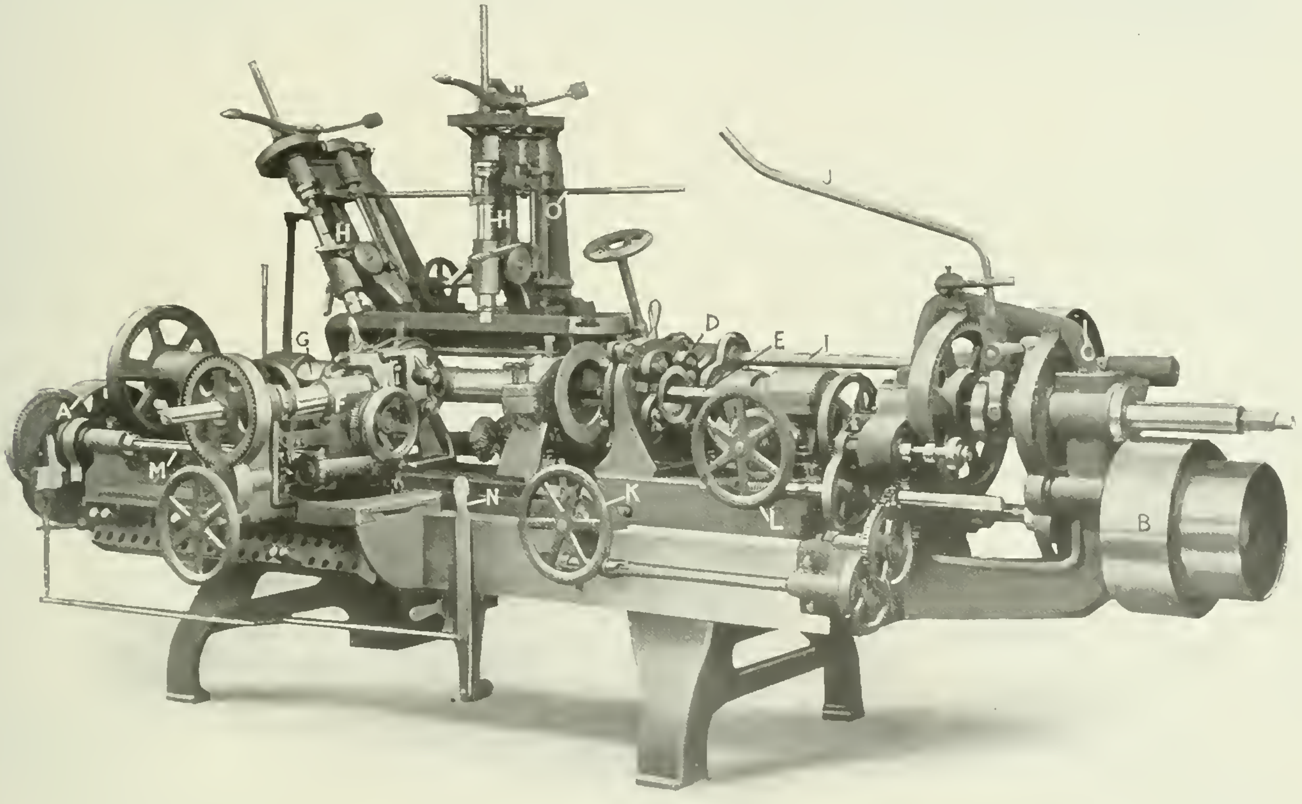


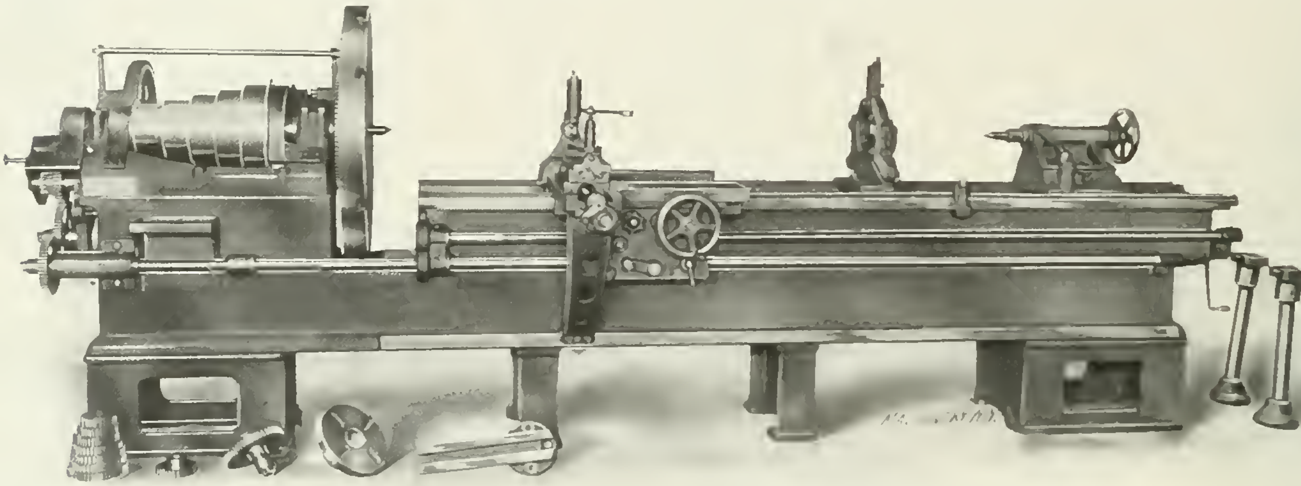
Fig. 1. Special Machine for Machining Force Pump Casting shown in Fig 2

HARRINGTON 16—32-INCH EXTENSION LATHE

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., have brought out a new size and design of high-duty extension lathe, which is shown in the accompanying halftone. All the general features common to the extension lathes regularly built by this company, have been retained, and, in addition, provision has been made for the application of a taper attachment, a quick-change gear-box, and a motor-drive, if such equipment is not ordered originally.

The extension and main beds of this lathe are very wide, securely braced and carefully fitted. The upper bed is ad-

justed by a screw that is operated from the end of the lathe, and it is supported, when extended, by two jack-screws, in addition to the regular clamping bolts. The headstock is equipped with triple gearing that gives ample power for turning work of large diameter. The spindle is of forged high-carbon steel, and it has large bearings in phosphor-bronze boxes. Feed and screw gears are provided for cutting all regular threads, and when the machine is equipped with an ordinary swing yoke, three changes of feed are obtained by operating a sliding clutch-pin. When a quick-change gear-box is attached, all threads and feeds are obtained by operating one lever and a clutch-pin. Gears for cutting metric threads can be provided with either the swing yoke or gear box. All regular threads from 2 to 28 per inch, including the 11½ per inch pipe thread, can be cut.



Sixteen—Thirty-two-inch Extension Lathe, built by Edwin Harrington, Son & Co., Inc.

The carriage has long bearings on the bed, and the cross-slide is provided with an extension for turning large diameters, which is rigidly supported by a bracket, as shown, having an adjustable shoe or guide on the lower edge of the bed. An extension toolpost is furnished, to replace the compound rest for turning across the gap. The apron has a geared friction feed operating the longitudinal and cross feeds. The feed is reversed at the apron and it has a positive interlocking device to prevent engaging the screw nut and feed simultaneously.

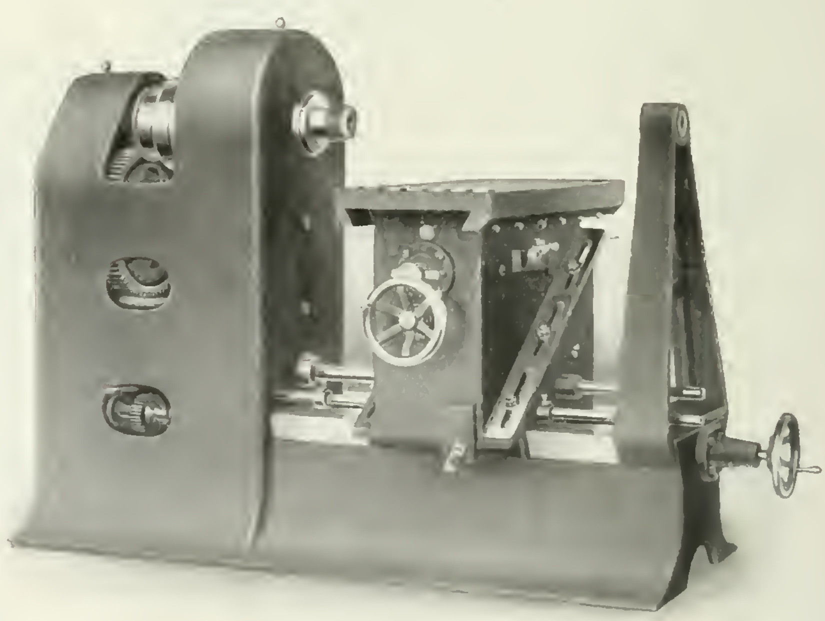
When a motor drive is employed, the motor is mounted on the headstock and engages gears which replace the cone. The motor speed control is governed by a handwheel on the apron. The taper attachment is connected to the back of the carriage, and does not require special lugs cast on the bed.

The principal dimensions of this lathe are as follows: Swing over the top shears, 16 inches; swing over the lower guides, 32 inches; swing over the carriage, 11 inches; ratio of back gearing, 6.25; ratio of triple gearing, 25.6; feeds in turn per inch, 6.85 to 96; diameter of hole through spindle, 1 9/16 inch; length of bed (not extended), 8 feet 2 inches; distance between centers, bed closed, 4 feet; distance between centers, bed extended, 7 feet 3 inches; size front spindle bearing, 3¼ by 5⅜ inches; size back bearing, 2⅜ by 4¼ inches; weight, 4000 pounds; additional weight per foot of extra length, 325 pounds.

BURKE MACHINERY CO.'S FACING AND BORING MILL

The Burke Machinery Co., Conneaut, Ohio, is now building a machine of the type shown herewith, which is adapted to both milling and boring operations. Provision is made for mounting milling cutters on the horizontal spindle, which is also fitted for driving boring-bars. Power feeds for longitudinal and cross movements of the work table are provided, which are conveniently controlled by the workmen.

By referring to the illustrations, it will be seen that the work table or platen is mounted on a large base which is made in two sections that are joined by angular ways. Obviously, with this construction, any movement of the upper section will result in a vertical adjustment of the table. This movement is effected by an angular screw, the squared end of which is seen projecting from the front. When the table is positioned vertically in this manner, the two members of its supporting base are rigidly locked by six bolts which pass through elongated slots. This simple arrangement gives the necessary vertical adjustment to the platen and at the same time furnishes an unyielding support. The spindle has a powerful geared drive, and the feeding and driving gears are all enclosed by the frame which affords protection to the operator and makes the design exceptionally rigid. This machine has a capacity for driving inserted-tooth milling cutters with a diameter of at least 14 inches.



Combined Boring and Facing Mill, built by the Burke Machinery Co.

The principal dimensions of the machine are as follows: Minimum distance from center of spindle to table, 7 inches; maximum distance from center of spindle to table, 11 inches; working surface of table, 18 by 54 inches; range of power feed for longitudinal and cross movements, 24 inches; ratio of gearing 12 to 1; width of driving belt, 3 inches; minimum and maximum diameters of steps on cone, 8 and 13 inches, respectively; taper in spindle, B. & S. No. 12; size of front spindle bearing, 4½ by 7¾ inches; size of rear bearing, 3½ by 5¾ inches; over-all height, 4 feet 6 inches; weight 4500 pounds; and floor space, 2 feet 6 inches by 6 feet 8 inches.

AMERICAN HIGH-DUTY LATHES

The American Tool Works Co., Cincinnati, Ohio, is now building the design of high-duty lathe shown herewith. This new design is constructed to withstand severe duty, and its power, range, durability, rigidity, and convenience of operation, show clearly that careful attention has been given to every important detail in the construction. This design is built in 36- and 42-inch sizes, and it can be furnished with a single-pulley belt drive and geared head, as shown in Fig. 1, with a motor drive as in Fig. 2, or with a cone-pulley head as indicated in Fig. 3. The makers recommend a motor drive, as a lathe of this size requires easy access to crane service, and is frequently operated overtime. As sixteen spindle speeds are regularly provided, a constant-speed motor may be advantageously used. If, however, a variable-speed motor is preferred, a speed variation of only 35 per cent will be required.

In the design of the geared head, the number of running parts has been reduced to a minimum, to overcome any unnecessary waste of power, and the drive for both the spindle and feed mechanism is as direct as possible. The matter of lubrication has also received careful attention; thus insuring the delivery of a high percentage of power to the tools. As the illustration shows, all levers and handwheels for the control are conveniently placed.

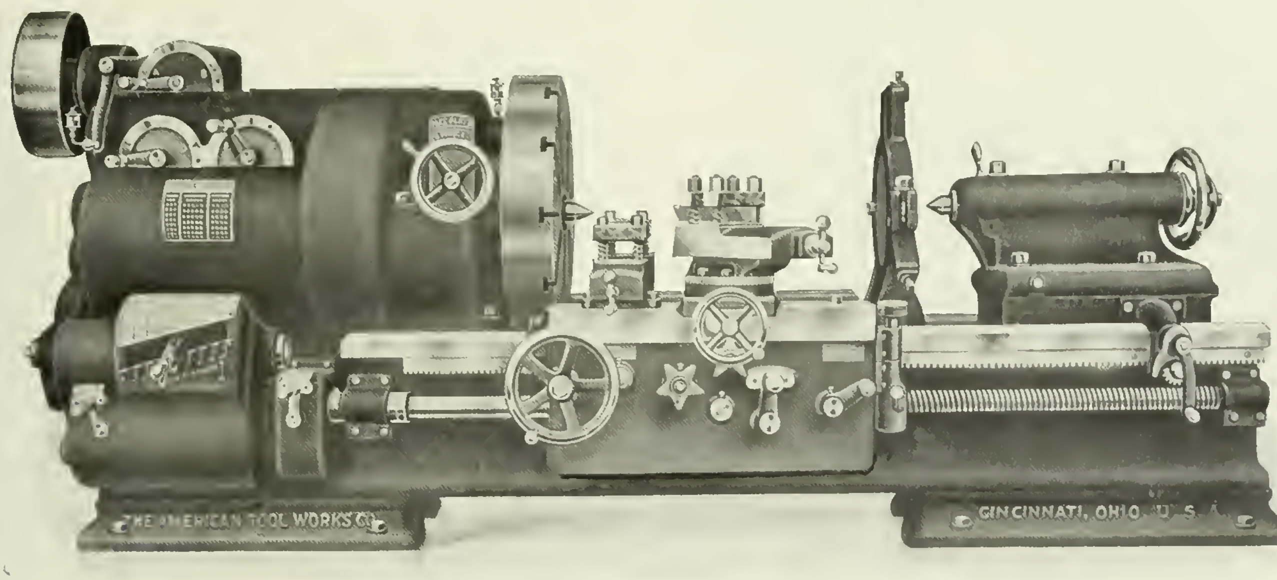


Fig. 1. High-duty Lathe, built by the American Tool Works Co.

The Geared Head

The geared head is arranged to give sixteen spindle speeds, all of which are obtained through slip gears and positive clutches. The clutches are of the selective type and easily engaged, and the teeth of the gears are machine-rounded so that they slide easily into mesh. All gears are mounted on the long bronze sleeves which are oiled from the outside of the head by means of sight-feed oilers. Of the sixteen speeds available, eight are obtained directly through the spindle gear, and the remaining eight through the faceplate drive. By having a large range of speeds through the faceplate drive, the latter can be used for a great deal of heavy turning on work of large diameter, thus relieving the spindle of excessive strains. The head is so constructed that the power is transmitted either by short shafts or sleeves, there being no long shafts in torsion at any time. All gears in the driving mechanism are of coarse pitch and wide face, and the pinions are of steel cut from the bar. Another important point in the construction of the head is the elimination of all loose gears from the spindle. The only gear on the spindle is the

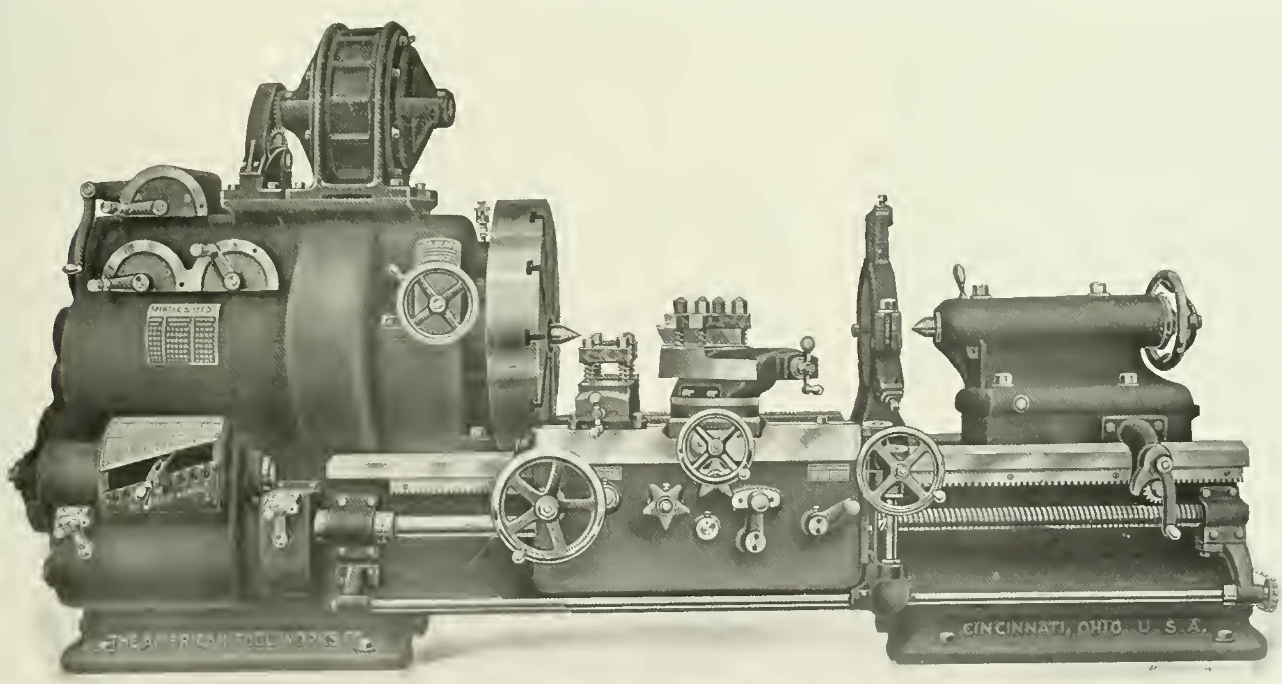


Fig. 2. American High-duty Lathe with Motor Drive

driving gear, which is set close against the front bearing so that the spindle is never under a severe torsional strain. The spindle is made in the taper form, which construction is common to heavy wheel lathes. The bearings throughout the head are all bored from the solid and are lined with phosphor-bronze bushings, and the bearings throughout the machine are also of phosphor-bronze. All speed changes can be made without stopping the initial drive, as the lathe may be started, stopped, or the speed reduced by means of a friction clutch which engages or disengages the driving pulley or motor gear. This clutch is operated by the lever seen to the right of the

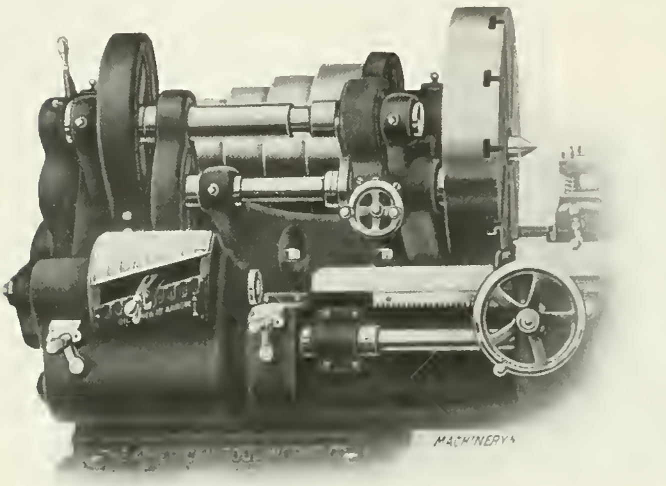


Fig. 3. Detail View of American Lathe with Cone-pulley Drive

driving pulley in Fig. 1. The various speed changes are made by operating the three handles or levers shown on the upper part of the headstock, in conjunction with the handwheel located just back of the faceplate, which controls the triple gear pinion. The positions of the levers for different spindle speeds are shown on an index plate, located just beneath the handles. This plate, a reproduction of which is shown in Fig. 4, is which may from time to time be desired. As the cone gears are all of the Brown & Sharpe 20-degree, involute, pointed type, the teeth are strong and the gears easily engaged while in motion. An important feature of this mechanism is that coarse threads and feeds are all obtained through the cone, and no member of the feed-box runs faster at any time than the initial driving gear. The different threads and feeds for different positions of the controlling levers, are plainly indicated on an index plate which is reproduced in Fig. 5.

Motor Drive—Single-pulley Belt Drive—Cone-pulley Drive

When a motor drive is employed, a motor of the constant-speed type for either direct or alternating current, is located on the geared head as shown in Fig. 2, and connection is made with the main driving shaft through spur gearing. The motor is constantly under the control of the operator, the controlling handle being conveniently located on the right end of the carriage, as shown.

The single-pulley type of drive is provided when a powerful belt drive is desired, and high efficiency is obtained by running the belt at the fastest speed consistent with good practice. The headstock is of the triple-geared type and is the same in construction as the one used with a motor drive. The pulley is bronze bushed and runs on a steel sleeve of large diameter, thus relieving the driving shaft from all belt pull. The pulley is self-oiling, the hub forming a retainer for the oil which is fed to the shaft through felt wipers. A single-pulley belt-driven machine can be easily changed for a motor drive, at any time after installation, by simply removing the pulley and placing a motor on the headstock and connecting it to the driving shaft of the head through spur gearing.

With the cone-pulley drive, the headstock is equipped with triple gears and has 12 spindle speeds. The detailed view, Fig. 3, shows the headstock end of a lathe arranged with this type of drive.

The Bed and Tailstock

The bed is of deep section, exceptionally heavy, and well braced by cross box-girths at short intervals throughout its length. It is the company's patented drop V-pattern which

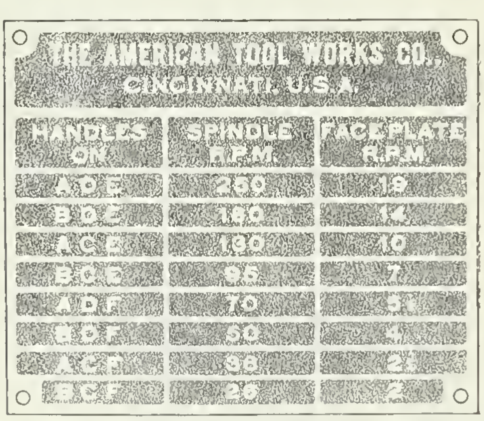


Fig. 4. Index Plate showing the Position of Control Levers and Spindle Speeds.

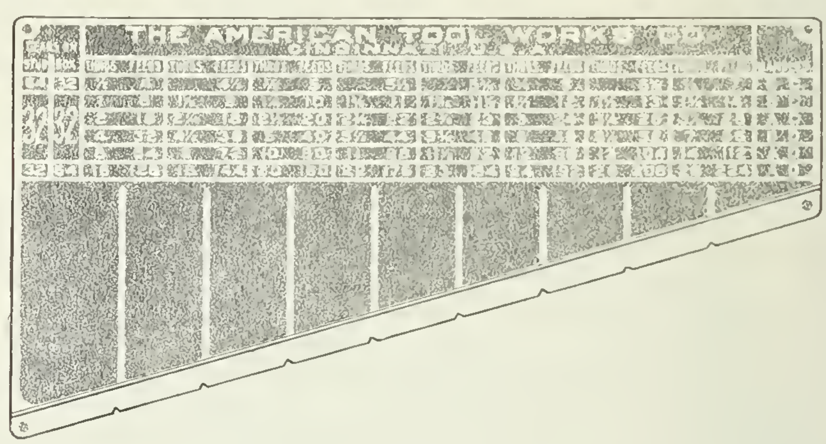


Fig. 5. Index Plate for the Feed-change Mechanism

simply arranged, and gives the revolutions per minute for the spindle and faceplate drives for different positions of the controlling levers.

Rapid Change-gear Mechanism

The rapid change-gear mechanism is embodied in a self-contained unit mounted on the front of the bed. This mechanism provides 32 fundamental changes for threading, ranging from 1 to 14 per inch. In addition to this, a compound quadrant gear located on the end of the bed, furnishes 16 additional changes, thus giving 48 threading and feed changes ranging from ½ to 28 threads (including 11½ pipe thread) and from 4 to 244 cuts per inch. The 32 changes in the box are all obtained through the medium of a cone and tumbler gear and two sliding clutches of the selective type. Any one of these changes may be instantly made while the machine is running. The quadrant gear previously referred to, supplements the regular feed mechanism and provides means for cutting threads of odd fractional or metric pitches or gives odd feeds gives additional swing and permits deepening the carriage bridge. The bed is further strengthened by a web cast through the center, which carries a rack for engaging a pawl attached to the tailstock.

The tailstock is of the quadruple clamping stud type with studs running to the top of the barrel, and it is further secured against movement by a pawl which engages the rack previously referred to, cast in the center of the bed. This pawl can be lifted out of engagement by a pull-rod at the end of the tailstock. The tailstock barrel is of large diameter, and it has an improved form of plug binder for clamping the spindle. The spindle has an exceptionally long travel, is graduated in inches, and is actuated by a dished handwheel which brings the rim closer to the operator. This tailstock is adjusted along the bed by a crank and gear, as the engraving shows.

Carriage—Apron—Compound Rest

The carriage is heavy, particularly on the bridge, owing to the drop V-formation of the bed. There is a continuous bear

ing of 50½ inches on the V's and an additional bearing on the top and inner surfaces of the front tailstock V, which resists the forward thrust of the tool and gives a bearing directly beneath it. The carriage is gibbed its full length at the back, and a clamp is provided at each end in front, the one to the right being for binding to the bed.

The apron is tongued, grooved and securely bolted to the carriage. It has the double-wall construction, thus giving all shafts a double bearing. Both longitudinal and cross feeds are reversed by a lever on the front of the apron. All the gears and pinions of the apron are of steel, cut from the solid with special cutters, and convenient means for thorough lubrication from the front are provided. The rack pinion can be withdrawn from the feed-rack when the lathe is being used for screw cutting, and it is impossible to engage, simultaneously, the screw-cutting and feeding mechanisms.

The top slide of the compound rest has a 14-inch power, angular feed, and a micrometer adjustment. It is equipped with a 4-stud tool-holder and two hardened steel clamps, the studs being so placed that the tool may be set outside of them in either a crosswise or lengthwise position. The swivel is graduated up to 90 degrees on each side of the zero mark.

Miscellaneous Features

The spindle of these lathes is made of high-carbon hammered steel and it runs in bearings of the best quality phosphor-bronze, that are equipped with sight-feed oilers. The lathe screw is exceptionally large in diameter, and it has one thread per inch, which permits the half nuts to be engaged at any point, when threading, without the use of the thread dial, except when cutting fractional threads. This screw is made from high-carbon round stock, and it is chased from a Brown & Sharpe master-screw and carefully tested by a special apparatus. The triple gears of the head are of the slip-gear type. The internal gear is planed integral with the faceplate, and the pinion is also integral with the steel shaft.

The principal dimensions of the 36- and 42-inch sizes are as follows: Standard length of bed, 12 feet; actual swing over the bed, 37¾ inches and 44 inches; swing over the carriage, 23⅜ inches and 30⅝ inches; maximum distance between the centers with the tailstock flush, 4 feet for geared-head construction, and 5 feet with cone-pulley head; diameter of the hole through spindle, 2⅝ inches; taper of centers, Morse No. 6; size of tool ordinarily used, 1 inch by 2 inches. The beds can be furnished in any length from 12 feet up, advancing by 1-foot lengths. The regular equipment includes compound-, steady- and full-swing rests, countershaft for belt drive, and the necessary wrenches. An improved taper attachment, or a turret on either the carriage or shear, can be supplied extra, if desired.

BARDONS & OLIVER MOTOR-DRIVEN GEARED-HEAD TURRET LATHE

Bardons & Oliver, of Cleveland, Ohio, are now manufacturing the motor-driven geared-head turret lathe, shown in Figs. 1 and 2. This machine, as the illustrations indicate, is constructed throughout along modern lines. It is equipped with an automatic chuck, wire feed, power feed to the turret and cross slide, and an automatic throwout for the cross and longitudinal feeding movements. The convenience of control has received special attention, and all revolving parts are carefully guarded.

A motor with a speed variation of three to one is used, this range covering the intermediate steps between the two mechanically-obtained spindle speeds. The ratio of these two mechanically-obtained speeds is about three and a half to one, which the builders have found to be what is generally required for the quick or instantaneous changes on these machines. This gives a total speed range of about ten to one. The reverse or backward speed is also obtained mechanically

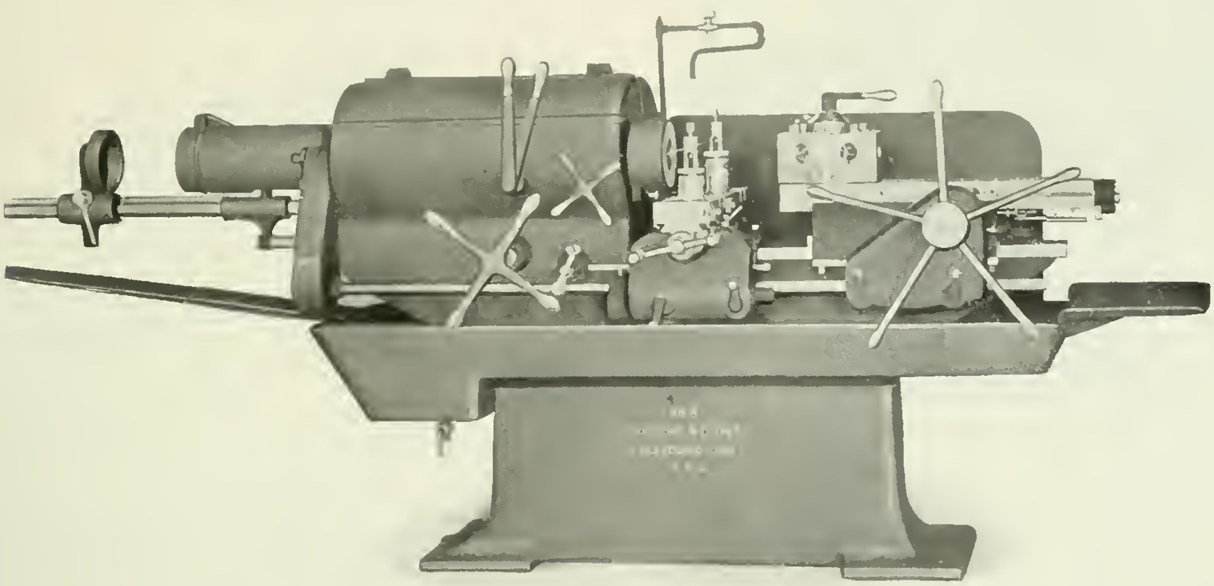


Fig. 1. Bardons & Oliver No 8 Motor-driven Geared-head Lathe

by means of friction clutches on the spindle. A detailed view of the geared head with the hinged cover thrown back is shown in Fig. 3. The mechanical changes are obtained by operating the vertical levers shown, which are conveniently located for the operator.

On the machine illustrated, a Reliance, adjustable-speed motor is used, and the small turnstile to the right of the vertical levers, controls the speed changes of the motor. This machine is built in all sizes common to the belt-driven type made by this company, with the exception of two small sizes, designated as Nos. 0 and 1. In the No. 8 size, illustrated herewith, the spindle speeds may be varied from about 30 to 300 revolutions per minute. The motor, which is a 4 horsepower variable-speed type on the No. 8 size, is mounted on an extension of the column and does not require a separate foundation. The machine is furnished complete with all electrical equipment, and the motor is wound to suit the customer's voltage. If desired, however, the motor can be furnished by the customer, but in this event it must be shipped to the company in order that the machine may be tested complete.

A noteworthy feature in the design of the geared head of this machine, is the method of reversing the spindle. The reverse gear, which is engaged by a friction clutch operated by one of the vertical levers shown, is mounted on the spindle. With this construction, the spindle, which is the slowest running member in the driving train, is the only part reversed, all the other parts continuing to run in the same direction for forward or reverse movements of the spindle. The advantage of this feature, particularly for high-speed work, is obvious.

The oil pump used for supplying the lubricant to the cutting

edge of the tools, is of the rotary type. It is located in the head and is driven direct from one of the shafts. The system of lubrication for the headstock gears and clutches is illustrated in Fig. 4, which shows a sectional view of the main pinion shaft. This shaft, and also the second shaft, is drilled longitudinally and radially for oil channels, as shown, and the lubricant is supplied through oil cups located in the bearings, as shown to the left at *F*. Felt wicks are provided to retain the oil and feed it to the bearings. These wicks are located at *A*, *B*, *C*, *D* and *E*, and the radial oil holes leading to them are clearly indicated.

As before stated, all gears and moving parts are carefully guarded. The guard for the rear end of the spindle is provided with a hinged cap which can be lifted for adjusting the chuck.

The automatic chuck on this machine has a maximum capacity for $2\frac{1}{4}$-inch round, $1\frac{5}{8}$-inch square, and 2-inch hexagonal

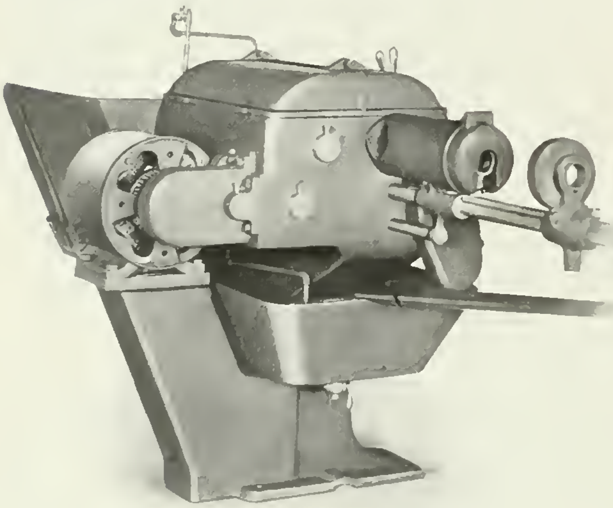


Fig. 2. Rear View of Bardons & Oliver Machine, showing Motor Drive

stock. The hole through the spindle is $2\frac{3}{4}$ inches in diameter, and the hole in the chuck plunger is $2\frac{3}{8}$ inches in diameter. A maximum length of 11 inches can be turned, and the greatest distance from the end of the spindle to the face of the turret is $23\frac{1}{2}$ inches, the saddle being even with the end of the bed. The swing over the bed is $19\frac{1}{2}$ inches, and over the cut-off slide, $8\frac{3}{4}$ inches. The hexagon turret measures $10\frac{1}{4}$ inches across the flats, and it has an independent stop for each of the six positions. Each face is provided with a hole 2

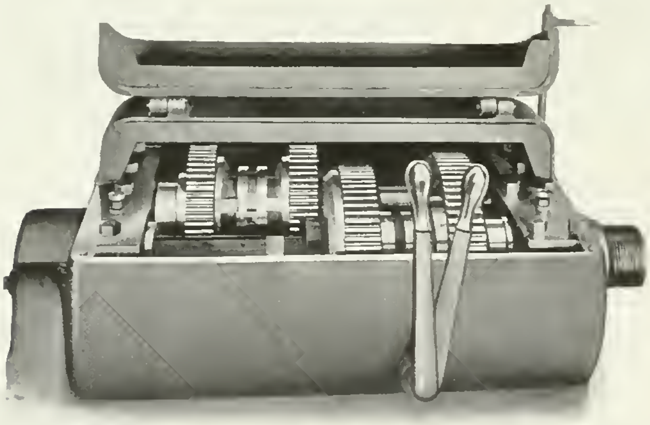


Fig. 3. Geared Head with Hinged Cover Thrown Back

inches in diameter, and, in addition, there are eight $\frac{1}{2}$-inch tapped holes for bolting tools to the turret faces.

The machine illustrated is equipped with a No. 8 standard master collet and false jaws for one size of round stock. Extra false jaws for rounds, squares, and hexagons can also be supplied. Other extra equipment that can be furnished is as follows: A hollow turret stud which allows stock to pass through the turret; extra capacity automatic chuck; and a standard set of tools for general work. This standard tool equipment contains one plain stop gage; one chamfering tool; one single cutter box-tool with roller back-rests; one multiple cutter box-tool with two adjustable tool-holders; two roller back-rests; two sockets for taper shank drills; one plain

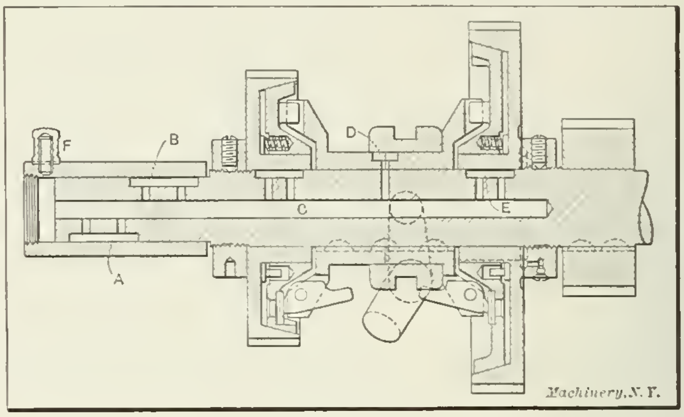
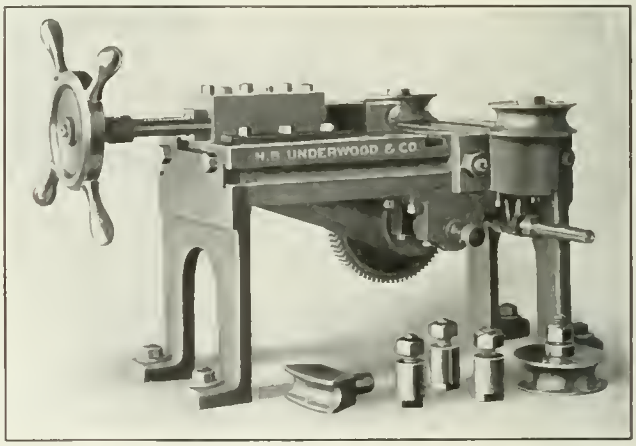


Fig. 4. Sectional View of Shaft in Geared Head, showing Lubricating System

drill-holder with collet; one cutting-off tool-holder and blade; and one $1\frac{1}{4}$-inch self-opening die-head with six sets of chasers for threads ranging from $\frac{5}{8}$ inch to $1\frac{1}{4}$ inch in diameter.

UNDERWOOD POWER BENDER AND STRAIGHTENER

A machine of new design for bending pipe, structural iron, round or flat bars of various kinds and sizes, has been developed by H. B. Underwood & Co., 1021 Hamilton St., Philadelphia, Pa. This machine is also capable of straightening material in a quick and efficient manner. In its operation,



Underwood Belt-driven Bending and Straightening Machine

a multiplicity of dies or formers is not required, it being necessary to have only a set for the different diameters. These formers may be placed in different locations to permit bending a large variety of shapes and to different radii.

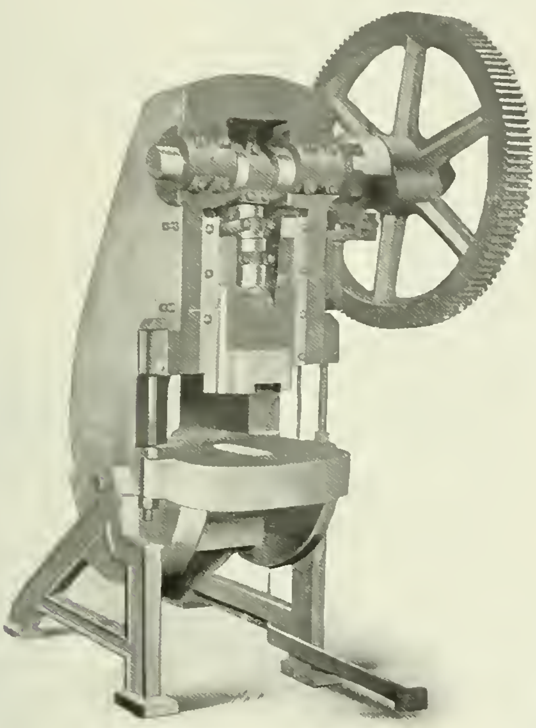
A belt drive is employed, and the ram is actuated by an eccentric shaft of small throw, which moves with a fixed stroke. The shaft is powerfully back-geared, thus giving the ram tremendous power. Sliding in this reciprocating ram is another which carries the former to be used and this is moved in or out by operating the handwheel shown. In this way, a very delicate adjustment is obtained which enables the work to be formed with considerable accuracy. Any number of pieces can be bent to practically the same shape, by noting the last position of the handwheel. The effect of bending in this manner, that is, by having the former follow up the work and exert a comparatively slight pressure at each stroke, is much better for the material than a sudden bend or shaping of the piece in one movement.

The formers or resistance studs on each side of the bed, slide in a T-slot as shown, and there are also transverse T-slots for formers, which make possible many different arrange-

ments. With this machine pieces of pipe, bars, etc., that have been bent into various shapes, can be quickly and easily straightened. Little skill is required in the operation of this tool, as the workman simply moves the pipe along and turns the handwheel to suit requirements

DANVILLE COMBINED PRESS, SHEAR AND PUNCH

The Danville Foundry & Machine Co., Danville, Pa., is now manufacturing the combination trimming press, slitting shear, and punch, a front view of which is shown herewith. This press can be furnished for either a belt or motor-drive. The particular machine illustrated is motor-driven, the motor being mounted on a bracket attached to the rear of the frame. The stroke of the press is 3¼ inches, and the knives, which have four cutting edges, are 10 inches long. The main housing is open in the back so that long narrow bars can be sheared. The opening between the housings is 12 inches, and the depth of the throat is 8 inches from the shear cutting edge. The driving gears are all cut to insure quiet operation. The



Combination Trimming Press, Shear and Punch

main crosshead is adjusted to suit different classes of work by means of a right- and left-hand screw. There is also provision made for taking up wear on the crosshead by means of adjustable V-shaped guides. When the knife-holders are removed, a punch-holder can be inserted for punching operations.

This press requires a floor space of 4 feet by 3 feet 6 inches. It has been designed especially for drop-forge works, or other metal-working establishments requiring shearing, punching, or pressing machinery.

GORTON SPECIAL ENGRAVING MACHINE

The engraving machine shown in Fig. 2 is a special design built by the Geo. Gorton Machine Co., Racine, Wis., for engraving names in automobile tire molds. The head of this machine is similar to the type used on the regular line of engraving machines manufactured by this company, but the frame and work table are of special construction. The mold-ring in which the firm name, trade name, and size of tire is engraved is shown in Fig. 1. This ring, which is of cast iron, is mounted on the large circular work-table, and the revolving graver or cutting tool, guided by a copy or master-pattern, cuts out the letters as shown on the finished ring illustrated. The copy is clamped in a holder at the rear of the head and the outline of its enlarged letters is followed by a small pin in the arm of the pantograph reproducing mechanism, which is worked by the hand of the operator. As the letters of the copy are traced in this manner, they are reproduced in the work on a smaller scale by the graver, the ratio of the reproduction being controlled by the setting of the pantograph arms. As the engraved surface of the mold ring is concave to conform to the shape of the tire, it is necessary to give the

Fig. 1. Tire-mold engraved on Machine illustrated in Fig. 2

cutter a vertical movement in addition to its regular movement, so that all parts of a letter will be cut to the same depth. To accomplish this, the spindle is held in contact (by a spring) with a small templet mounted above it, as shown in the illustration. This templet has the same radius as the curved part of the mold, and it guides the spindle up and down as the cutter is moved across the convex surface. The

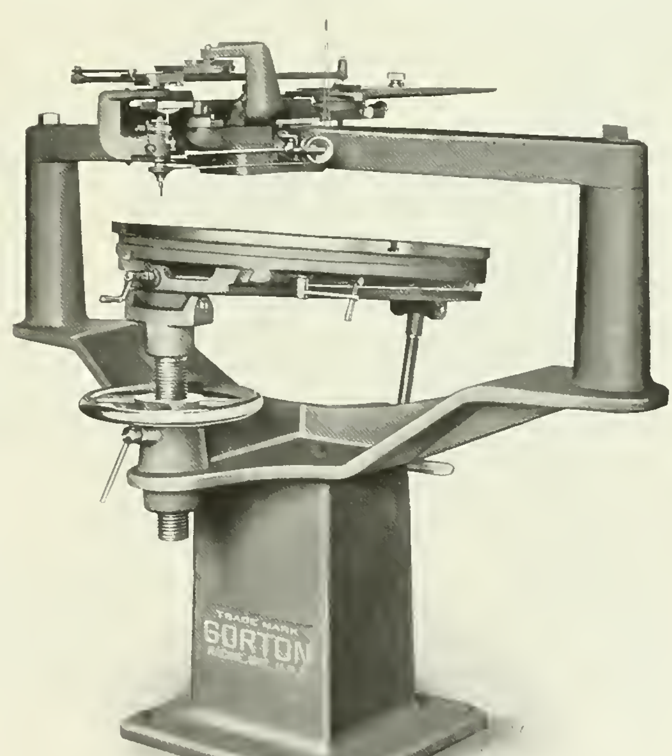


Fig. 2. Engraving Machine specially designed for Engraving Automobile Tire Mold Rings

work in this particular case is an example of intaglio or sunk engraving, the letters on the tire being, of course, raised. These machines are, however, adapted to engraving letters in relief if desired.

LANDIS SOLID ADJUSTABLE DIE-HEAD

A solid adjustable die-head has been brought out by the Landis Machine Co., Waynesboro, Pa., that is designed to take the place of the solid dies now used on screw machines and other types of machines in which the work is backed out of the die after the thread is cut.

This die-head, the 1-inch standard size of which is illustrated herewith, has a capacity for threads varying from 1/4 inch to 1 inch in diameter, so that it is adapted to a wide range of work. The chasers are adjusted to and from the center on radial lines, for different sizes, and they are held rigidly in their seats. These chasers, one of which is illustrated in Fig. 1, can be ground to suit the material being operated upon. Any amount of rake can be given that is necessary, thereby insuring the best possible cutting conditions and securing ideal results.

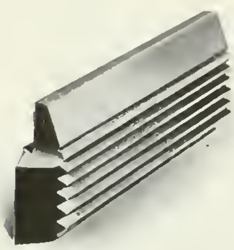


Fig. 1. Type of Chaser used in Solid Adjustable Die-head

The chasers are made from high-speed steel, and they can be ground and re-ground many times, thus giving a long life. Adjustments for wear are readily made, in addition to the adjustment for different diameters. If desired, the chasers can readily be set above or below their rated diameter; that is, any diameter within the range of the head can be cut with one set of chasers so long as the pitch is the same. For instance, the 1/2-inch chasers (having 13 threads per inch) can be set to cut 1 inch in diameter, and they can also be set for a 1/4-inch thread. The angle of the thread, however, while not ideal, will be all that is required on ordinary screw machine work. In special cases where great accuracy is required, it would be advisable to use special holders.

These heads can be supplied in standard sizes with shanks suitable for holders in ordinary screw machines. The 1/2-inch head is 2 3/4 inches in diameter, and is capable of cutting a thread 1 1/2 inch in length. The 1-inch head is 4 5/8 inches in diameter, and it will cut threads 2 1/2 inches long. Other sizes with special shanks can be made to order.

The special advantages claimed for this type of head are that it will permit comparatively high cutting speeds; it has a long life; a wide range; independent adjustment for any one chaser of a set; and when the chasers are ground, the die is as good as new. Any chaser of a set can be replaced without replacing the complete set.

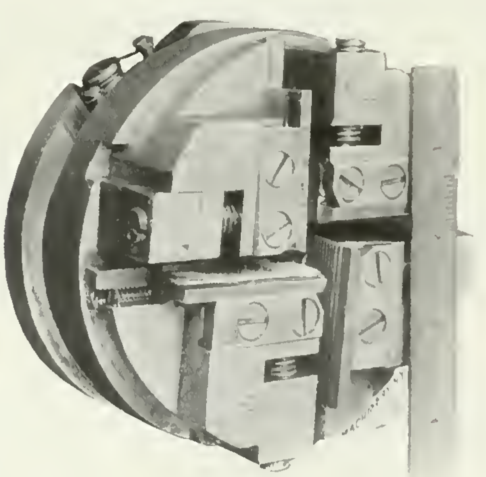
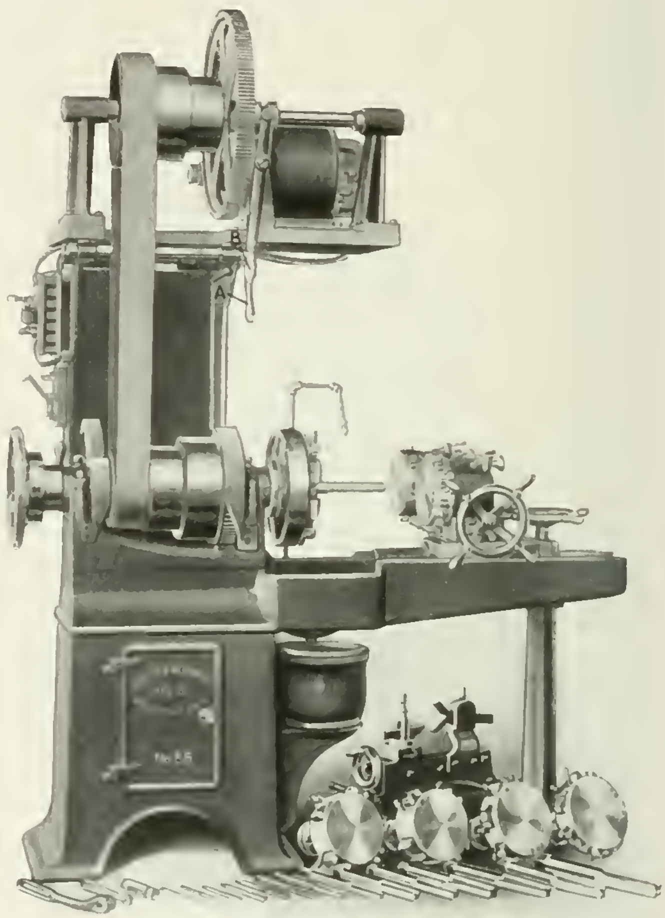


Fig. 2. Laudis Solid Adjustable Die-bead for Automatic Screw Machines, etc.

WILEY & RUSSELL THREADING, TAPPING AND CUTTING-OFF MACHINE

In the department of New Machinery and Tools for June, 1910, we illustrated and described a combined bolt-cutter, nut-tapper, pipe-threader and cutting-off machine built by the Wiley & Russell Mfg. Co., Greenfield, Mass. This type of machine has recently been equipped with a self-contained motor drive, as shown in the accompanying halftone.

The shelf for the motor is attached to a bracket that is fitted and bolted to the bed. This shelf is hinged at the back and it has finished projecting lugs which rest on a cam-shaft operated by lever *A*. By this means, sufficient tension can be kept on the belt at all times, and the belt can also be quickly slackened when it is desired to shift it from one step to another on the cone pulley. After the belt is tightened, the cam-shaft is locked with a binder. The lever *B* controls a clutch engaging the large spur gear shown, so that the bolt-cutter can be stopped independently of the motor. The motor is of constant-speed type and it is fitted with a rawhide driving pinion. A motor of two-horsepower capacity is required. It can be furnished for direct or alternating current, and it may be reversing or non-reversing as desired. The starting rheostat is mounted in a convenient location on the side of the motor-supporting bracket, as shown.



Wiley and Russell Combined Bolt-cutter, Nut-tapper, Pipe-threader and Cutting-off Machine with Motor Drive

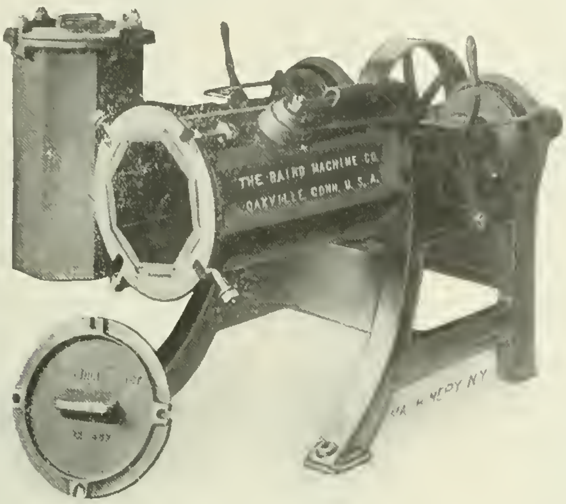
The dies used on this machine are the company's standard quick-change opening dies. The dies proper are held in two die-heads, which are revolved to bring any size die within their capacity in the working position.

This machine is strongly constructed throughout, and it is guaranteed to cut bolts and pipes up to 2 inches in diameter. Its weight, complete with the motor drive, is 2300 pounds.

BAIRD DOUBLE HORIZONTAL TILTING TUMBLER

In the department of New Machinery and Tools for July, 1909, we illustrated a double horizontal tilting tumbler, built by the Baird Machine Co., Oakville, Conn. This machine has been redesigned, as shown in the accompanying view. The barrels are driven by friction clutches, which allows them to be started easily and without shock when heavily loaded. The wood-lined cast-iron covers formerly used, have been

replaced with brass covers, as the former became leaky if not properly cared for, allowing the water and small burnishing balls to trickle out. The brass cover requires no lining and remains tight, a rubber gasket being used, of course, around the joint. Cast brass is used for the covers, as German silver, brass and plated articles should not be rolled against an iron surface. When this type of tumbler is in operation, the barrels are in a horizontal position, but they may be easily tilted



Baird Steel Ball Burnishing and Buffing Barrel

for emptying or filling, as they are supported on trunnions mounted in heavy yokes that are attached to the driving shafts. The locking device which holds the barrels in a horizontal position, is simple and convenient to operate. Both barrels are driven through bevel gears and friction clutches. As either barrel may be operated independently, one can be at work while the other is being emptied or filled. All bearings are bronze-bushed, and the main shaft bearings are ring oiled. The barrels are polygonal in shape and are lined with maple. The length of each barrel is 24 inches and the inside diameter, 10½ inches. It has been the company's experience that a small diameter lessens the danger of bending, denting or otherwise injuring small or delicate parts, without retarding the speed or quality of finish.

STANDARD SPECIAL MULTIPLE PRESS

An interesting multiple press equipment has recently been brought out by the Standard Machinery Co., 7 Beverly St., Providence, R. I., which consists of three presses mounted on the same bed, as shown by the accompanying halftone. This machine is designed for piercing pieces of unusual length, that cannot be handled in a gang piercing press, there being one stationary and two movable presses for performing separate operations.

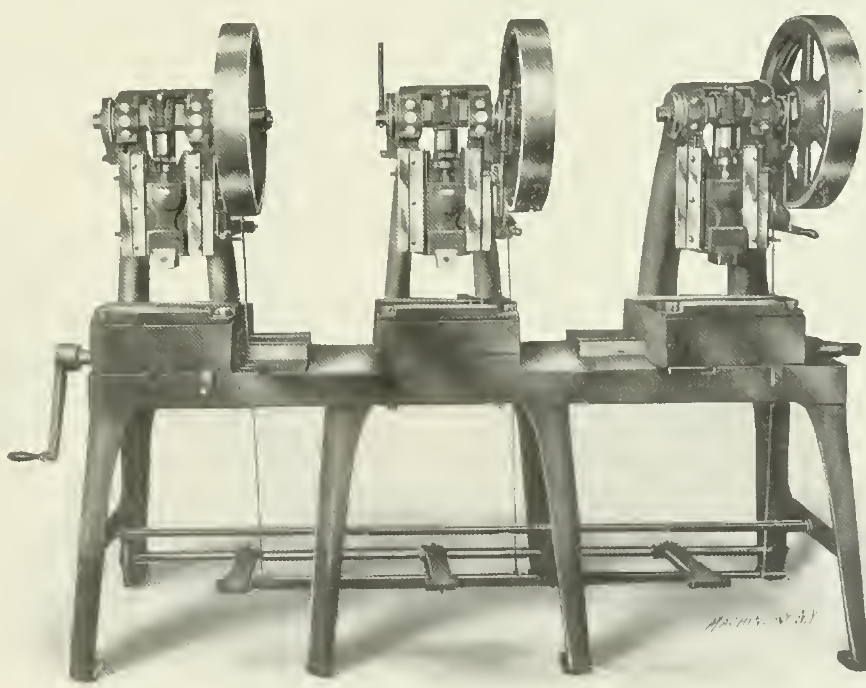
The three presses are of the open-side type, and the frames are a modification of those used on the maker's No. 7-S press. The center press is stationary, being rigidly attached to the center of the bed, and the two end presses are adjustable. The bases of the adjustable presses are fitted to dovetailed ways, as shown, and adjustments are effected by a square-threaded screw that extends through the center of the bed and is actuated by the crank seen to the left. This screw passes through bronze nuts that are attached to the bases of the movable presses.

The work for which the particular machine illustrated was intended, required three different locations for each of the adjustable presses, the center-to-center distances between the central and outer presses varying from 22 to 43 inches. These locations are positively and accurately obtained by taper keys which fit corresponding keyways cut in the bed and base, as shown. These keys are fitted with set-screws in the outer ends, for drawing them when an adjustment is desired. In addition to the keys, the movable presses are also provided with powerful clamping screws at the back, so that they can be located in any desired position.

The presses can be run either singly or simultaneously. When they are all in operation at the same time, the clutch mechanism is controlled by a single treadle which connects the three individual treadles together. When each press is operated independently, the hand levers seen just beneath the flywheels are used for tripping the clutch.

The overall height of this machine is 6 feet 8 inches, and the overall length of the bed is 7 feet 6 inches. The bed is 6 inches thick, and it contains a slot beneath each press to allow pieces to drop through into boxes or carriers. The height of the table of each press from the floor is 40 inches. The flywheels have a diameter of 23 inches, a face width of 3¼ inches, and the wheel rims weigh 200 pounds. The machine runs at a speed of 100 revolutions per minute. The stroke of each press is 1½ inch; width between the gibs, 4½ inches; width of opening in the back of the frame, 7 inches; and adjustment 1⅞ inch. The end machines can be adjusted while the balance wheels are running, there being a special countershaft which carries wide-faced driving pulleys for the end presses, to permit the necessary adjustment.

This equipment is particularly adapted for the piercing of angle-irons, long flat plates, and other work of a similar nature.



Special Press for Piercing Long Work

COMBINATION TOOL-ROOM GAS FURNACE

The Rockwell Furnace Co., 26 Cortlandt St., New York, has recently placed on the market a new combination tool-room furnace to use gas fuel only, which is illustrated herewith. This furnace was designed for tool departments in which a variety of small tools made from both high-speed and carbon steels have to be heat treated and where accurate temperatures are required. It is claimed that a working temperature is possible within eight minutes of lighting the cold furnace. In size the furnace is very small, as shown by Figs. 1 and 2, the floor space occupied being only 16 inches square.

For end-heating carbon steel tools such as reamers, taps, and tools of this type under 1½ inch diameter, the furnace is

used as in Fig. 1, the work being introduced into the entrance *cc*, which is $1\frac{1}{2}$ inch in diameter. Fig. 2 shows this furnace arranged as an oven furnace for heating carbon steel tools, such as dies, cutters, etc. The heating chamber *gg* is used, this chamber being 7 inches long, 4 inches wide by 3 inches high. When desired to use it as a muffle furnace, the bottom tile *H* shown in Fig. 1 on the ledge, may be removed and the muffle *J* shown on the ledge in Fig. 2 may be inserted. This has an inside height of $2\frac{3}{4}$ inches.

As a cylindrical furnace for hardening high-speed steel tools, the muffle and bottom tiles are removed and tools up to 8 inches long by $1\frac{1}{2}$ inch in diameter may be suspended in the heating chamber through the opening *ii*. By the removal of the annular tile surrounding this hole, tools up to 3 inches in diameter may be inserted.

For lead hardening, the iron pot *I* shown on the ledge in Figs. 1 and 2 is placed in the entrance *ii*. The heat is evenly distributed over the body of the pot, and the lead bath can be kept at the desired temperature for an indefinite period without danger of overheating. A similar method is followed for oil and sand tempering, these mediums being placed in the iron pot referred to.

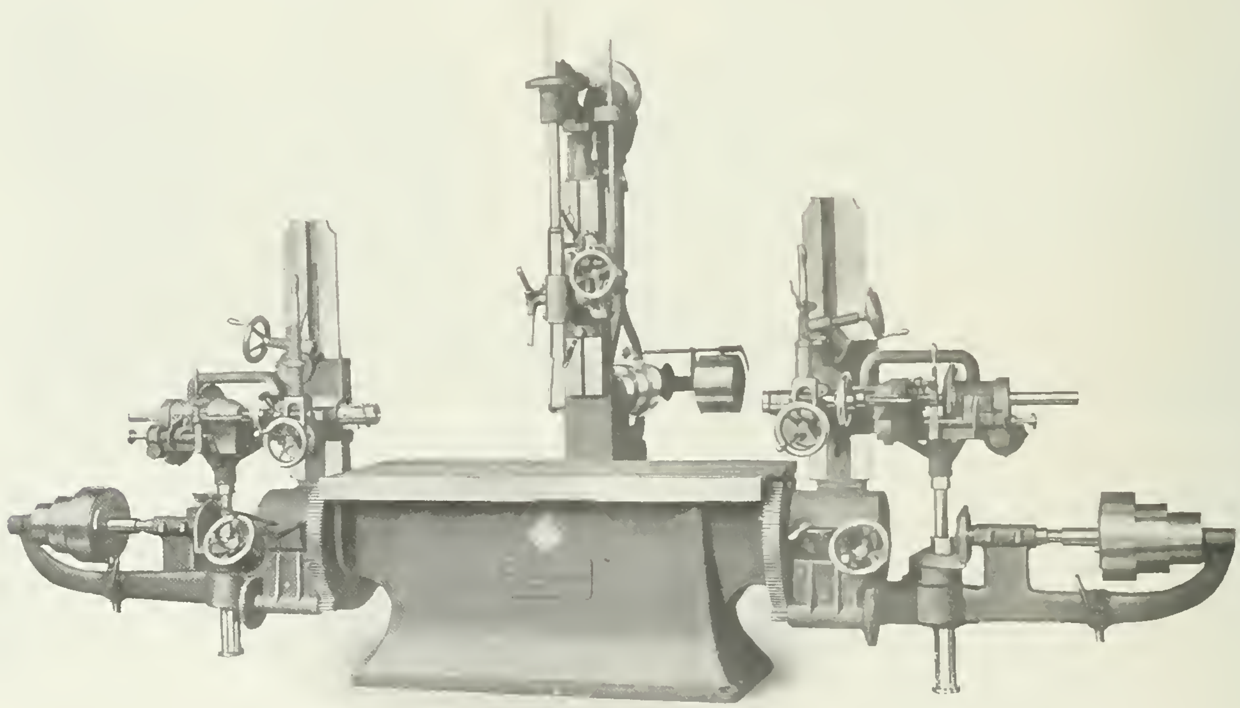
The pipe arrangement for the gas fuel and air is shown to the rear, and the supply is controlled by two valves *A* and *B*. The furnace is very substantially constructed, being made of cast iron throughout, and is lined with the best quality of fire brick. The gas consumption per hour varies from 80 to 130 cubic feet. As the makers emphasize, it is a very convenient furnace, combining all the features of eight complete furnaces in one.

Fig. 1. Rockwell Tool-room Gas Furnace End-heating Carbon Steel Tools

Fig. 2. Rockwell Tool-room Gas Furnace as an Oven Furnace with Muffler Removed

SPECIAL HORIZONTAL AND VERTICAL DRILLING MACHINE

A special combined horizontal and vertical drilling machine has just been built by W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., which is unique in its construction. This special machine, which is shown in the accompanying view, is composed of the main parts of the regular No. 3 horizontal radial drill, together with one of the company's sliding head gang drill heads. The machine was designed for a special job which consisted of a casting in which it was desired to bore one or more holes in each end, in addition to a hole on top. With this design, it is unnecessary to change the position of the work after it has once been set in order to drill any of the holes with the three drill heads, within the limit of the machine.



Horizontal and Vertical Drilling Machine built by W. F. & John Barnes Co.

As just mentioned, the end heads are the same as those used on the No. 3 horizontal radial drill which was described

in detail in the December, 1908, issue of MACHINERY. As will be recalled from the previous description of the end head, the spindle is capable of all the movements and adjustments of a regular radial drill, only it is in a horizontal instead of a vertical position. The only adjustment which is not provided is that corresponding to the raising and lowering of the radial arm.

In the machine here illustrated, the spindle travel of the horizontal head is 18 inches, which is sufficient for the special parts to be drilled. A swing adjustment of the head is provided through the handwheel shown, which connects through a worm and worm-gear with a pinion meshing with a segment-gear attached to the frame. The spindles have No. 4 Morse taper holes and they are provided with positive geared feeds. The vertical head is the same as that used on the regular sliding head gang drills of the same size, and is attached to a sliding rail at the back of the machine, being therefore adjustable horizontally. The vertical head can thus be set at any position between the horizontal heads.

The platen of the machine is 24 inches wide by 65 inches long, corresponding to the previously mentioned No. 3 horizontal radial drill. All cone-pulleys on both the horizontal drill heads and the vertical drill head have three steps for a 4-inch wide belt, and all cones are back-geared. The horizontal spindles, as well as the vertical spindles, are equipped with an automatic stop.

The machine weighs complete about 7000 pounds, and occupies a floor space about 16 feet long by 7 feet wide.

MORSE NO. 2 UNIVERSAL GRINDING MACHINE

The Morse Twist Drill & Machine Co., New Bedford, Mass., in designing the universal grinder illustrated in Figs. 1 and 2, aimed to produce a machine that is durable, convenient to the operator, and capable of accurate results. The general construction is not radically different from other well-known makes, but a number of changes that have been found desirable are incorporated in the design.

The table has an automatic reciprocating movement, and the point of reversal is controlled by dogs in the usual manner. The table can be stopped at any point by a lever at the front of the machine, thus leaving it free to be traversed by a handwheel. The rate of the table traverse can be quickly changed, for roughing or finishing, by means of a feed-box

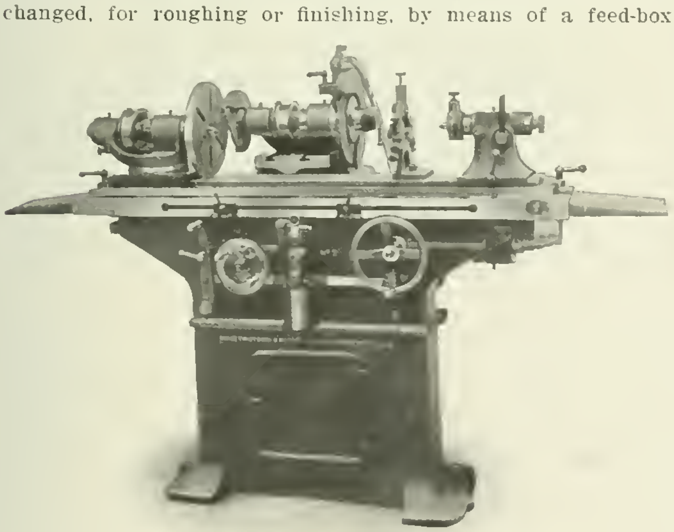


Fig. 1 Twelve- by Thirty-inch Universal Grinder built by the Morse Twist Drill & Machine Co.

attached to the rear, as shown in Fig. 2. These changes are effected by the operation of a lever. The table has a swiveling platen which turns on a hardened and ground central stud. This platen is clamped at both ends, and the swiveling movement permits the grinding of tapers as great as 1 3/4 inch per foot. A scale indicates the taper, and the adjustment is made by a screw at one end.

The wheel-slide has a swiveling base graduated in degrees and it is adjusted by a handwheel having a dial graduated to indicate thousandths of an inch on the diameter of the work. The automatic cross-feed will size work to within 0.00025 inch. The wheel and slide are held back by means of a weight which prevents any lost motion and insures an even and equal feeding movement. The way in which this weight is attached to the wheel-slide is indicated in the sectional view, Fig. 3. A bracket carrying a grooved roller is bolted

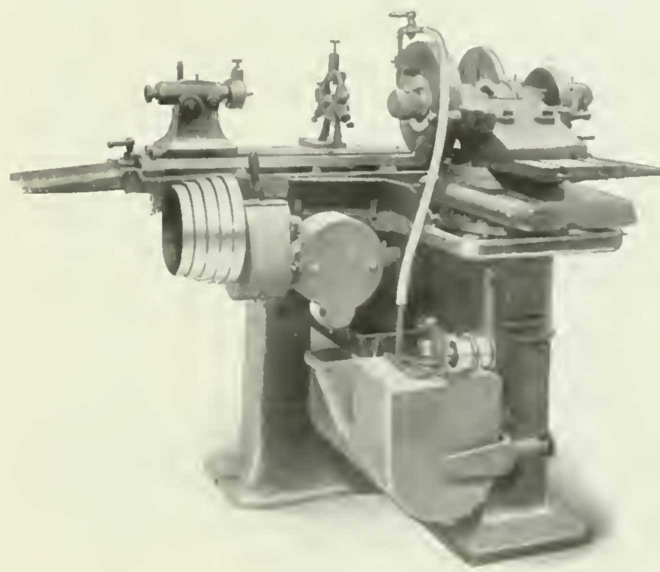


Fig. 2. Rear View of Morse Grinder

to the saddle, and passing over this roller is a cable W, one end of which is fastened to the wheel-slide while the other is attached to a weight. As the engraving shows, this cable passes through the center of the vertical feed-shaft, and does not interfere with the swiveling movement of the slide.

The wheel spindle is hardened, ground and lapped and runs in phosphor-bronze boxes which may be adjusted if necessary.

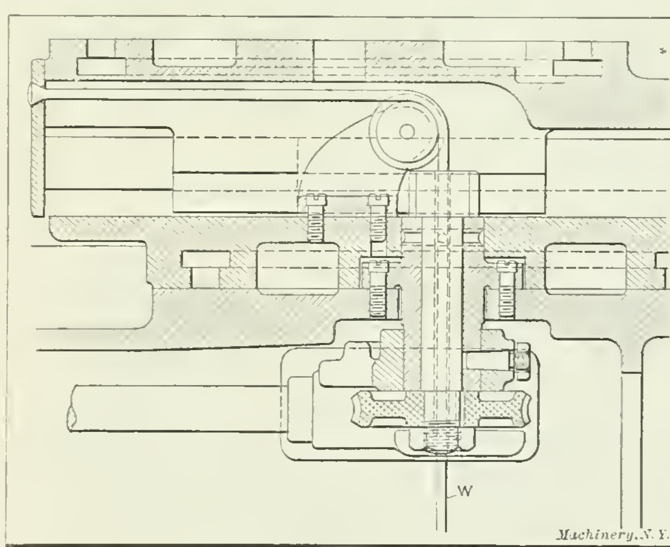


Fig. 3. Section of Wheel-slide

It will take wheels 12 inches in diameter and from 3/8 to 3/4 inch thick, and 7 inches in diameter with a thickness of 3/8 inch. The headstock and footstock are clamped to the table-ways by levers, and the base of the former is graduated in degrees. The headstock spindle is threaded and it has a No. 3 Morse taper hole. Provision is made for locking the spindle when grinding on dead centers. Provision has been made for wet grinding, there being a pump of ample capacity and the necessary piping. The water tank is suspended on trunnions, as shown in Fig. 2, so that it may be easily cleaned. There are two shifter levers connecting with the overhead works, one of which controls the drive for the wheel and feed and the other the work and pump. The countershaft has 12-inch tight-and-loose pulleys for a 3-inch belt, and it should run at 300 revolutions per minute. The work speeds may be varied

from 50 to 480 inches, and the wheel speeds range from 1025 to 3333 revolutions per minute. Both the work speeds and wheel speeds have six changes, and there are ten changes to the traverse of the platen, varying from 12 to 100 inches per minute. The net weight of the machine is 3750 pounds.

The equipment includes a No. 4 internal grinding fixture; 8-inch four-jawed chuck; large faceplate; 2 universal back-rests; center-rest; set of dogs; one emery wheel 12 inches in diameter, 3/4-inch face; one emery wheel 7 inches in diameter, 3/8-inch face; overhead works; wrenches, etc.

ALMOND TOOL-HOLDER

The tool-holder shown in Fig. 1 is the product of the T. R. Almond Mfg. Co., Ashburnham, Mass. This holder is of a simple, practical design, and it is adapted to a wide range of work, as each of the various types of cutters which it holds can be placed in five different positions. The cutter is held by a bolt and clamp which have beveled or dovetailed gripping faces, so that when the bolt is tightened, the cutter

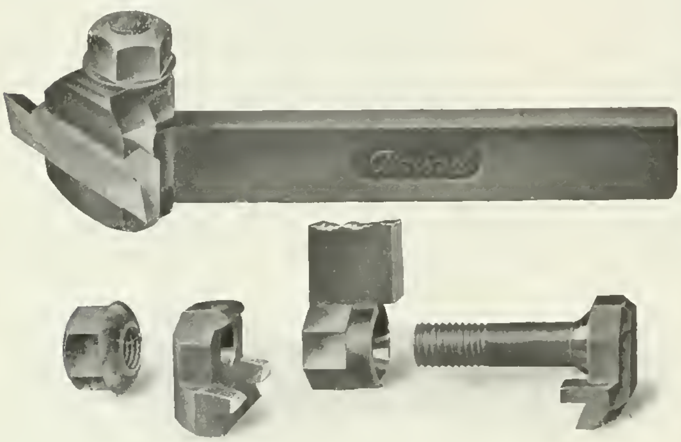


Fig. 1. Almond Tool-holder and Parts

(which is also beveled), is drawn against one of the five faces of the octagonal-ended shank. With this construction, the cutter is gripped positively and it is further held in position by the octagon faces of the bolt which come against a shoulder on the shank. Any style or shape of cutter may be held, and, if necessary, special cutters may be quickly filed to fit the clamping members.

Thirteen cutters of various kinds are furnished with each complete set. These include right- and left-hand and round-

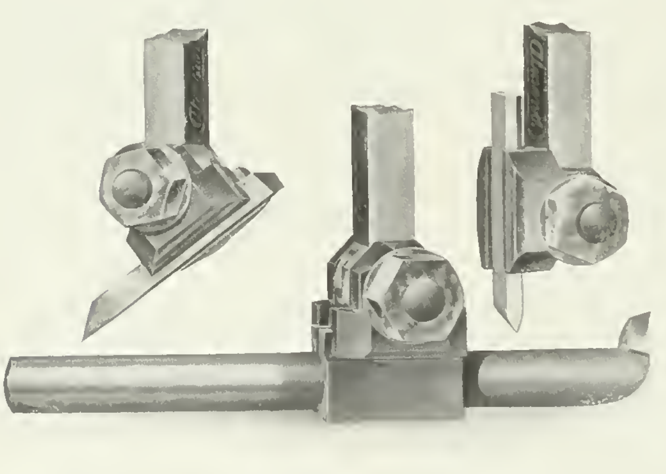


Fig. 2. Side-tool, Threading Tool, and Method of Holding Boring Tool

nose turning cutters; right- and left-hand side-tools; wide and narrow cutting-off tools; threading tools for roughing and finishing; a spotting or centering tool; heavy and light boring tools; and an inside threading tool. All of these tools are made from merchant bar stock. The square turning cutters are held in split bushings and are clamped their entire length on four sides, when in the working position. The tools for spotting, boring, and threading are held in split bushings and they may be adjusted for length, as required. The holder with a boring tool in place, is shown in Fig. 2. The tool shank passes through a split bushing which is firmly gripped by the beveled faces of the bolt and clamp. This illustration also shows a side-tool in a right-hand offset position, and a threading tool in a left-hand side position.

For high-speed rough turning, the makers' recommend high-speed steel cutters made similar to the side tools, but having

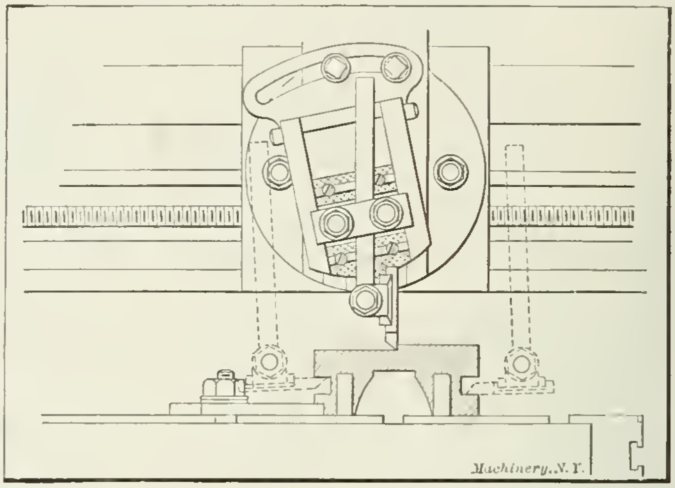


Fig 3. Almond Tool-holder as applied to Planer Work

cutting points ground curved and with top rake. This design of cutter gives 3/4 inch of metal to back up the cutting point and take away excessive heat.

Figs. 3 and 4 show two of the many classes of work for which this holder is adapted. Fig. 3 is a planer job requiring a cut across the top and finished slots at the sides. The slots

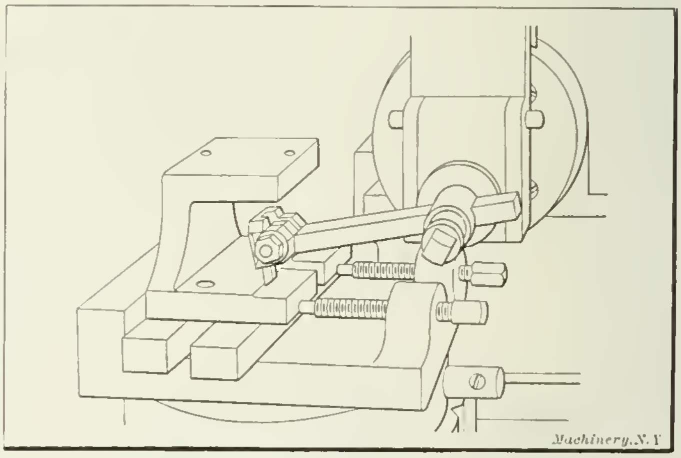


Fig. 4. Planing Operation in the Shaper

after being roughed out with a cutting-off tool, are finished by a side tool, as the dotted lines indicate. Fig. 4 is a shaper job, and the illustration is self-explanatory.

GARVIN NO. 9 INDEX MILLING MACHINE

The Garvin Machine Co., Spring & Varick Sts., New York City, is putting on the market the index milling machine shown in Fig. 1. This machine is particularly adapted for cutting spur gears or sprockets, notching operations, grooving shafts, gashing bevel gears and pinions preparatory to planing, etc., and it will cut steel at the rate of 9 inches per minute with the cutter running at 100 revolutions per minute. The operation of the machine is completely automatic, and it is capable of multiple working, which, with the capacity and power available, insures efficient results.

The safety index device on the machine is a special feature which disengages the feed automatically, if the completion and locking of the indexing is prevented by accident. The indexing is positive, but there is the further assurance that if anything should happen, work cannot be spoiled. The return of the table and the indexing take place at a constant rate. The table is wide and it has integral with it a large

chip basin that gives ample room for large multiple centers. Different index centers and fixtures can be mounted interchangeably on the table, having from two to eight spindles, all of which index automatically and simultaneously. To compensate for variations in the diameters of gear-cutters and form cutters, multiple centers can be furnished with spindles having individual micrometer adjustments, thus enabling very accurate work to be done on multiple centers.

An example of one of these multiple centers is shown in Fig. 2. This is a three-spindle fixture, one spindle having a fixed center while the other two may be adjusted to compensate for variations in the size of cutters. This adjustment is made through a micrometer screw and wedge, and there is provision for locking the adjustable parts. Small bevel gears can be cut side by side, in similar centers of a tilting type, and large bevel gears can be cut tandem on a special fixture such as the one illustrated in Fig. 3. The bevel gears shown in this illustration are 11 inches in diameter; have a face width of 1½ inch; 43 teeth of four pitch; and are

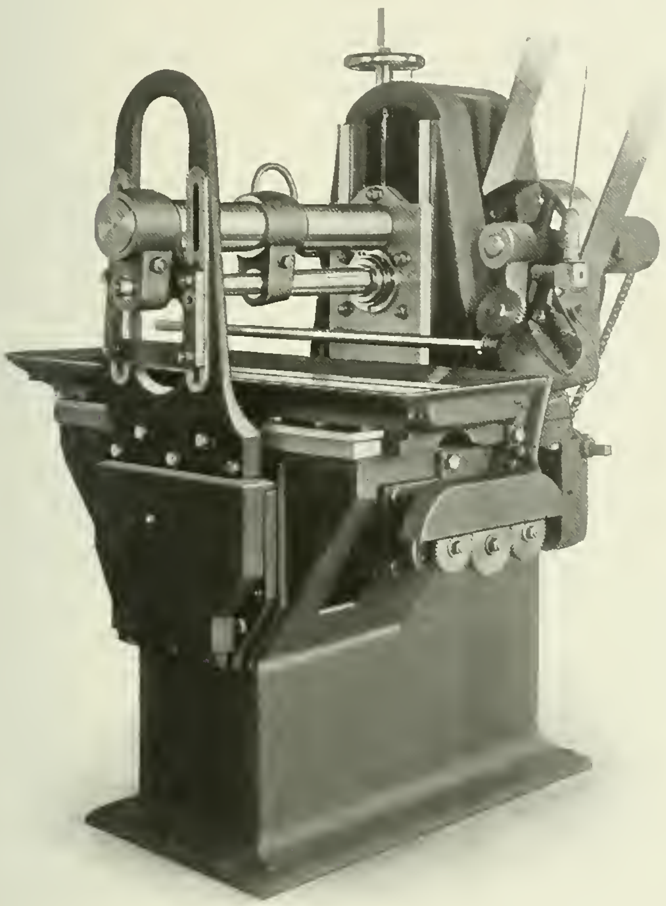


Fig. 1. No. 9 Automatic Index Milling Machine built by the Garvin Machine Co.

made of 3½ per cent nickel steel. Both of these gears can be cut in thirty minutes or at the rate of fifteen minutes each.

The table is fed by means of a large screw running in a trough of oil in which the nut also travels. The feeding and indexing mechanisms are combined in one large box located in front of the machine. The gears run in oil, and the box can be inspected by swinging down the front cover shown; by removing four bolts the box can be taken out. Changes for feed are made by change gears located inside the front cover, and the change gears for indexing are mounted on the right-hand side of the bed.

The spindle runs in solid bronze boxes of the standard type used on Garvin milling machines. It has a No. 11 B. & S., taper hole and a driving slot for the arbor. The spindle is driven by a gear 20 inches in diameter. The spindle block has a micrometer vertical adjustment and it is clamped in "V" grooves by four bolts which bind the headstock and spindle block rigidly together. A large arm carries an intermediate yoke for the arbor, and the outer end of the arm, as well as the outboard bearing of the arbor, is supported by a framed base bolted to the bed. The driving pulley shaft is fitted with ring oilers. An oil reservoir is formed in the base, and the oil, after being used, passes through an overflow nozzle and an intermediate strainer trough, into the reservoir. A pump and piping are included in the equipment.

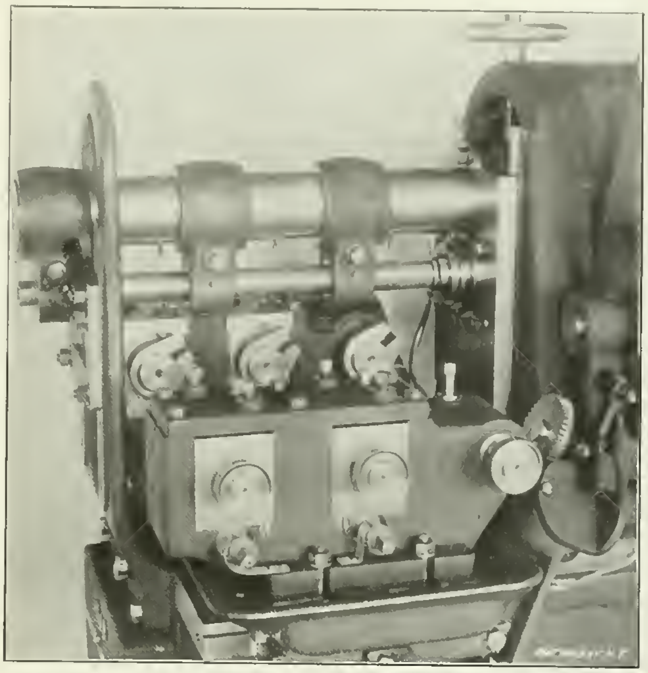


Fig. 2. Index Milling Machine equipped with 3-spindle Centers

The general dimensions of this machine are as follows: Working surface of the table, 12 by 42 inches; length of feed, 14 inches; greatest distance from center of spindle to top of table, 15½ inches; minimum distance from center of spindle to top of table, 6½ inches; distance between the head and braces, 24 inches; swing under the arm for cutters, 5½ inches; dimensions of front spindle bearing, 3 by 4½ inches; floor space, 64 by 54 inches; domestic shipping weight, 4550 pounds; export shipping weight, 5200 pounds.

DRAFTSMAN'S SEGREGATED SCALE

Every draftsman has experienced the difficulty of setting dividers to dimensions containing small fractional parts of an inch, as the required division on a finely-divided scale cannot be located so quickly or easily as the principal or larger frac-

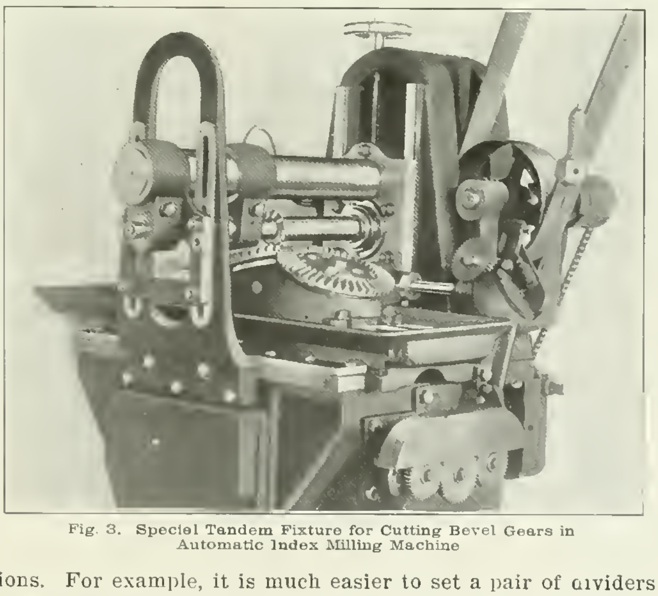
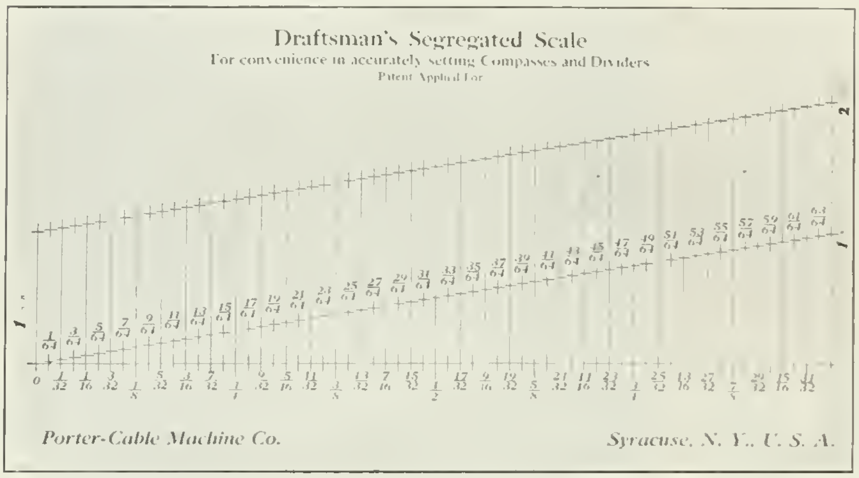


Fig. 3. Special Tandem Fixture for Cutting Bevel Gears in Automatic Index Milling Machine

tions. For example, it is much easier to set a pair of dividers to ½ or ¾ inch, than to some fraction containing a smaller subdivision of the scale, such as sixty-fourths or hundredths. The draftsman's scale illustrated herewith, which is known as the "segregated" scale, is so designed that any subdivision within its capacity can be quickly located. As the illustration

shows, this scale is simply a table or chart having a horizontal base-line and a series of short dashes, beginning at zero and advancing by the unit of division, up to the capacity of the scale which, in the present instance, is 2 inches. As each dimension is separated from the others, it follows that it is just as easy to set an instrument to 53/64 as it is to ½ or ¾ inch. This scale is accurately graduated, and it is printed on the finest grade of Bristol board. The base-line is scored or depressed slightly to form a groove into which the stationary leg of the dividers will readily fall. As will be appreciated, the sharp points of a fine instrument will not be injured by the use of this scale, and it may be replaced when worn out or soiled at a slight expense. These scales are graduated in sixty-fourths, as shown in the illustration, or in hundredths; they are made by the Porter-Cable Machine Co., 501 East Water St., Syracuse, N. Y.



Draftsman's Scale designed to facilitate setting Dividers to Fractional Dimensions

NEW MACHINERY AND TOOLS NOTES

Grindstone Truing Device: Athol Machine Co., Athol, Mass. Adjustable grindstone truing device with provision for clamping to flanged grindstone frame not over 14½ inches wide. The results obtained with this device are said to be highly satisfactory.

Shop Truck: Lansden Co., Newark, N. J. Electrically-driven power truck for shop use, built in three different styles and equipped with the Edison storage battery. The driving wheels are provided with the usual type of solid rubber tire, and the design of the carrying platform is governed in each case by individual requirements.

Friction Clutch: A. S. Baldwin & Co., Sharon, Pa. Friction clutch applicable to the driving of machine tools, automobiles, motor boats, etc. In the operation of the clutch, a sectional tapering ring is expanded radially by wedge-shaped pieces on a sliding clutch-spool, which forces the gripping members against the friction disks. The design of this clutch is simple and compact.

Friction Clutch: J. G. Blount Co., Everett, Mass. Friction clutch intended for use on lineshafts, etc. The friction surfaces on the expanding member are large, to insure durability. When the clutch is used for driving speed lathes, an automatic brake is provided which is released by the movement of the shifter-rod when the clutch is engaged, and is thrown into action when the clutch is disengaged.

Pipe Threading Tool: Toledo Pipe Threading Machine Co., Toledo, Ohio. Pipe threading tool adapted to pipes ranging from 2½ to 6 inches in diameter, with one set of dies. The dies are shifted easily and positively by hand. When changing their position, a spring-bolt engages a rack that, in turn, engages a taper pin which causes the dies to recede. Two sets of dies are furnished, so that when one set becomes dull, the other can be substituted.

Ball Bearing: B. L. Co., Norwich, Conn. Ball bearing of chrome nickel steel having imported balls made within a limit of 0.0001 inch. The design is such that the entire space occupied between the balls by the retainer, is equal to the space required for one ball, thus allowing a large number of balls in the bearing. The retainer has a certain amount of elasticity which allows the balls to crowd or extend at certain points, as they naturally tend to do, but they are not permitted to touch one another.

Surface Grinder: Bay State Grinder Co., Worcester, Mass. Rotary surface grinder of the vertical-spindle cup-wheel type. The work is held on a magnetic chuck, mounted on a knee that is fed vertically to an adjustable stop. This feed is by a lever which also controls the operation of the clutch for the driving mechanism of the chuck. A handwheel feed graduated to 0.00025 inch is also provided. This machine can be equipped with chucks ranging from 6 to 20 inches in diameter, and with cup-wheels varying from 8 to 12 inches in diameter.

Vise: The Emmert Mfg. Co., Waynesboro, Pa. Rapid-acting vise especially adapted for the work of the patternmaker, and for woodworkers in general. In its design, particular attention was given to the locking device, the aim being to secure simplicity, positiveness, and durability. The vise is locked and unlocked automatically by simply turning the vise handle or lever about one quarter of a revolution to the right for locking, and the same distance to the left for unlocking. A noteworthy feature in connection with this locking device is that the nut encircles the lock-rod, so that when pressure is applied, the rod is gripped firmly on two sides. This type of vise is built in a number of different sizes, having a maximum capacity between the jaws ranging from 6 to 20 inches.

Automatic Indexing Multiple Drill: Langelier Mfg Co., Providence, R. I. Multiple drilling machine adapted to the drilling of Jacquard loom "cylinders." As the holes have to be spaced very close, spindles are only provided for each alternate hole, in order to make possible a rigid and powerful spindle construction. After a row of holes representing half the number required in a row, has been drilled, the head automatically shifts sideways, bringing the drills into a position midway of the holes previously drilled. With the American or French index, the machine bores 240 holes per minute, and with a "fine" index, 320 holes per minute. After the last row of holes is drilled, the machine stops automatically. By pressing a foot lever, the table is returned to its starting position.

Milling and Drilling Machine: W. B. Knight Machinery Co., 2019 Lucas Ave., St. Louis, Mo. Combined milling and drilling machine particularly adapted to the making of dies, jigs, molds, metal patterns, etc. The general construction of this machine, which is the No. 1½ size, is similar to the No. 1 size illustrated in the department of New Machinery and Tools for October, 1910, though it is somewhat larger and much more heavily constructed. Some of the principal dimensions of this new size are as follows: Vertical movement of the spindle, 4 inches; vertical adjustment of the spindle head, 10 inches; distance from center of spindle to column, 8½ inches; working surface of table, 7½ by 24 inches; cross movement of table, 16½ inches; transverse movement, 8 inches; maximum distance from table to spindle, 15½ inches; drill chuck capacity, 1-16 to 3-4 inch; diameter of circular attachment, 12 inches; maximum opening of vise jaws, 3⅜ inches; and net weight, 1125 pounds.

Horizontal Boring Machine: Lucas Machine Tool Co., Cleveland, Ohio. Improved horizontal boring machine that is also adapted to vertical and horizontal milling operations. This machine is driven by a single constant-speed pulley, through a geared speed-box giving nine changes, which number is doubled by back-gears located in the head. The speed-box is entirely closed, there being sliding plates under the controlling levers to prevent the entrance of dust or other foreign matter. The spindle is of forged steel and it has a large tapered front bearing, similar to modern milling machine construction. Eighteen feed changes are available, ranging from 0.004 to 0.600 inch per revolution of the spindle, and the feeding movement is so derived that it is dependent upon the spindle speed. By means of an ingenious design of distributing box, feeds can be imparted to the head, spindle, table or platen, as desired. A power traverse is provided which operates for the particular feeding movement selected, and its direction is always opposite to that of the feed, thus eliminating any chance of spoiled work by engaging the power traverse by mistake. A locking device prevents the engagement of more than one feed at a time. The boring-bar of this machine is 3½ inches in diameter and it has a total traverse of 48 inches. This machine is adapted to a wide range of surface milling by the insertion between the column and outboard support, of a cross-rail carrying a heavy vertical milling spindle. This spindle is driven through bevel gears by the regular boring-bar, and the milling head can be fed along the rail either by hand or by the power traverse of the boring-bar. All vertical adjustments can also be effected either by hand or power as desired.

* * *

Cast iron or malleable iron that has been sand-blasted instead of pickled for cleaning the surface, gives, according to the *Brass World*, much better results in electroplating, as there is less liability to "spot out." Many platers have, therefore, abandoned the pickling of castings.

PERSONALS

A. C. Hunter has left Pittsfield, Mass., and is now foreman in the Auto Truck Works at Detroit, Mich.

George E. Frost, for several years foreman of the tape department of the L. S. Starrett Co., Athol, Mass., has resigned.

George E. Hodson, first vice-president of the Winchester Repeating Arms Co., New Haven, Conn., has been elected president of the company.

Frank C. Harmon, foreman of the saw department of the Goodell-Pratt Co., Greenfield, Mass., has left this company to take up out-of-door work.

L. T. Wilmarth, president of the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has left for Los Angeles, Cal., for a six weeks' vacation.

David M. Hood, for sixteen years general foreman of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has severed his connection with that company.

M. H. Westbrook, formerly foreman of the Grand Trunk Railway shops at Battle Creek, Mich., has resigned his position and is now connected with Joseph T. Ryerson & Son, Chicago, Ill.

George J. Thompson has resigned from the Garvin Machine Co., Spring and Varick Sts., New York, and is now connected with the sales department of Manning, Maxwell & Moore, Inc., 85-89 Liberty St., New York.

Louis M. Zach has resigned as mechanical expert with the Wells Bros. Co., Greenfield, Mass., and will, after March 1, be connected with the firm of Wickes Bros., Saginaw, Mich., in a designing and estimating capacity.

H. H. Pinney, who for several years has been manager of the Union Metallic Cartridge Co., of Bridgeport, Conn., has resigned and will in the future be manager of the works of the Chalmers Motor Co., Detroit, Mich.

A. L. Lovejoy has resigned his position as sales manager of the New York office of the Pratt & Whitney Co., and will after March 1 be manager of the Chelsea division of the Flanders Mfg. Co., with headquarters at Chelsea, Mich.

Thomas G. Bennett, for many years president of the Winchester Repeating Arms Co., New Haven, Conn., has resigned on account of poor health. He will still be active in the affairs of the company in the newly-created office of consulting director.

Herbert T. Fisher, for the past five years manager and treasurer of the Granite State Mowing Machine Co., Hinsdale, N. H., has severed his connection with this company, and is now general office and sales manager for the Wells Bros. Co., Greenfield, Mass.

Frank Koester, previously employed with the Interborough Rapid Transit Construction Co., J. G. White & Co., the Guggenheim Exploration Co., and the American Smelting and Refining Co., all of New York, has recently opened an office at 115 Broadway, New York, as consulting engineer.

E. T. Hendee, assistant to the president of the firm of Joseph T. Ryerson & Son, Chicago, Ill., and C. A. Johnson, president of the Gisholt Machine Co., Madison, Wis., sailed for Europe February 1 on a six weeks' trip in the interests of the foreign business of their respective firms.

Ralph E. Flanders, formerly associate editor of MACHINERY, and now with the Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., delivered a lecture on "The Design and Manufacture of Spur Gearing" Friday, February 17, before 250 mechanics at the Central Y. M. C. A. of Cleveland, Ohio.

James Greenaway, for several years foreman of the machine shop of the Chapman Valve Mfg. Co., Springfield, Mass., and for the past two years foreman of the machine department of the Stevens-Duryea Co., Chicopee Falls, Mass., has returned to the Chapman Valve Mfg. Co. as general foreman of the machine shops.

Lewis H. Morgan, who was formerly superintendent and general manager of the Ridgway Machine Co., Ridgway, Pa., and also for many years with the Pond Tool Works, Plainfield, N. J., and who is now settled in England, has been elected a member of the Institute of Mechanical Engineers, London.

Edward Blake, Jr., who has been sales manager for the Wells Brothers Co., Greenfield, Mass., for the past four years, and also a director of the company, has severed his connection with this concern and is now connected with the Canadian Tap & Die Co., Ltd., Galt, Ontario, Canada, in which he has obtained a controlling interest.

Dyer Smith, who was an associate editor of MACHINERY in 1904 and 1905, has resigned from the legal department of Thomas A. Edison and the affiliated Edison companies, and has opened an office at No. 2 Rector St., New York, where he will continue his practice in connection with patents and patent causes, trademarks and copyrights. Mr. Smith graduated from Lehigh University with the degree of Mechanical Engineer in 1903. After some practical experience in the machine shops and around the open hearth furnaces and blast furnaces of the Bethlehem Steel Co.'s plant, at Bethlehem, Pa., he became an assistant to Dr. Edward J. Houston in the preparation of several books on technical and industrial subjects, after which he became an associate editor of MACHINERY. Thereafter he was an assistant examiner in the United States Patent Office in Washington, having charge particularly at different times of the examination of patent applications for inventions in cash registers, coin handling appliances, workman's time recorders and automatic telephone systems. In the spring of 1908 he joined the legal staff of Thomas A. Edison and the associated Edison companies, in which position he prepared and prosecuted practically all of Mr. Edison's personal patent applications and the patent and trade mark applications of the affiliated Edison companies, chiefly in the arts of phonographs and sound records, storage batteries, moving picture apparatus, and the Portland cement industry. He also was associated as counsel in various litigations concerning the patents owned and controlled by the Edison companies.

* * *

OBITUARIES

Simon Wing, inventor of the first multiplying camera and many other photographic devices, died at his home in Charlestown, Mass., aged eighty-four years.

Frederick G. Hesse, aged eighty-six years, died at his home in Oakland, Cal., January 27. Prof. Hesse was connected with the department of mathematics and mechanical engineering at the University of California for twenty-nine years.

Edward L. Bowers, superintendent of the New Home Sewing Machine Co., Orange, Mass., died at his home, February 2, aged fifty-four years. Mr. Bowers began to work for the New Home Sewing Machine Co. thirty years ago as draftsman, from which position he was rapidly promoted. He was born in East Berlin, Conn., and "served his time" with the Pratt & Whitney Co., Hartford, Conn.

* * *

COMING EVENTS

March 4-11. Ninth annual show of the Licensed Automobile Dealers Association, Mechanics Bldg., Boston, Mass.

March 9.—Monthly meeting of the Institute of Operating Engineers at the Engineering Societies Bldg., 29 W. 39th St., New York. Prof. Wm. D. Ennis of the Polytechnic Institute of Brooklyn will read a paper entitled "Commercial Aspects of the Work of the Operating Engineer."

April 3-5. Annual convention of the Southern Supply and Machinery Dealers' Association; National Supply and Machinery Dealers' Association; and American Supply and Machinery Manufacturers' Association, Louisville, Ky. T. D. Mitchell, 309 Broadway, New York, secretary and treasurer, American Supply and Machinery Manufacturers' Association.

April 10-11. Congress of Technology, Boston, Mass. Walter B. Snow, publicity manager, 170 Summer St., Boston, Mass.

April 12-13. Thirteenth annual convention of the National Metal Trades' Association at Hotel Astor, New York.

May 30-June 2. Sixty-third meeting of the American Society of Mechanical Engineers, at Pittsburg, Pa. Office of local committee, 2511 Oliver Bldg., Pittsburg, Pa.

June 14-16.—Annual Convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers Association, in conjunction with the American Railway Master Mechanics', and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

CATALOGUES AND CIRCULARS

DESMOND-STEPHAN MFG. CO., Urbana, Ohio. Leaflet listing emery wheel dressers.

RACINE TOOL MACHINE CO., Racine, Wis. Leaflet of Racine high speed saws.

ROCKFORD LATHE & DRILL CO., Rockford, Ill. Folder of loose-leaf sheets, describing this firm's lathes and drills.

LINK-BELT CO., Philadelphia, Pa. Leaflet illustrating the Ewart friction clutch and the Link-Belt disk friction clutch.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Leaflets describing magneto bearings and centrifugal basket mountings.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Catalogue listing and describing the Schureman types of elevator controllers.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Souvenir book of Fort Wayne, containing over two hundred illustrations of the city.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. Bulletin R, describing the Rockwell combination tool-room gas furnace, illustrating its various uses.

DE LAVAL STEAM TURBINE CO., Trenton, N. J. Booklet illustrating and describing the company's steam turbines for both high- and low-pressure.

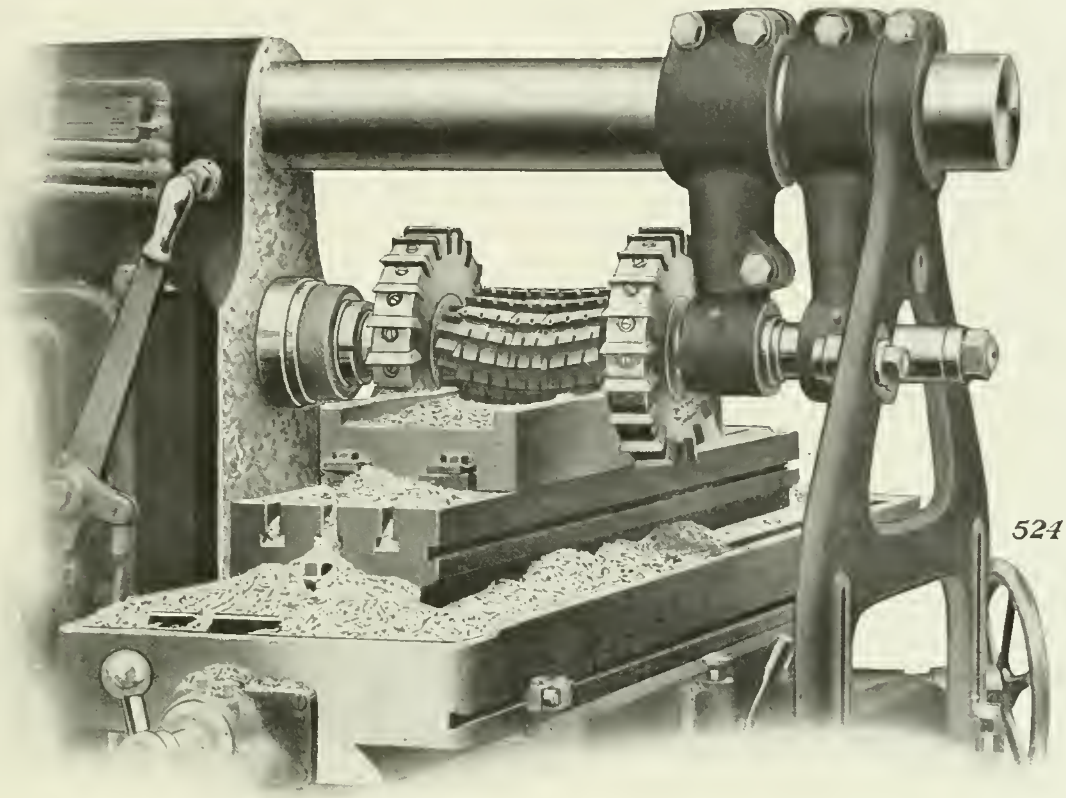
DIAMOND CHAIN & MFG. CO., 240 W. Georgia St., Indianapolis, Ind. Leaflet entitled "Chain Drive, the Logical Method for Commercial Vehicles."

T. R. ALMOND MFG. CO., Ashburnham, Mass. Catalogue of the Almond tool-holder, showing its construction in detail and setting forth its advantages.

RICHARDSON-PHENIX CO., Hudson Terminal Building, New York City. Bulletin No. 53, describing and illustrating the Richardson Model M mechanical lubricator.

SAFETY POWER TRANSMISSION CO., 114 Franklin St., New York City. Booklet illustrating and describing the "Safety Shaft Guard," manufactured by this company.

NINETEEN CUBIC INCHES PER MINUTE



The total width of surface roughed off at one cut on these gray iron castings is 16⅜ inches—maximum depth of cut $^3/_{16}$″—length of cut on each piece 8¼″—largest cutters 10½″ diameter, running 21 rev.—6.3″ feed.

The pieces are held in a string jig, removed as fast as traversed by the gang and others chucked in their places.

The pieces are made in lots of 125 at a time and an entire lot is regularly milled on a No. 4 Plain High Power Cincinnati Motor Driven Miller at this enormous rate without stopping to sharpen the cutters.

It takes a powerful, rugged machine to do such milling and it must go through without vibration—otherwise the cutters would be dulled, forcing a reduction in the feed, long before an entire lot of pieces is finished.

Our machines are designed for this kind of service.

Get our complete Catalog.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.
JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana.
ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

CONTENTS FOR MARCH

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition.

Garvin Machine Co., Spring and Varick Sts., New York City. Large-size chart, 25 by 25 inches, of decimal equivalents, suitable to hang on the wall in the shop or drafting room.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Catalogue of riveting tools, reamers, punches and dies, punch couplings, punch and shear machinery, bending rolls, etc.

Barber-Colman Co., Rockford, Ill. Catalogue of carbon and high-speed steel milling cutters, attractively arranged, containing twenty-four pages of useful information and data.

Moore & White Co., Philadelphia, Pa. Catalogue for 1911, containing complete descriptions of the Moore & White lines of friction clutches and speed changing devices, all types being listed.

Ingersoll-Rand Co., 11 Broadway, New York. Pamphlet No. 9003 entitled "Rock Drill Mountings, Steels, Hose and Accessories," completely describing these products and their uses.

C. H. Hughes & Co., 82 Beaver St., New York. Leaflet calling attention to the "reports on the commercial possibilities of mechanical and electrical devices" of which this firm makes a specialty.

Northern Engineering Works, Detroit, Mich. Crane catalogue No. 25 is a compilation of several Northern bulletins in condensed form. The catalogue illustrates the application of the cranes in practice.

Wm. Gaertner & Co., 5345-5349 Lake Ave., Chicago, Ill. Catalogue M-L, containing a very complete line of instruments of precision and practically all the apparatus needed for a physical laboratory.

E. R. Caldwell & Co., 34-86 Hilton St., Bradford, Pa. Special circular No. 46, describing the Scranton upright power hammers, and containing a partial list of users and some testimonial extracts.

DeLaval Steam Turbine Co., Trenton, N. J. Catalogue A devoted to the single stage type of turbine and containing so much information that it might be considered as a practical treatise on the subject.

Sprague Electric Co., 527-531 W. 34th St., New York. Bulletin No. 111 containing a partial list of installations of this company's engine-type generators. Catalogue 436 describes the company's complete line of conduit products.

J. E. Rhoads & Sons, 12 N. Third St., Philadelphia, Pa. The latest catalogue production of this firm is in the form of a condensed book containing a large amount of useful belting information, with a number of rules and tables.

Bristol Co., Waterbury, Conn. Bulletin No. 127 on Bristol's Class III recording thermometers. This catalogue includes the compensated gas-filled thermometers for recording temperatures up to 800 degrees F., illustrated in the January, 1911, issue of Machinery.

E. F. Lake, Consulting Metallurgist, 19 W. 43rd St., Bayonne, N. J. Pamphlet briefly outlining the different lines of heat treatment of iron and steel on which Mr. Lake is prepared to give expert advice, with the ultimate aim of improving the efficiency of plants.

Peerless V-Belt Co., 547 West Jackson Blvd., Chicago, Ill. Leaflet illustrating and describing the Peerless V-Belt silent chain drives, especially adapted for short center-power transmission from an electric motor to a driving pulley on the line-shaft or the machine.

Gardner Machine Co., Beloit, Wis. Booklet on abrasive disks and how to use them. A unique feature of this little book is the small circular portion of an actual abrasive disk which is mounted on the first leaf of the booklet, and shows through a hole cut in the cover.

General Electric Co., Schenectady, N. Y. Bulletins: No. 4787, Wires and Cables, containing considerable data; No. 4811, Drum Controllers for Industrial Service; No. 4812, Small Direct-Current Generators of the Belted Type; and No. 4813, Oil Brake Switches for Pole Line Service.

Nelson Valve Co., Philadelphia, Pa. Wall chart of valves, accompanied by one of the Nelson danger signals which have been designed to be hung up at dangerous points around a steam plant, etc. The danger signal is a round red card with a skull on it, below which is the legend "Danger, hands off."

Technical Data & Appliance Co., 92 LaSalle St., Chicago, Ill., has recently brought out a new publication called *Data* which is decidedly unique. It is a small book 3 by 5 inches, of the standard filing card size, the pages being printed on one side only. Nothing but compact data are given, and the sheets are merely glued together along the edges, so that they may be taken out and filed. Suggestions as regards filing are given.

Gould & Eberhardt, Newark, N. J. *Practical Hints* is the title of a little book issued by this firm, containing numerous suggestions arranged for ready reference in connection with the correct operation of their automatic gear-cutting machines and cutter grinders. It is really a small text-book on gear-cutting. The 1911 catalogue on shapers is also an attractively arranged booklet describing the latest production in this line, and illustrating many of the machines in operation.

TRADE NOTES

Westcott Chuck Co., Oneida, N. Y. has recently been notified that it has been awarded the gold medal for the Westcott chucks, at the Brussels Exposition, 1910.

Mephus-Pihl Mfg. Co., whose pliers were mentioned in the January number of Machinery, is located at Hastings, Minn., instead of Hastings, Mich., as was stated.

W. B. Knight Machinery Co., St. Louis, Mo., will have an exhibit at the Boston Automobile Show, held in the Mechanics Bldg., March 4-11. Mr. Knight will be in charge of the exhibit.

Landau & Howe, 1779 Broadway, New York, have opened a branch of their consulting and designing engineer's office at 701 Fireman's Insurance Bldg., Newark, N. J., in charge of Richard A. Shaaf.

Pawling & Harnischfeger Co., Milwaukee, Wis., builder of cranes, hoists, etc., announces the opening of a branch office at 533 Baronne St., New Orleans, La., under the management of T. W. Waddell.

E. R. Klemm, manufacturer of cutting-off saws, stone jacks, grinding machinery, etc., is erecting a new shop at 1447 Austin Ave., Chicago, Ill. The new plant is 90 x 145 feet, two stories, and will be ready for occupancy about May 1.

Scranton & Co., New Haven, Conn., announce that the manufacture and sale of the Scranton improved upright power hammers which they formerly conducted will in the future be in charge of E. R. Caldwell & Co., Bradford, Pa.

Queen City Punch & Shear Co., Cincinnati, Ohio, announces the removal of its plant to the corner of Front and Pike Sts., into the building formerly occupied by the Bickford Tool Co. The capacity of the plant will be doubled, enabling orders to be handled more expeditiously.

Joseph T. Ryerson & Son, Chicago, Ill., at the annual meeting of the directors January 23, elected the following officers: Clyde M. Carr, president; Jos. T. Ryerson, vice-president and treasurer; Gilbert H. Pearsall, secretary; and Edward L. Ryerson, chairman of the board of directors.

Brunswick Gas Engine Co., New Brunswick, N. J., announces its advent into the field of automobile gas-engine manufacture. The purpose of the company is to manufacture engines designed to fill the particular needs of the customer, instead of marketing a standard engine. A staff of designing and production engineers will be maintained. Inquiries are solicited.

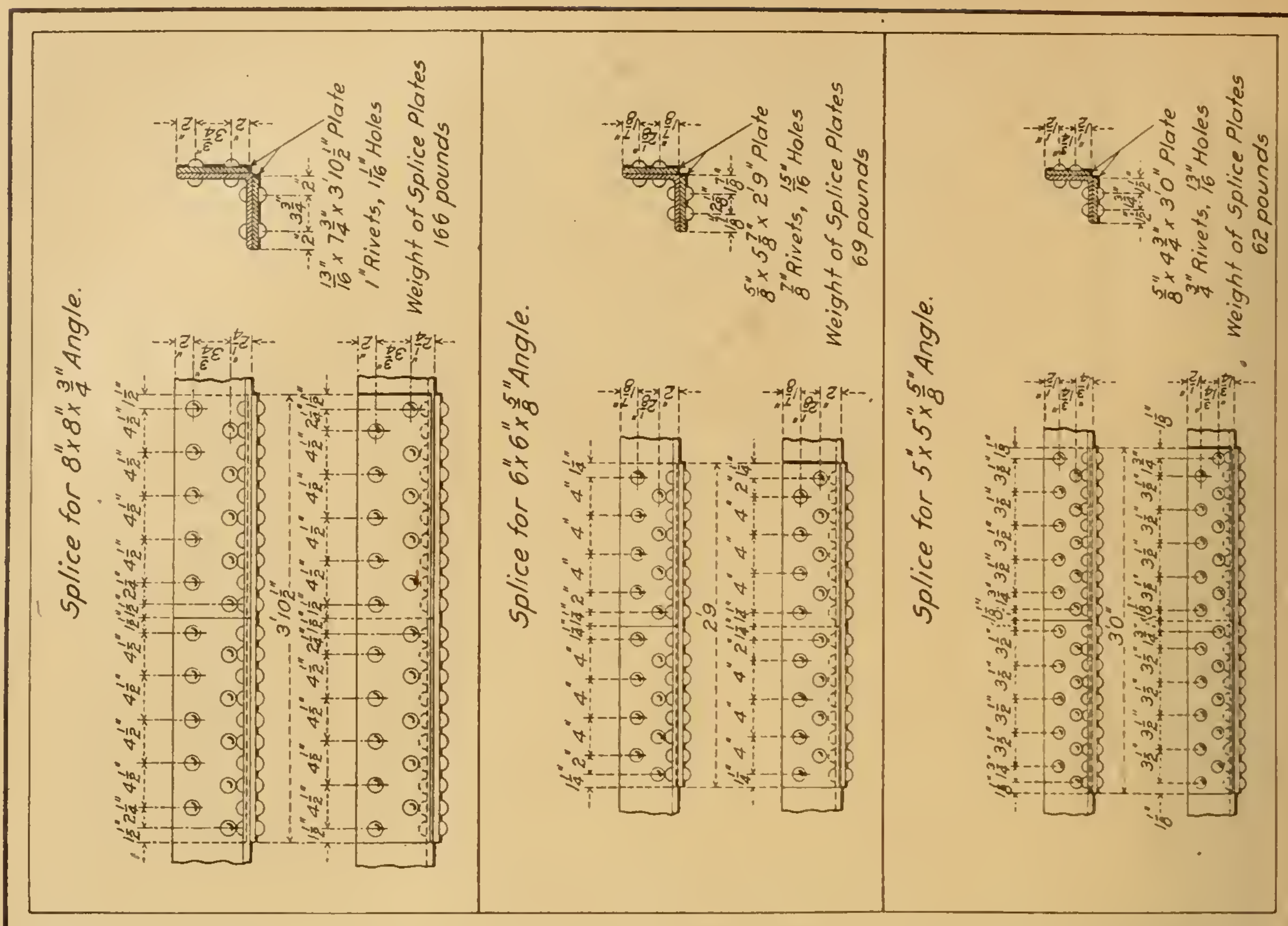
Canadian Railway Club held its ninth annual dinner at the Windsor Hotel, Montreal, January 27, 1911. Among the guests present were many prominent machine tool builders from both sides of the line as well as representative railway men. The reply to the toast to the railway supply men was made by G. H. Pearsall, secretary of Joseph T. Ryerson & Son, New York and Chicago.

Baker Bros., Toledo, Ohio, has nearly completed a fine power plant, equipped with a 175 K. W. Northern generator and Hamilton-Corliss engine. Two McNaull water-tube boilers are provided as steam generators, and space is available for a third boiler. The engine and boiler house are of absolute fireproof construction, being built with concrete roofs, brick walls and a "tarrazzo" floor in the engine room.

Cammell, Laird & Co. Ltd., Sheffield, England, has recently formed an American company to handle its business in this country. This new corporation is known as "Cammell Laird & Co. of New York," and its main office and warehouse will be located at No. 34 Cliff St., New York. A large stock of English tool and high-speed steel will be carried. The officers of the company are: Leonard Munn, president; Lionel Samuel, secretary and manager; and Alexander Muir, treasurer.

Racine Tool & Machine Co., Racine Junction, Wis., maker of the Racine high-speed metal-cutting saw, has moved into its new factory. The building is 40 by 100 feet, two stories and basement. The walls are cream-colored pressed brick, and the floors are supported by heavy steel beams and cast-iron columns, the floor rating being 400 pounds per square foot. The largely increased capacity of the

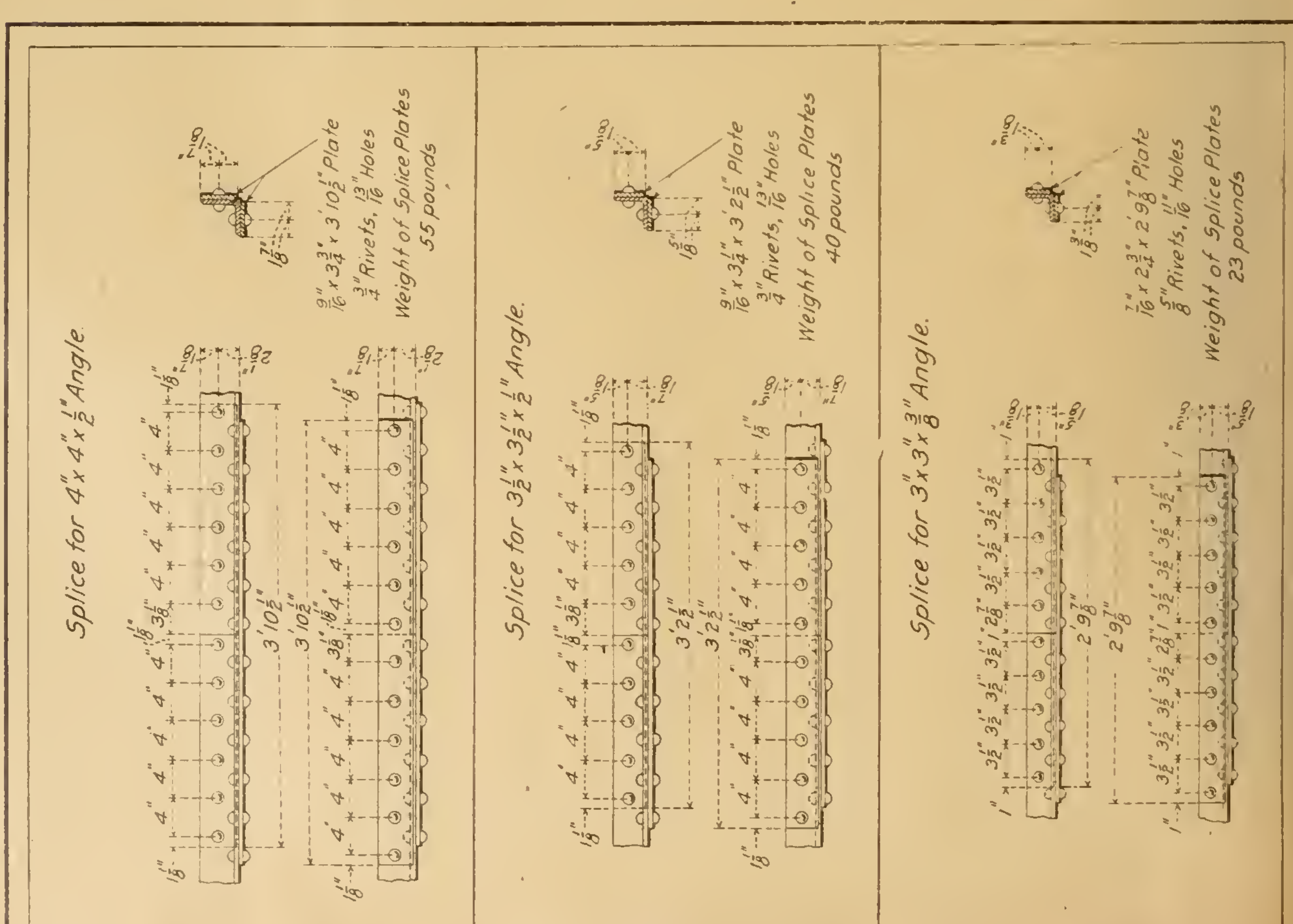
SPLICES FOR ANGLES—I



Contributed by A. L. Campbell

No. 141, Data Sheet, MACHINERY, April, 1911

SPLICES FOR ANGLES—II



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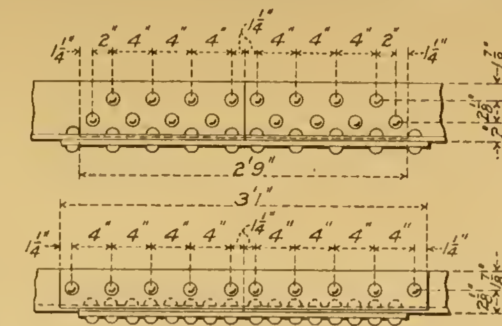
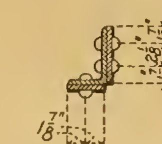
No. 141, Data Sheet, MACHINERY, April, 1911

entitled "Splices for Angles"

SPLICES FOR ANGLES—III

Splice for 6" x 4" x $\frac{5}{8}$" Angle.

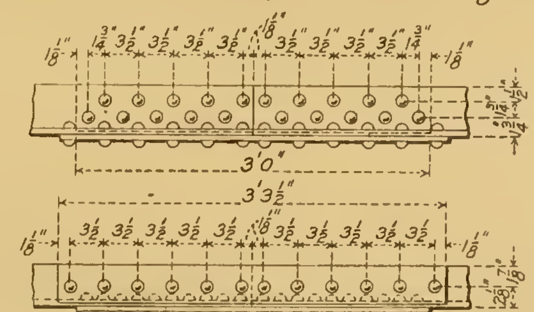




1 Plate $\frac{11}{16}$" x $5\frac{7}{8}$" x 2' 9"
1 Plate $\frac{11}{16}$" x $3\frac{3}{4}$" x 3' 1"
$\frac{7}{8}$" Rivets, $\frac{15}{16}$" Holes

Weight of Splice Plates 65 pounds

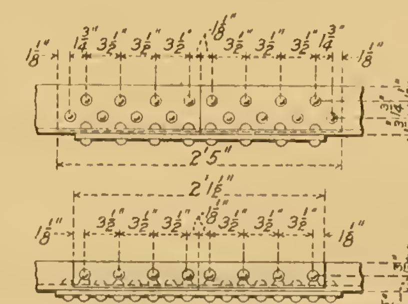
Splice for 5" x 4" x $\frac{5}{8}$" Angle.

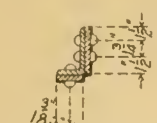


1 Plate $\frac{11}{16}$" x $4\frac{3}{4}$" x 3' 0"
1 Plate $\frac{11}{16}$" x $3\frac{3}{4}$" x 3' $3\frac{1}{2}$"
$\frac{3}{4}$" Rivets, $\frac{13}{16}$" Holes

Weight of Splice Plates 60 pounds

Splice for 5" x 3" x $\frac{1}{2}$" Angle.





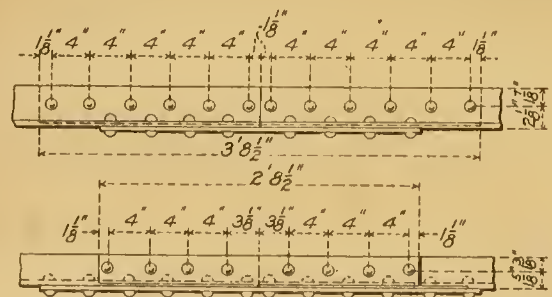
1 Plate $\frac{9}{16}$" x $4\frac{3}{4}$" x 2' 5"
1 Plate $\frac{9}{16}$" x $2\frac{3}{4}$" x 2' $1\frac{1}{2}$"
$\frac{3}{4}$" Rivets, $\frac{13}{16}$" Holes

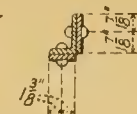
Weight of Splice Plates 33 pounds

Contributed by A. L. Campbell

SPLICES FOR ANGLES—IV

Splice for 4" x 3" x $\frac{1}{2}$" Angle.

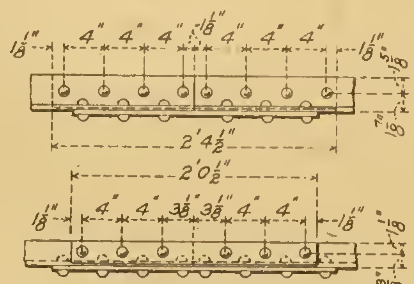




1 Plate $\frac{9}{16}$" x $3\frac{3}{4}$" x 3' $8\frac{1}{2}$"
1 Plate $\frac{9}{16}$" x $2\frac{3}{4}$" x 2' $8\frac{1}{2}$"
$\frac{3}{4}$" Rivets, $\frac{13}{16}$" Holes

Weight of Splice Plates 41 pounds

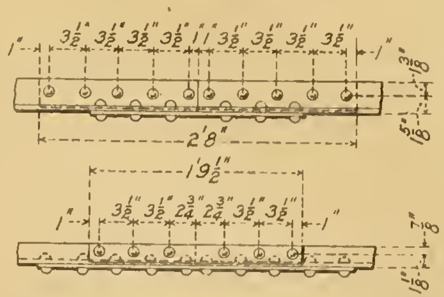
Splice for $3\frac{1}{2}$" x $2\frac{1}{2}$" x $\frac{3}{8}$" Angle.

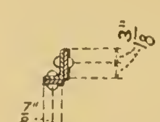


1 Plate $\frac{1}{2}$" x $3\frac{1}{4}$" x 2' $4\frac{1}{2}$"
1 Plate $\frac{1}{2}$" x $2\frac{1}{4}$" x 2' $0\frac{1}{2}$"
$\frac{3}{4}$" Rivets, $\frac{13}{16}$" Holes

Weight of Splice Plates 21 pounds

Splice for 3" x 2" x $\frac{3}{8}$" Angle.





1 Plate $\frac{1}{2}$" x $2\frac{3}{4}$" x 2' 8"
1 Plate $\frac{1}{2}$" x $1\frac{3}{4}$" x 1' $9\frac{1}{2}$"
$\frac{5}{8}$" Rivets, $\frac{11}{16}$" Holes

Weight of Splice Plates 18 pounds

Contributed by A. L. Campbell

MACHINERY
April, 1911

CARTRIDGE MAKING—2

METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO. IN THE MANUFACTURE OF CENTER-FIRE CARTRIDGES

By DOUGLAS T. HAMILTON*

Few sportsmen not acquainted with the methods employed in the manufacture of cartridges realize the amount of care and accuracy necessary to their production. There are so many points to be taken into consideration that even to those familiar with the subject, it is in some cases a difficult task to design and manufacture a cartridge suitable for the high-powered rifle of the latest pattern. Considering the difficulties encountered, it is interesting to note how the Dominion Cartridge Co., Montreal, Canada, is mastering these problems.

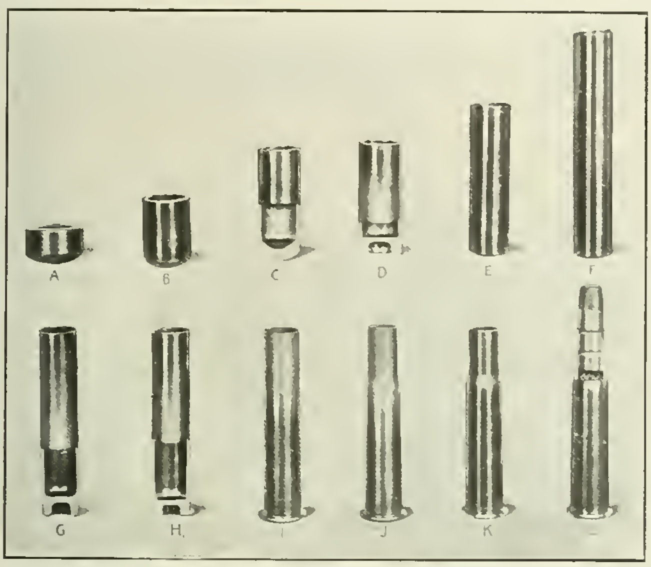


Fig. 19. Evolution from the Cup to the Finished Cartridge

Among the chief factors governing the accuracy with which a bullet strikes a target, may be mentioned: 1. The rifling in the barrel; 2. The nature and the amount of charge behind the missile; 3. The shape and equilibrium of the bullet. The rifling and the explosive charge behind the bullet have a direct effect on the velocity, and also govern the height of the trajectory curve. Theoretically, it is impossible for a body to travel through the air in a straight path, but with the high-powered rifles, considering a range of one hundred yards, the height of the trajectory curve at fifty yards is very slight. In the case of the cartridge to be described, the height of the trajectory curve at fifty yards is 1.280 inch. The shape of the bullet has not such a pronounced effect on its accuracy as has its equilibrium—that is to say, if a bullet does not balance properly on its axis, it is impossible for it to travel in an anywhere nearly a straight path. This is one of the problems a manufacturer of cartridges has to deal with, and is, in all probability, one of the most difficult to master.

Probably the most popular and the best-known high-powered sporting rifles using smokeless powders are the 0.30-30 Winchester, Marlin and Savage rifles. The bullet for the cartridges used in these rifles is made in three distinct patterns, *viz.*, the full metal-cased or hard-point, the part metal-cased or soft-point and the mushroom or hollow-point. The first-named of these is used more particularly for target practice, while the two latter types are used for hunting and sporting purposes in general. The soft-point bullet which weighs about 170 grains is the type most commonly used for hunting purposes. When fired, this bullet has a muzzle velocity of approximately 2000 feet per second—a rate of 23 miles per minute. This is the type of bullet which will be described in connection with the 0.30-30 Winchester smokeless cartridge in the following. In this article reference is made to Figs. 2, 3, 5, 9, 12, 14 and 16, which appeared in the previous installment, in the March issue.

Annealing and Washing the Cups—First and Second Drawing Operations

The case for the 0.30-30 cartridge is received in the form of a cup, as shown at A in Figs. 19 and 21. These cups are taken to the annealer, shown in Fig. 2, where they are annealed, washed and dried, as previously described. When dry, the cups are taken to the friction-dial drawing press shown in Fig. 20, where they are placed on the stationary table A, from which they are removed by means of a shaker to the revolving dial B. This drawing press is similar to that shown in Fig. 5, except that it is single-headed. After the cup has passed through two drawing operations, as shown at B and C in Figs. 19 and 21, it is ready for the inserting or indenting operation.

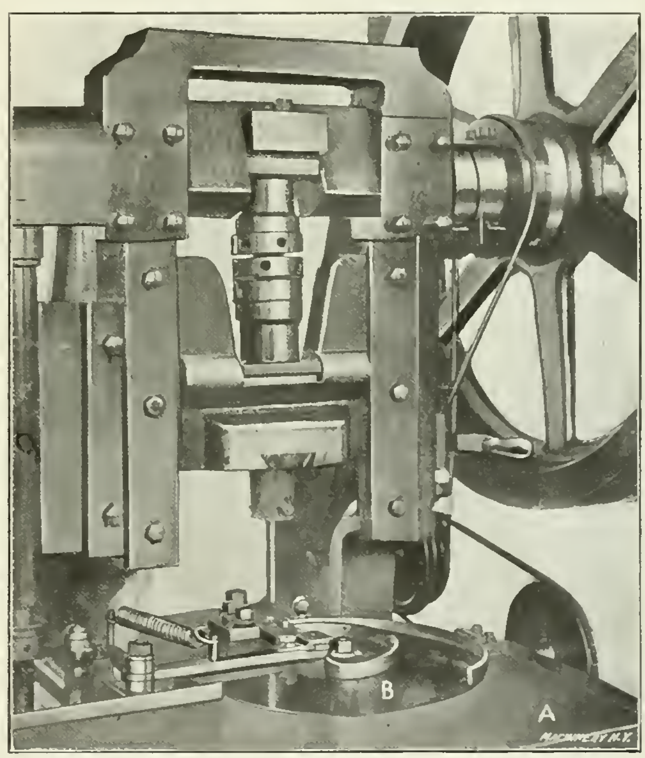


Fig. 20. Friction-dial Drawing Press for Drawing the Cups

Inserting—Rough Forming the Pocket for the Primer

The shell for the 0.30-30 Winchester cartridge is made with a solid head, which is not the case with cartridges of smaller size, in which, as a rule, smokeless powders are not used. The solid head is necessary to withstand the high pressure developed by smokeless powders. After the second drawing operation, the cup is not annealed, but is taken directly from the drawing presses to the headers, one of which is shown in Fig. 22. This header is used for inserting the pocket as well as forming the head. The principle on which this header works is similar to that of the horizontal header shown in Fig. 14, so we will turn our attention to the method used in rough forming the pocket. This is clearly shown at A in Fig. 24. As the shell comes down the slide of the header

* Associate Editor of MACHINERY.

shown in Fig. 22, it is located in a pocket, from which it is carried by the punch *a* (Fig. 24) into the die *b*. Here it is held by the punch while the inserting bunter advances and forms the pocket. Both punch and bunter then retreat, and on the forward stroke of the ram carrying the punch, the shell previously inserted is forced out of the die, as the punch carries another shell in.

Third and Fourth Drawing Operations

The shell was not annealed after the second drawing operation, and it is necessary to do this before it can pass through the successive drawing operations. The shells are taken to the annealer, annealed, washed and dried, and brought back to the drawing presses. The shells are now of considerable length, and it is not advisable to perform the third and fourth drawing operations in the press shown in Fig. 20, as they would not stand up properly on the dial. For these operations, a ratchet-dial drawing press is used, the design of the dial of which is somewhat similar to the dial of the swaging machine shown in Fig. 34. After the third drawing operation the shells are again annealed, washed and dried, and then given a fourth drawing operation, which increases their length as shown at *F* in Fig. 21.

Trimming the Shells to Length

As shown at *F* in Fig. 21, the top edge of the shell is extremely ragged. Cracks develop in the mouth of the shell which makes it necessary to remove a certain amount to obtain a good finish. This is accomplished in the semi-automatic trimming machine shown in Fig. 23. Here the shells are placed in the slide *A* by the operator, from which they pass into a pocket at the base of the slide. From the pocket they are carried into the chuck by means of the punch *B* held in the punch head *C*, which is actuated by an eccentric crankshaft. The chuck begins to close before the punch reaches the limit of its travel, thus allowing the punch to insert the shell to the desired depth. The chuck is closed by means of a cam (not shown) at the rear of the machine, operating a clutch, which, in turn, forces a sleeve forward, thus closing the chuck. The tool-slide *D* carrying the trimming tool *E*, is now brought forward, and trims the shell to the desired length. As the trimming tool *E* advances, the punch *B* retreats from the shell. The chuck is now opened, and the punch advances carrying in another shell, which forces the previously trimmed one into a hollow sleeve. This hollow sleeve passes through the spindle of the machine, the trimmed shells dropping through it into a box placed beneath the machine. The pulley *F* drives the camshaft, which, in turn, operates the chuck closing, trimming and shell-inserting mechanisms. The machine is started by operating the lever *G*.

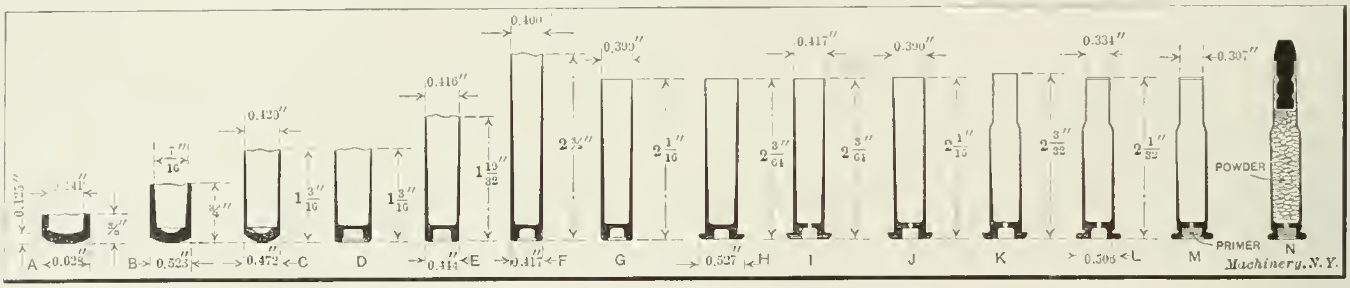


Fig. 21. The Various Operations on the Shell up to the Finished Cartridge

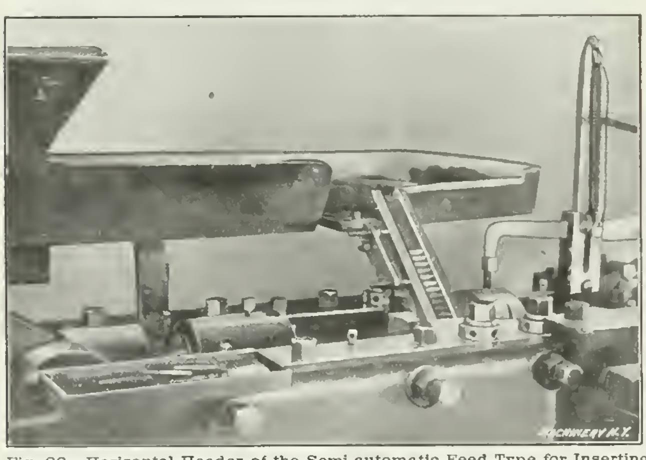


Fig. 22. Horizontal Header of the Semi-automatic Feed Type for Inserting the Cup and Forming the Head on the Shell

Forming the Head, Pocket Sizing and Piercing

The shell is now of the shape shown at *G* in Fig. 21, and is ready for the heading and stamping operation. It is again taken to the heading machine shown in Fig. 22, and operated on as shown diagrammatically at *B* in Fig. 24. As before, the shell is placed in the slide and drops down into the pocket, from which it is carried by the punch *d* into the die *e*. The heading bunter *f* now advances, finishing the pocket, and expanding the end of the shell to form the head. In this operation the punch does not retreat, but remains in position, supporting the shell, while the head is being completed. An end view of the heading bunter is shown at *C*, and the shape of the shell after the heading operation is shown at *H*, Fig. 21.

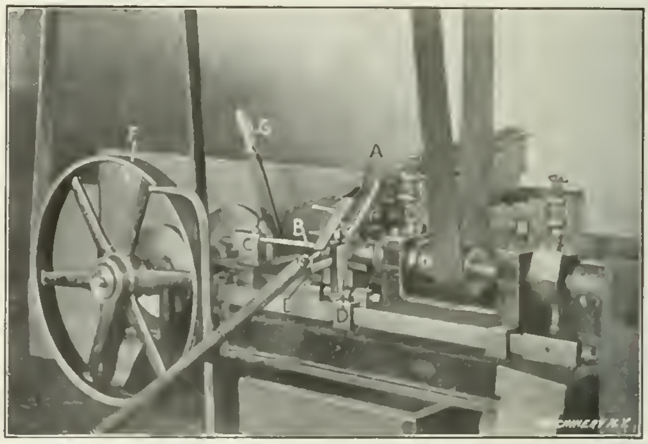


Fig. 23. Trimming Machine of the Semi-automatic Feed Type for Trimming the Shell to Length

There is considerable wear on the teat of the heading bunter in the heading operation, thus making it necessary to size the pocket so that the primer can be inserted without undue pressure. For this purpose, the shells are taken to a sizing machine of the ratchet-dial type, where they are placed on pins driven into this dial, and pass successively under a piercing, and a pocket-forming punch. The pierced shell is

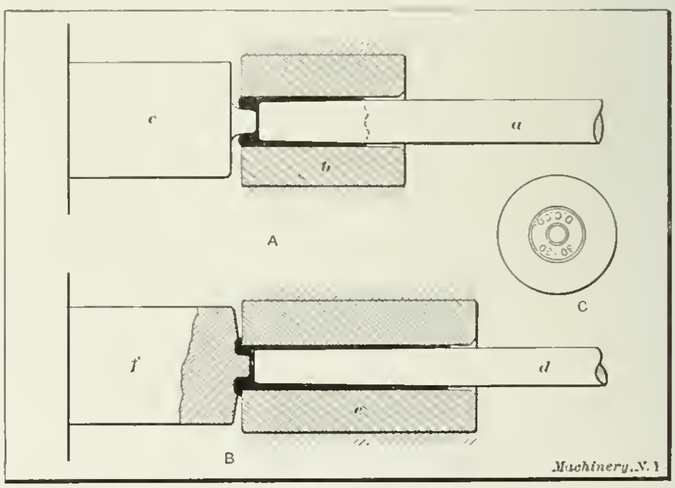


Fig. 24. Illustration showing how the Cup is inserted and the Shell headed

not shown in Fig. 19, but may be seen at *I* in Fig. 21 where all the other operations on the shell are also more clearly shown.

Mouth Annealing

When the pocket has been sized and the hole pierced in the shell, thus making an opening so that the powder can be exploded by the discharge of the primer, the shells are taken to what is called a "mouth annealer." This machine, which is

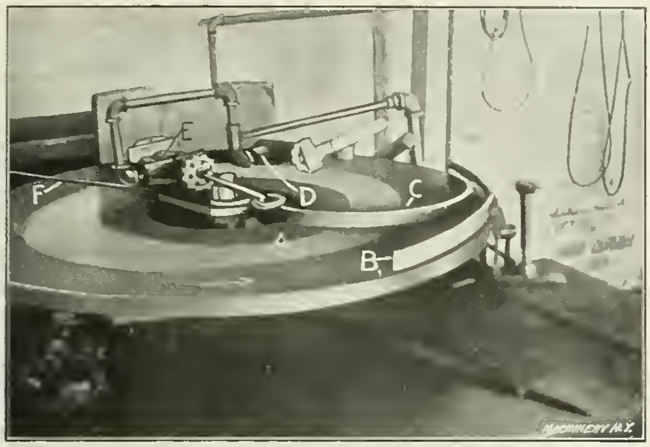


Fig. 25. Friction-dial Mouth Annealer

shown in Fig. 25, anneals the shells for about two-thirds of their length. The shells are placed in a vertical position, resting on their heads on the revolving dial *A*, which is rotating in the direction of the arrow. They pass around on this dial between the guard *B* and the spring *C*. This spring is given a vibrating motion by the action of the revolving dial, thus agitating the shells and arranging them in single file, so that each shell will be exposed to the flame. As the shells are carried around on this dial they pass in front of two gas burners *D* and *E*, where the mouth of the shell is annealed. Gasoline is used as a fuel, being pumped into the burners at the desired pressure by a pump located at the right of the annealer, but which is not shown in the illustration. The speed at which this dial revolves is such, that the shells remain in front of the burners long enough to be sufficiently annealed. They are then removed from the dial by a wire *F* which pushes them off into a box, where they are allowed to cool gradually.

Reducing and Verifying

The reason for annealing the mouth of the shell is to make it soft, so that it can be reduced on the mouth without cracking or folding. Before the shells are reduced, they are oiled with a rag which has lard oil spread over it. They are then taken to the machine shown in Fig. 26, which is a reducing press of the ratchet-dial type. Here they are dumped into a box placed in front of the machine, from which they are removed by the operator and placed in the holes in the friction-dial *A*. This dial is driven by a finger *B*, which is held to a dovetailed slide *C*, the slide being actuated by the lever *F*, which is connected eccentrically to the crankshaft.

As can be seen in the illustration, the holes in the dial *A* are larger at the front end. The dial is made in this manner so that the heads can be inserted in the larger hole, and as the dial revolves, the friction between the head of the shell and the base of the machine draws the shell back into the smaller portion of the hole. When the shell is in this position, it cannot be removed by the reducing dies, should they stick to the shell. The friction between the head of the shell and the bed of the machine, however, cannot be relied upon to locate the shells properly, so a spring pad is placed in the bed of the press, over which the shells pass before reaching the first reducing die.

The ram of this machine is made to hold two reducing dies. The first boss *D* holds what is called the breaking-down die, which only passes down a certain distance over the mouth of the shell, while the second boss *E* holds the reducing die. This latter die travels down practically the whole length of the shell, and gives it a tapering shape. The action of reducing is more clearly shown in Fig. 29, where the dies are located in the relative positions that they occupy when in the machine. The breaking-down die is shown at *A* while the reducing die is shown at *B*. It is necessary in this operation to support the inside of the shell while reducing, and for this purpose punches *a* and *b* are inserted in the die, as shown, to prevent the shell from folding.

From the reducing machine the shells are transferred to the verifying machine shown in Fig. 27. Here they are placed by the operator in verifying dies, sixteen of which are held in the ratchet-dial *A* by spanner nuts *B*. This ratchet-dial *A* is actuated in the same manner as that of the reducing press. As the shells pass around, the punch *C* seats them in the verifying dies, and as they pass around still further, the punch *D* forces them down into the die until the under side of the head of the shell rests on top of it. As the ratchet-dial continues in its travel, a "knock-out" placed beneath the dial lifts the ejector pins, which forces the shell up out of the die to a sufficient height, so that the pick-up *E* can grip it.

As each shell is picked up, it forces the preceding one up through a brass tube from which it falls out at *F* into the chute *G*. This pick-up is operated by a lever *H* fulcrumed to the ram of the machine and pivoted to a bracket *I*, which is fastened to the uprights of the machine. The end of the

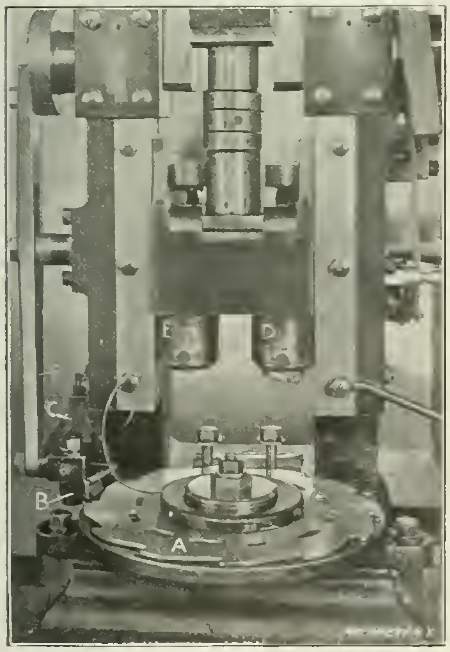


Fig. 26. Ratchet-dial Reducing Press for Reducing the Mouth of the Shell

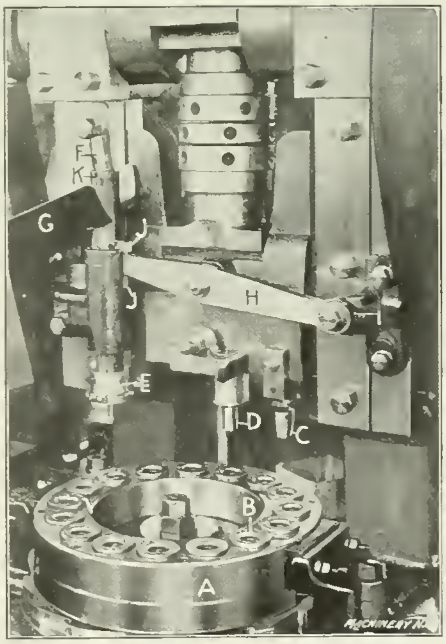


Fig. 27. Verifying Machine in which the Reducing of the Shell is completed

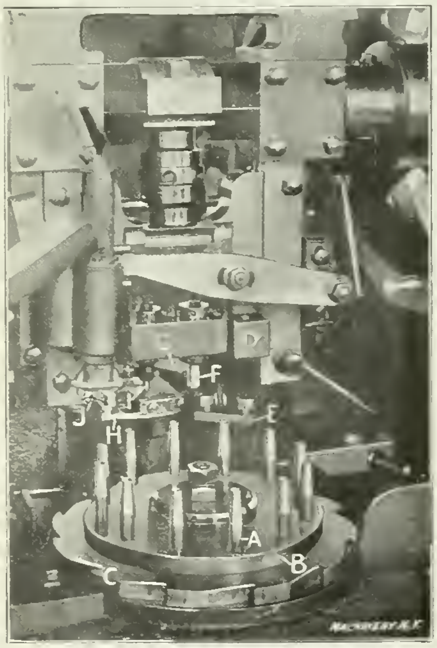


Fig. 28. Priming Machine for Inserting the Primer in the Pocket of the Shell

lever which operates the pick-up is rounded, so that it "rolls" freely between the projections *J* formed on the pick-up spindle *K*. This verifying operation reduces the shells on the mouth to the correct diameter, as shown at *K*, Fig. 21. Small pins or knock-outs are used to support the mouth of the shell while being reduced, acting on the same principle as those shown in Fig. 29.

Head Trimming, Mouth Trimming and Trimming to Length

After the shells have been verified they are removed to the washing-room, where they are put into the revolving tubs

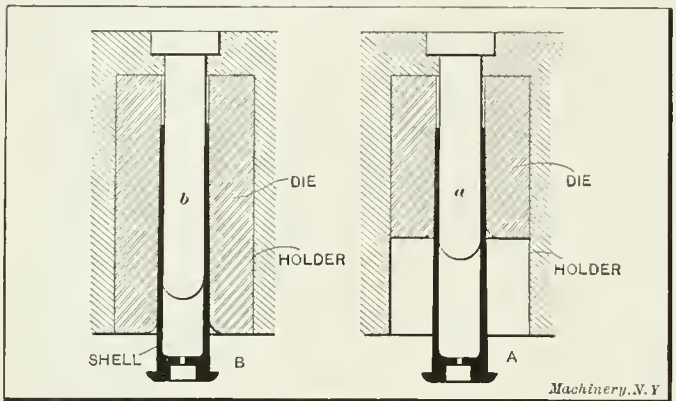


Fig. 29. Showing how the Mouth of the Shell is Reduced

shown in Fig. 3, washed, dried, and then brought to the trimming department. The operations now to be performed on the shell are trimming the head, trimming the shell to the proper length, and burring the mouth so that the bullet can be inserted easily. The trimming machine for performing these operations is shown in Fig. 31. The shells are placed in the slide *A* by the operator, from which they pass into a pocket *B*, the head of the shell facing the punch *C*, as shown. The drum *D* to which cams are attached actuates the slide *E*, carrying the punch *C*, which, in turn, forces the shell into the revolving chuck *F*. This chuck is made in two pieces, and

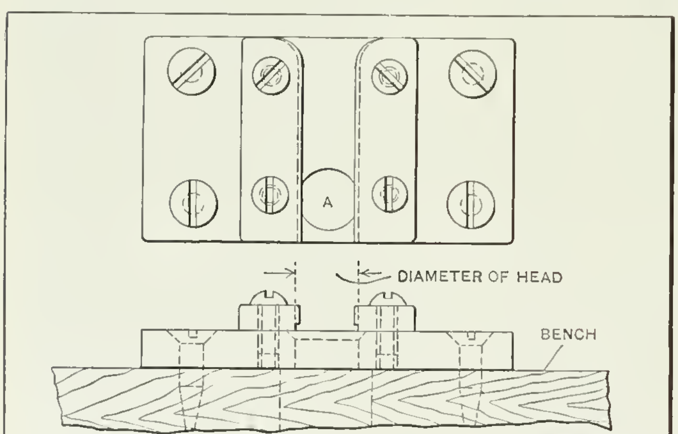


Fig. 30. Snap-gage used on the Bench for Gaging the Head of the Shell

is closed by split rings F_1, operated upon by a cam, attached to the main driving shaft beneath the machine. The chuck is rotated by a belt *G*, which runs on the pulley *H*.

Now that the shells are held in the chuck, a cam attached to the driving shaft carries a slide *I* forward, in which is held a trimming-tool holder J_1. Circular forming tools are held on this trimming-tool holder for trimming the head of the shell, giving it the appearance as at *L*, Fig. 21. A group of these circular tools may be seen hanging on the hopper at *J* to the left of the illustration. At the same time that the slide carrying the head-trimming tool is being advanced, the slide *K* also advances, carrying a trimming tool, which trims the shell to length. This trimming tool is similar to that previously shown in Fig. 16. As soon as the shell is trimmed to length, the mouth-trimming tool *L* advances and trims the mouth of the shell. This tool is made from $\frac{3}{8}$-inch drill rod.

After the trimming operations are completed, the chuck is automatically opened, and the punch *M* advances carrying the shell out of the chuck, from which it drops into the chute *N*, and thence into a box *O*. The snap-gage used for gaging the head and length of the shell in this operation, is shown at *P*, hanging to the hopper. It is the ordinary type of combination snap- and ring-gage, and will not need description. Gage *P* is only used when setting up the machine, and testing at the beginning of each box of shells. After the shells come from this machine, they are deposited on a bench, where an operator passes them through a snap-gage shown in Fig. 30, which is attached to the bench. This gage is so constructed that it is impossible to pass a shell through the hole *A* and into the box, without first passing the head of the shell through the slide of the gage. If any shells are found to have large heads they are put to one side and again pass through the trimming operation, so that all shells that pass this inspection have heads of the correct diameter.

Inserting the Primers and Inspecting for High Primers

The shells are now transferred from the trimming department to the priming machines, one of which is shown in Fig. 28, where they are placed in hollow pins *A*, twelve of which are driven into a dial *B*, fastened to a ratchet-dial *C*. This ratchet-dial is driven in a similar manner to the other ratchet-dials previously described. As the operator places the shells

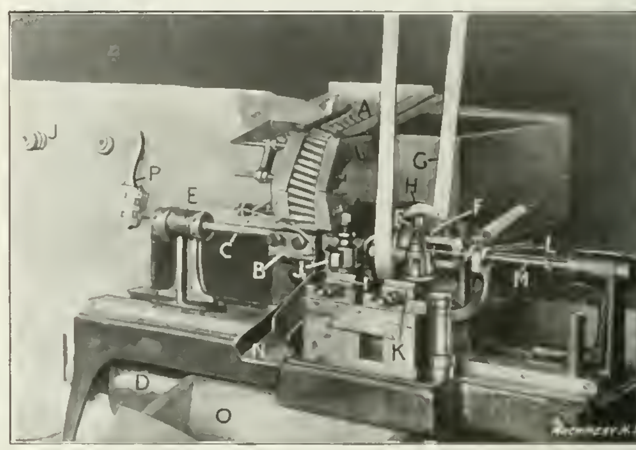


Fig. 31. Trimming Machine for Trimming the Head and Mouth, and for Trimming the Shell to the Desired Length

in the hollow pins *A*, they pass around under a punch (not shown) which is held in the boss *D*. This acts as an emergency punch to insure that all the shells have been pierced. A plate *E* acts as a guard to prevent the emergency punch from pulling the shells off the pins. However, this plate *E* is not relied upon exclusively, a punch *F* which is held in the ram of the press being used for seating the shells properly in the hollow pins.

The primers are shaken into small vulcanite plates, from which they are transferred to the table *G*, located at the rear of the machine. A friction-dial which is operated by a round belt driven from the main crankshaft, rotates just in front of this table. The operator now shoves the primers from the table onto the friction dial, which carries them around between two guards. This action of feeding the primers is

Fig. 32. Operations performed on the Lead Filling before and after Assembling in the Metal Case

similar to the action of the friction-dial drawing press, shown in Fig. 20. A finger *H* held on a slide carries one primer at a time out from the dial, and holds it central with the pocket in the shell. The punch *I* now descends, and carries the primer out of the finger, seating it in the pocket. As the dial passes around still further, the pick-up *J* descends, lifting the shells from the pins, and transfers them to a box in a similar manner to that shown in Fig. 27.

As can be seen in the illustration, the pins *A* are tapered so that the pick-up jaws can pass down over the head and get a good grip on the shell. The reason for using hollow pins instead of the ordinary solid pins for this operation is that the mouth of the shell is considerably smaller than the upper part of the body. This makes it necessary to put the shells in hollow pins, so that they will not be able to "wobble" when the primer is being inserted, as would be the case if solid pins were used. After the primers have been inserted in the pockets of the shells, they are transferred to a bench where an operator, by means of a small straightedge which is rubbed across the top of the shell, tests the primers to see whether any project above the face of the head. If a primer projects, a bright spot is noticed, so that this primer has to be knocked out and another one inserted.

Casting, Tumbling and Swaging the Slugs

The shell is now completed, so we will next take up the making of the bullet. The bullet which will be described in this article is called the "soft-point," and consists of a lead center which is partially enveloped by a metal case. The various stages through which this bullet passes are clearly shown in Fig. 32. *A* is the slug as it comes from the molds. placed in the loading machine, Fig. 33. Seating punches *A* are held to the ram of this machine and as the lever *B* is pulled down, the ram descends, and the seating punches force the shells out of the plate *C* over the lead centers held in the plate *D*. These seating punches are made so that they pass into the holes in the shell plate.

The bullet plate or "center holder" is made to give the bullet a shape such as shown at *C*, Fig. 32. The bullets as now formed are again transferred to the swaging department, where the operator places them on the table *A* of the machine shown in Fig. 34, from which they are put on the ratchet-dial *B*, the lead point extending downward. As the dial passes around, the punch *C* seats the bullet properly in it, and as it continues in its rotary movement, the punch *D* forces the bullet out of the dial into a die. This die gives the bullet the shape shown at *D*, Fig. 32, and also makes it symmetrical, so that it will balance properly on its axis. It might here be mentioned that the finishing of the bullet in one die insures this result.

As the ram of the press ascends, it carries upward two rods connected to the knock-out motion under the press, which, in turn, force a punch up through the die, the action of which again transfers the bullet from the die to the dial *B*. Just

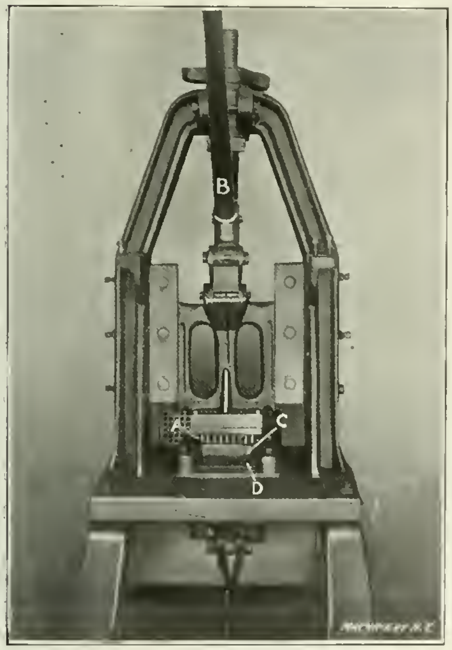


Fig. 33. Hand Loading Machine for Loading the Cartridge

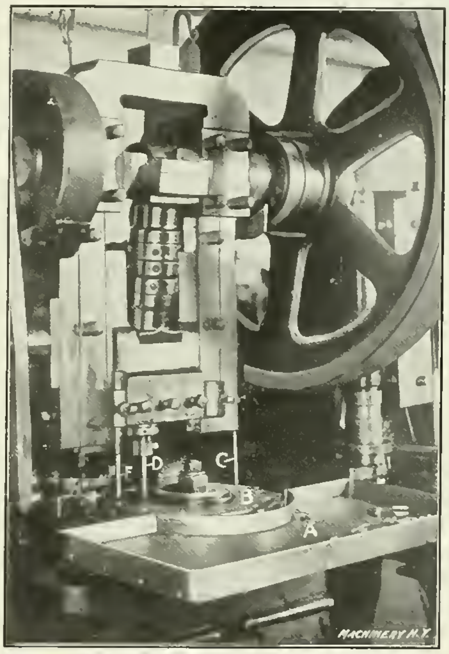


Fig. 34. Swaging Machine for forming the Lead Filling and the Metal Case to the Desired Shape

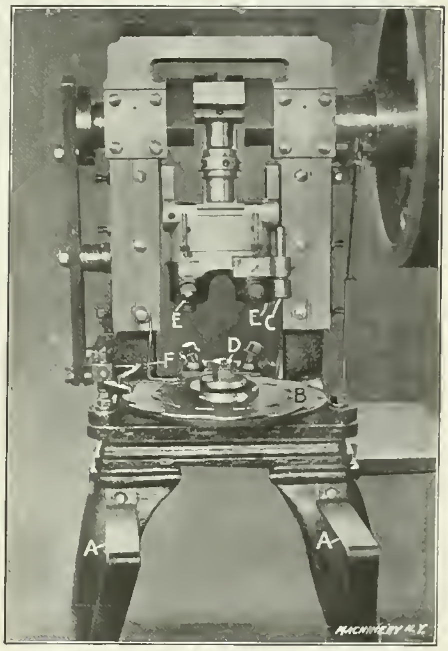


Fig. 35. Crimping Machine for Tightening the Cartridge Case on the Bullet after Loading

These slugs are cast in molds of a similar design to those shown in Fig. 12, but of course, the forms in the molds are of the desired shape.

The slugs are removed from the molding department to a tumbling barrel, where they are tumbled for a considerable length of time to remove the fins; then they are dumped into the hopper of an automatic swaging machine, similar to that shown in Fig. 9, and come out in the form shown at *B*, Fig. 32. This finishes the operation on the lead center.

Drawing and Trimming the Metal Case

The metal case which is shown assembled on the lead center at *C*, *D* and *E* in Fig. 32, is made from copper and is nickel-plated after it has been trimmed to the desired length. This case for the bullet comes in the form of a cup and passes through three drawing operations, and the annealing, washing and drying operations, as was previously described regarding the shell for the 0.22 long. The same class of machines is also used for the various operations on this case.

When the case is completed, that is, after the drawing and trimming operations are performed, the case and the lead centers are transferred to the loading department. Here the lead centers are shaken into one plate while the copper cases are shaken into another. These plates are now assembled over each other, the plate holding the shells being on top, and a slip-plate is put under them. The three plates are then as the bullet is located in the dial, the latter is revolved and the punch *E* forces the bullet out of the dial into a chute, from which it is deposited into a box.

The next operation on the bullet is the forming of the knurled grooves shown at *E*, Fig. 32. The knurling of these grooves is accomplished in the canneluring machine shown in Fig. 36. The bullets are dumped on the dial *A*, from which they are removed by the operator and placed in a vertical position on the revolving dial *B*. Attached to the revolving dial *B* is a dial *C*, which has two knurled projections on its periphery. Back of dial *C* is a stationary segment *D*, which also has two knurled projections on its face.

In operation, as the bullets pass around on the dial *B* in the direction of the arrow, they are rotated by the action of the dial *C* revolving against the stationary segment *D*. This action forms the knurled grooves entirely around their peripheries. As the dial carries the bullets around still further, they are removed from it by means of a guide *E*, and drop into a box placed under the machine. The object of this canneluring operation is to form a groove in the bullet so that the top of the shell can be turned in, thus holding the bullet more securely in the shell. After the canneluring operation, the bullets are taken to the swaging machine shown in Fig. 34, and again pass through the operation of swaging, the same die being used as before. This is to correct any eccentricity of the bullet which might have been caused by canneluring.

Loading and Crimping

The shell and bullet are now ready for assembling or loading, and are transferred to one of the explosive departments where this operation is accomplished. In operation, the shells are taken into one plate and the bullets into another. Then the desired amount of powder is shaken into a charger, which is located over the shell plate and rapped slightly, thus depositing the powder in the shells. The shell plate containing the shells, and the bullet plate are removed to the loading machine shown in Fig. 33. Here the shell plate is put into the slide, the bullet plate located on top of it by means of dowels, and the handle *B* pulled down, carrying down the ram of the press to which the seating punches are fastened. These seating punches force the bullets out of the bullet plate and locate them in the shells. The plates are then removed and the loaded cartridges dumped out. The plates shown in the illustration, however, are not those used in this operation.

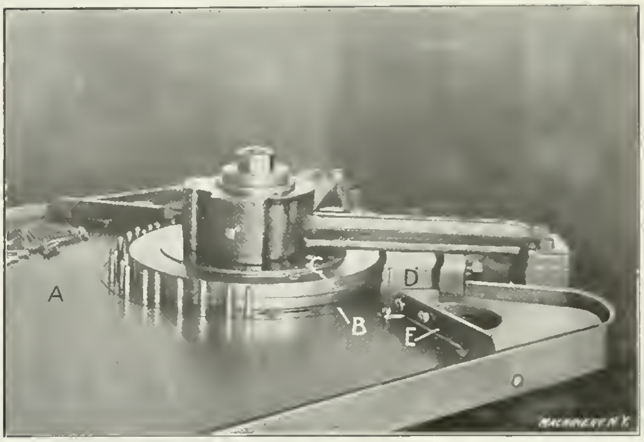


Fig. 36. Canneluring Machine for Forming the Grooves in the Bullet

The loaded cartridges are now transferred to the crimping machine, Fig. 35, in which the top of the shell is tightened around the bullet. The operator dumps the cartridges into a box, which is held on the brackets *A* in front of the machine. He then removes the cartridges from the box and places them in the holes in the dial *B*. This dial rotates to the left, and as the cartridges come below the punch *C*, the bullet is seated in the shell to the correct depth. It will be noticed in the illustration that two bosses *E* are provided on the ram of this machine. Both bosses, however, are not used for crimping, as this machine is also used as a reducing press, when both bosses are necessary. The crimping die can be held in either boss, but is held preferably in the one to the left. This die is made so that it passes over the bullet and turns the shell in the groove, thus tightening the shell securely on the bullet. As the shells pass around still further, they are removed from the dial by the wire *F* and are deposited in a box under the machine. Spring pads are also used under this dial, the purpose of which was explained in the preceding in connection with the reducing press shown in Fig. 26.

Testing and Packing

The cartridges are now finished as regards the manufacturing operations, but they are not ready for the market until they pass through a rigid inspection. This inspection consists in testing for accuracy, velocity and penetration.

The accuracy of the cartridge is tested by means of shooting the bullets at various ranges for which the cartridges are adapted. This is done both by off-hand shooting, and also by locating the rifle in stocks, sighting it directly over the bull's-eye, firing it, and then noting the results.

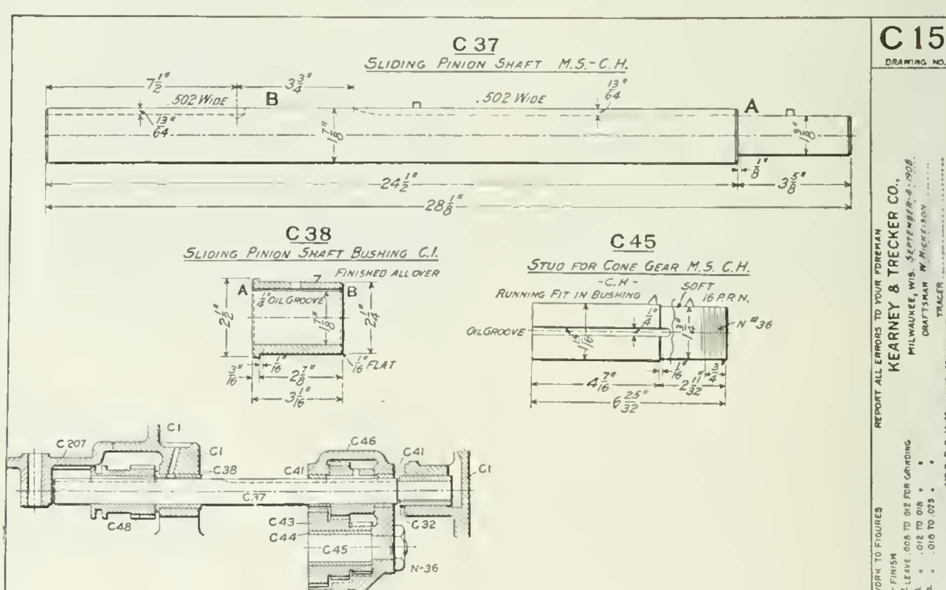
The velocity of the cartridge is determined by means of an instrument called the chronograph. This is an electrical instrument which operates in the following manner: The recording mechanism is connected with a wire, which is held just in front of the muzzle of the gun from which the cartridge is to be fired. Another wire is placed in front of the target and connected to the chronograph by an electrical circuit. When the apparatus is adjusted, a signal is given for the cartridge to be fired. As the bullet leaves the muzzle of the gun, it cuts the first wire which is connected to the chronograph, and the latter commences to record the flight of the bullet. When the bullet strikes the target, it breaks the electric circuit connected with the chronograph, and the instrument instantly stops registering. The recording apparatus shows the time taken by the bullet in traveling from the gun to the target, and as this distance is always known, it is an easy matter to determine the velocity in feet per second. The velocity of the 0.30-30 cartridge was previously given.

This cartridge is tested for penetration by shooting the bullets into boards of a given thickness. Pine boards, 7/8-inch thick, are, as a rule, used for this purpose. The penetration of the 0.30-30 soft-nose bullet, which is described in this article, is eleven boards, at a distance of 15 feet. If the cartridge does not pass this inspection satisfactorily, the cause is ascertained and rectified before any are shipped. These cartridges are packed by hand in boxes which hold 25. The boxes are then put in cases holding 5000 cartridges.

* * *

KEARNEY & TRECKER CO.'S DETAIL DRAWING PRACTICE

The illustration is a reproduction of a detail sheet which is an example of the drafting practice of the Kearney & Trecker Co., Milwaukee, Wis. A shaft and two studs are detailed in the usual manner, and the location of the three parts when assembled is shown on the same sheet. The drawing is typical, the location of every detail part being shown in this manner. The advantage of this practice in the shop is obvious; it shows the workman how the parts on a shaft must be assembled and where the assembled unit goes. The sheet also shows certain finish convention marks used to designate the allowance for grinding.



A Kearney & Trecker Detail Drawing

* * *

One advantage of aluminum over copper for electric wires is that the "oily" surface of aluminum, due to the coating of the metal by hydroxide, causes it to shed water better than copper, so that aluminum wires are less likely to be coated with sleet even when they are larger in diameter than copper wires.

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—1

By S. N. BACON

The assembling of parts in the automatic screw machines is a practice which is not widely followed as yet, and the writer has only witnessed such jobs in shops where contract work was being done. In this article light assembling operations are described, and the attempt is made to prove that up-to-date methods are really worth while. The examples given include not only the assembling operations themselves, but also the making of the parts to be assembled from the same bar at the same chucking. This not only decreases the cost of making the parts, but also eliminates the necessity of handling them a second time.

In Fig. 1 is shown a small brass bolt and nut which a jobbing shop had been making for several years, each part being made on a separate machine. The assembling was done by hand, and consisted of screwing the nuts on the bolts. These parts are now made in a No. 0 Brown & Sharpe automatic screw machine at the same chucking, and assembled without rehandling.

The most interesting feature of the present method is the revolving of the turret twelve times during one revolution of the cams, that is, the turret makes two complete revolutions while the cams make one; the necessity for this will be explained later. The machine spindle is reversed three times. The additional revolving of the turret and reversing of the spindle are accomplished by the use of extra tripping dogs.

The method of applying the circular tools and the assembling tool is shown in Fig. 2. *A* is the form tool which forms the body of the bolt and cuts off the nut, and *B* is the tool which cuts off the bolt. This latter tool is mounted on the front cross-slide. This layout requires but one feeding of the stock for both pieces. The turret tool shown in Fig. 2, which is a carrier for the nut, comes forward just before the nut is cut off, and the spring chuck *C* closes over it. (The stock at this point is running backward.) The clutch finger *D* allows the carrier *C* to revolve in the holder *E*, thus preventing the nut from turning in the spring chuck and wearing off the corners. When the nut is inserted in the chuck *C*, and has been cut off, the spindle is reversed to run forward, the clutch finger preventing the carrier from turning. This clutch also acts while the nut is being screwed on the bolt. The clutch is more clearly shown in the sectional view to the right. The order of operations is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	18	3
Revolve turret	18	3
Drill 0.178-inch rise at 0.0034-inch feed	53	9
Revolve turret	18	3
Tap in	12	2
Tap out	12	2
Cut off 0.145-inch rise at 0.0017-inch feed	83	14
Revolve turret twice and bring carrier forward	(36)	(6)
Form with tool on rear-slide 0.130-inch rise at 0.00085-inch feed	159	27
Back away form tool to clear threading die	12	2
Revolve turret five times	(90)	(15)
Thread on	17	3
Thread off	17	3
Revolve turret	17	3
Thread on nut	12	2
Reverse spindle and withdraw turret	12	2
Cut off bolt 0.237-inch rise at 0.0019-inch feed	124	21
Revolve turret twice	(36)	(6)
Clearance	6	1
Total revolutions	590	100

With a spindle speed of 1474 revolutions per minute this layout gives a gross production of 1500 pieces in 10 hours, or 1350 pieces net. The time required to make and assemble both pieces is 24 seconds.

After the stock is fed out to a length sufficient to make both pieces, the end is drilled and tapped for the nut, which is then inserted in the carrier and cut off. The problem which now arises is to revolve the turret a sufficient number of times to bring the carrier into position to screw the nut on the finished bolt, as soon as the latter has been threaded. This is successfully accomplished by revolving the turret twice while cutting off the nut, and five times while forming the bolt.

The most interesting part of the job is the laying out of the cams. The usual set of three cams is shown in Fig. 3, the outline of the lead cam being shown as a solid line. It will be noticed that the lobe for centering is omitted from the lead cam. This is done because of the shallow depth of the hole to be drilled, and also because the work is not required to be very accurate.

The lobe which operates the carrier when gripping the nut is shown from 28 to 36 on the lead cam. Careful calculations

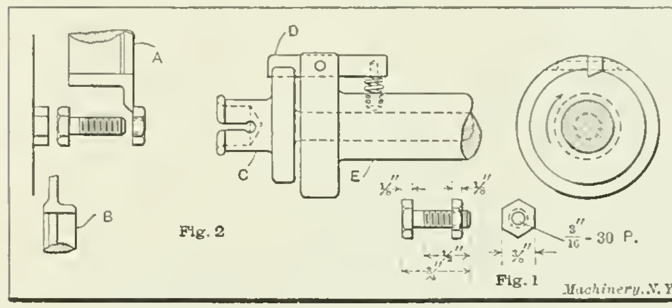


Fig. 1. Nut and Bolt to be made and assembled. Fig. 2. Method of Applying the Circular Tools and Construction of the Carrier or Assembling Tool

are necessary to determine the exact position of this lobe, so that the carrier will grip the nut before it is cut off. The method used to determine the position of this lobe is as follows: During the time from 22 to 28, which is equal to 36 revolutions of the spindle, the cut-off tool has advanced at the rate of 0.0019 inch per revolution, or $36 \times 0.0019 = 0.0684$ inch. The diameter of the stock across the corners is 0.432 inch, and the diameter of the drilled hole is 0.125 inch. Then the thickness of the wall on each side of the hole when the carrier advances on the work

$$= \frac{0.432 - (0.0684 \times 2) - 0.125}{2} = 0.085$$

inch, which is great enough to prevent the nut from breaking off when the carrier closes over it.

The hook shaped lobe from 74 to 76, threads the nut on the bolt, and the sudden drop pulls the carrier off the nut.

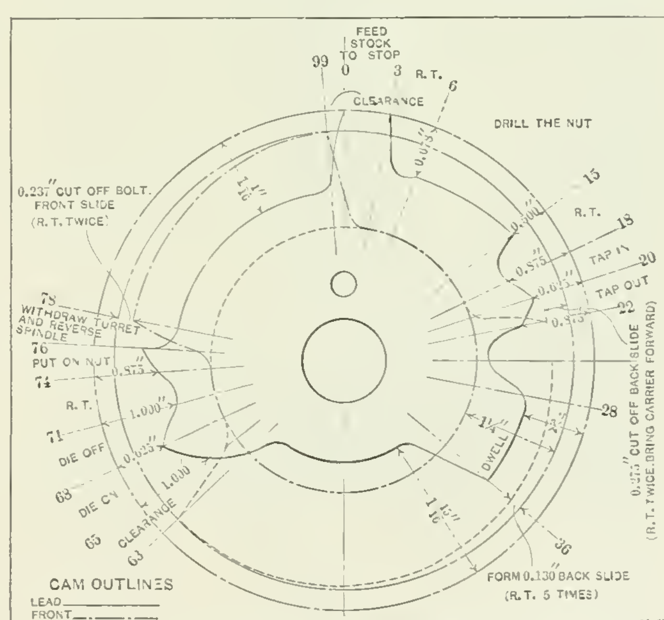


Fig. 3. Cams used for Making and Assembling the Nut and Bolt

The spindle is then reversed, so that it will be rotating in the correct direction to cut off the finished piece. The portion of the cam surfaces from 99 to 0 allows the cut-off tool to drop back and clear the stock before it is fed out for the next piece.

* * *

One of the best-known scientific authorities on aerial navigation in France, M. Soreau, has estimated that there is one fatal accident in aerial flights for each 4500 miles covered.

EQUIPMENT FOR ENGRAVING PEARL REVOLVER HANDLES

The mother-of-pearl used for handles of fine knives, revolvers, etc., is the hard iridescent lining of pearl oyster or river mussel shells. It is a calcareous concretion in irregular layers of nacre or nacreous substance, capable of taking and retaining a polish with luster and iridescence unequalled by any other common material. Although pearl is hard and brittle, it is cut with little difficulty by tools properly hardened and tempered, and is readily machined to any required shape; but the peculiarity of its stratified structure prevents the shaping of the exterior of handles to a prescribed form, as is always done, of course, with wood, ebony and bone handles. Pearl must be shaped by following the natural cleavage lines if the highly prized iridescent and lustrous effect is to be secured. The necessity of following the natural shapes of pearl makes no two knife or revolver handles alike. The contour and thickness of every pair of sides vary considerably and these variations make a pretty problem for the designer of the engraving machine to solve. The following description applies to the method developed by Messrs. George Gorton and Charles Rothweiler, of the Geo. Gorton Machine Co., Racine, Wis., for engraving pearl revolver handles on the Gorton engraving machine.

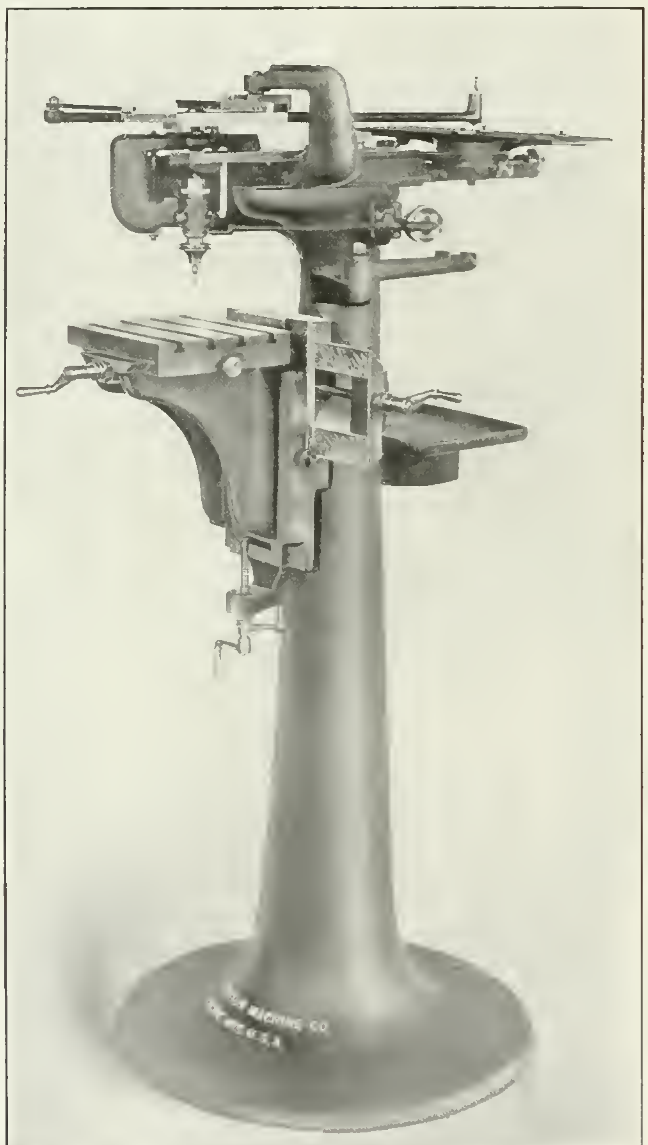


Fig. 1. Gorton Engraving Machine adapted to engraving on Rounded Surfaces

The Gorton engraving machine is of the vertical work-spindle pantograph type, the revolving cutter being guided laterally by "copy" several times the size of the desired reproduction. Fig. 1 shows the column-type of machine, No. 1 G, the knee and work spindle being in front and the copy table in the rear. The desired reduction is obtained by setting the pivot distances of the pantograph levers in the proper ratio. The work spindle is made to follow the form of the copy in reduced scale and the design is cut in the work by a flattened point V-shaped tool having one side cut away to the center the same as the half-center used for reaming lathe centers. The original design of the machine did not provide for guiding the spindle vertically for depth, although adjustment, of course, was provided for setting the tool. In engraving curved surfaces, there must be means for varying the vertical position of the cutter to conform to the shape of the piece, if the depth of engraving is to be uniform. But as each half of a pearl revolver handle is of different shape and thickness, and no two are alike in a lot of a thousand, an individual former must be provided for every piece.

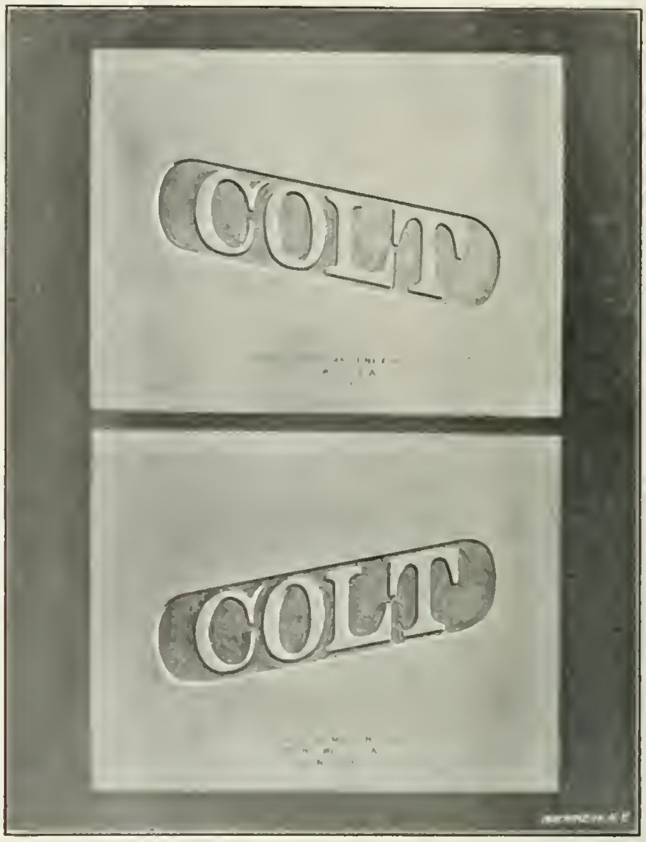


Fig. 2. Copy for Both Sides of Pearl Revolver Handles

Fig. 3. Engraved Pearl Handle, Mold and Wax Former Produced in Mold

The formers are made of sealing wax, one at a time, in a mold containing the pearl handle to be engraved; and the wax former and pearl go to the engraving machine together. The pearl is mounted on a plate having three locating pins in the top side and two guides on the under side. The mold, made with tapered inner sides (see Fig. 3), is placed over the

pearl and plate and all are clamped in place as shown in Fig. 4. The melted wax is poured in the funnel-shaped opening and the plug at the right is used to expel the air bubbles and force the wax into close contact with the handle. When the wax has hardened, the handle *A* is pulled a quarter-turn to the right to cut off the sprue. The hole in the funnel is made eccentric, as will be seen in Fig. 6, to accomplish this action. This view shows the leaf of the mold jig raised to permit removal of the mold and wax former. The sprue is broken off

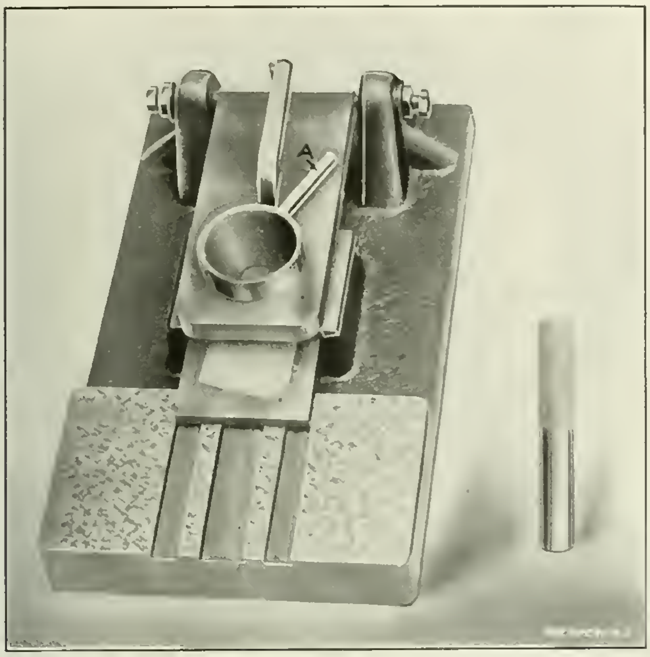


Fig. 4. Jig for Molding Wax Formers for Engraving Pearl Handles

below the level of the top surface, and no after trimming is necessary.

In Fig. 5 is shown the jig used on the engraving machine for holding the pearl handle. The handle is mounted on a plate—a duplicate of that on which it is mounted when the wax mold is made. The wax former is used on the machine directly over the spindle, where it is fixed in a dovetail groove holder, the same as the convex former shown in Fig. 1. The

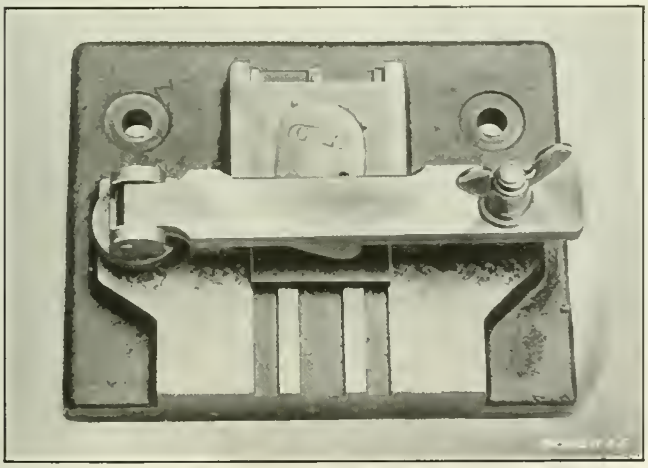


Fig. 5. Jig for Holding Pearl Handle for Engraving the Name

guide point on top of the spindle casing is held in contact with it by a spiral spring concealed in the side of the case.

The method of making the copy, Fig. 2, is simple but interesting. Manufacturers generally send an engraved sample to be duplicated. A rubbing taken off the sample on tracing paper is thrown on a screen with a projecting lantern to a scale, say, twenty times the size of the sample. The outline of the image is traced on a sheet of manila paper in pencil. The tracing is then tacked on the drawing-board and gone over to smooth up the lines, correct irregularities, distortions, etc. When the sketch has been corrected, it is cut out and mounted on a sheet of galvanized steel, using shellac both to mount it and to harden the edges of the paper, which is a guide for the pantograph tracing point. Several thicknesses of manila paper are used in order to get a thickness of about one-sixteenth inch. This makes the "first copy" that is used to generate the brass-plate copy shown. The first copy in the case of the engraving for the pearl handle is about five times the size of the finished copy in brass and this, in turn, is about four times the size of the engraving.

The actual engraving of a pearl handle does not differ materially from engraving the same design on a curved metal surface, except that care must be taken to prevent breaking away delicate points of the letters or tracery when the supporting material on the opposite side has been cut away. For instance, the slender sharp point of the "C" in the design must be traced with care to prevent slivering, on the finishing

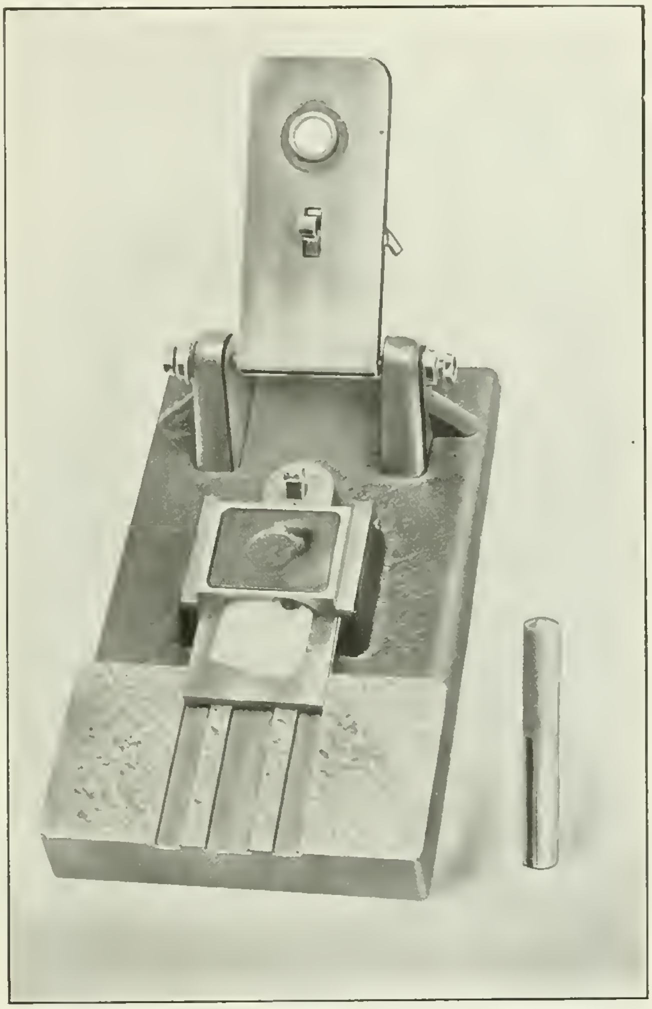


Fig. 6. Jig for Molding Wax Formers, with Leaf Turned back showing Eccentric Sprue Cutter, etc.

cut. The design should be traced if possible so that the cutter action is *toward* the body of the remaining material, thus insuring some support for the pearl in direct line with the push of the cut. F. E. R.

* * *

PATENTS AND PATENT PROTECTION

The patent laws of the United States were framed to encourage the arts and industries. Inventors were given monopoly rights in their inventions for the term of seventeen years, at the expiration of which anyone is free to make and market the device protected by the patent. Notwithstanding the broad intent of the patent law and the aim of its framers to encourage competitive manufacturing by giving inventors a monopoly in the beginning, a certain odium attaches to the making of machines on which patents have expired. Certain interests in a few well-known cases have fostered the belief that the young competitive concerns engaged in making the products developed by them, are little better than thieves and pirates. While we admire most the concerns that develop original ideas and design and push their own peculiar products, there certainly can be no blame attached to the makers of machines no longer protected by patents.

PUNCH AND DIE FOR BENDING A PERFORATED BLANK

By C. H. ROWE*

The writer was at one time called upon to consider the best method of bending the piece shown in Fig. 1. This at first glance appeared to be a simple operation, but upon trying it out, it was found that on account of the stock being so thick, and the web between the holes so narrow, it was a difficult proposition to prevent the webs from being distorted. The width of the rectangular holes was also increased.

The blanks were first cut to the required length in a power shear, and afterwards pierced in the die shown in Fig. 2, the

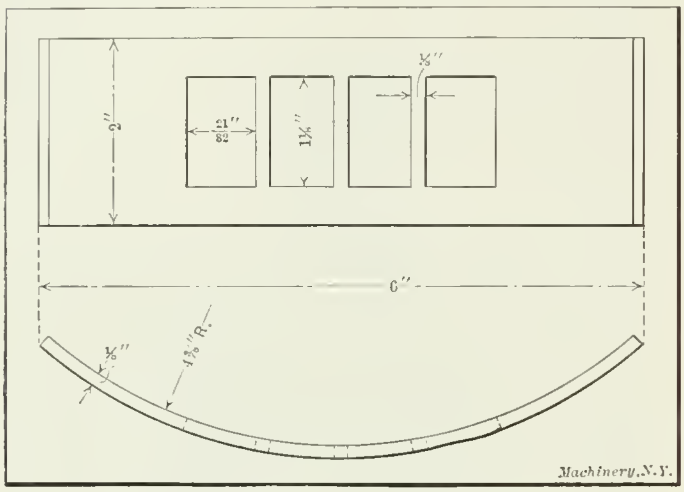


Fig. 1. Perforated Blank to be bent to a Circular Shape

stock, of course, being of the required width. The piercing die is made up of two sections *A*, which are held in a die-holder not shown. The dowels *D* were used for locating the two segments in the correct relation to each other. As it was thought impracticable to make the webs integral with the sections *A*, they were made from steel strips *C*, which were inserted as shown. All the parts of the die were carefully hardened and ground, after which they were assembled in a heavy cast-steel die-holder having a clearance hole cut in it

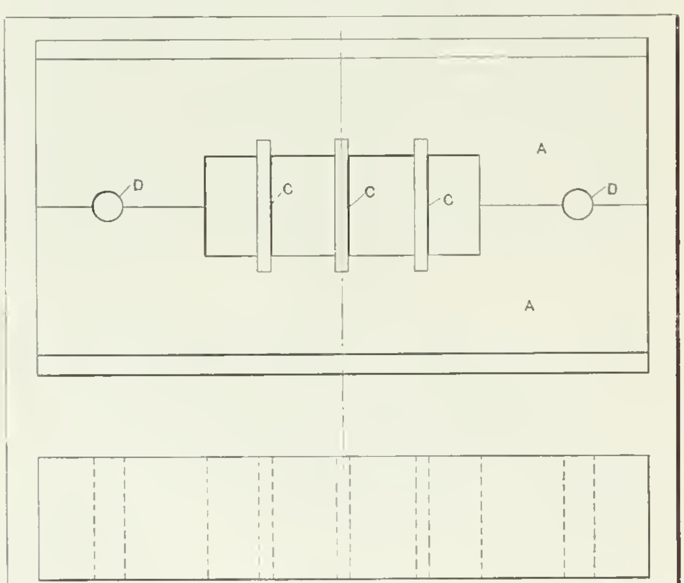


Fig. 2. Die for Piercing the Holes in the Blank

a few thousandths of an inch larger than the holes in the die, to let the scrap drop through.

As is our usual practice when making dies for piercing thick stock, the die was made 6 per cent of the thickness of the stock larger than the punch, and with a clearance angle of 5/8 inch per foot. The blank was located by gages held on the face of the die, and was stripped from the punch by a 3/4-inch machine-steel stripper, both of which are not shown in the illustration. The punch, which is not shown, was of ordinary construction but great care was exercised when sharpening it, to give it a shearing cut in order to decrease the strain when cutting such thick stock.

When in use, it was found that the 1/8-inch strips *C* (Fig. 2), which were set into the die, began to settle in the die-holder, so to overcome this trouble the die-holder was planed out 1/2 inch deep by 1 inch wide, and hardened steel strips were inserted close to the clearance holes. This gave a firm support to the die members, and no further trouble was encountered on this point.

The first attempt to bend this blank was made with a punch and die somewhat similar to that shown in Fig. 3, but after bending a few samples and checking the dimensions, it was found that the 1/8-inch webs were out of line, and that the spacing of the holes lengthwise was uneven. As the holes were required to be in line, and in the correct relation to each other, these irregularities were not allowable. This first die was just a plain die without any guiding members to fit in the pierced holes and thus prevent the partitions from bending.

The next plan adopted was to bend the blanks in a die which had projecting blocks fastened in it, that fitted in the holes in the blank. Corresponding holes were also cut in the punch for these projections made in the die. This method was also a failure, as it was found that the blanks would

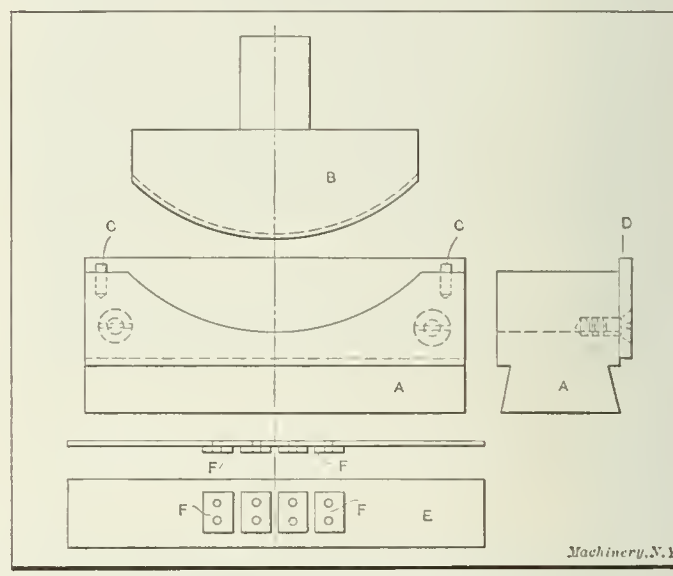


Fig. 3. The Successful Bending Punch and Die

stick in the die, and it was necessary to pry them out, which changed their shape.

The final bending punch and die used for this operation, and which gave satisfactory results, is shown in Fig. 3. The die *A* and punch *B* were made plain, as shown, the die having two locating-pins *C* for locating the blank lengthwise, and a strip *D* for locating it sidewise. A flexible steel spring *E* was made, and four blocks *F* riveted to it, as shown. These blocks were made the size of the holes in the blank, and were located on the flexible spring to correspond with the holes. The punch *C* was cut away as shown by the dotted lines, to fit the steel spring *E*, so in this way the spring was located by the pins *C*, the gage *D* and the projecting edges of the punch.

In operation, the blank is located on the face of the die, and the flexible steel spring *E* placed on top of it, with the blocks *F* located in the holes. Then as the ram of the press descends, the punch *B* forces the blank and flexible spring into the die, giving the blank the desired shape. When the punch ascends, the blank and spring still remain in the die, but by giving the die a slight tap, the spring is released and flies back to its original shape, when the blank can be easily removed from the die.

* * *

The interior of gear boxes is likely to retain some sand even if ordinarily well cleaned. To avoid trouble from sand working loose and getting into the bearings, the inside should be painted or shellaced. One or two coats will securely hold stray grains of sand and perhaps save cutting out a bearing.

* Address: 254 Mason St., Milwaukee, Wis.

RAPID NUT TAPPING

The illustration shows a battery of twelve automatic nut tappers installed in the plant of the National Screw & Tack Co., Cleveland, Ohio, by the Acme Machinery Co. of the same city. These machines are remarkable for the speed of output and consequent low cost of tapping. One operator attends four machines and each machiue taps from 34,000 to 36,000 1/4-inch nuts per day of ten hours. The labor cost per thousand nuts is less than 1 1/2 cent.

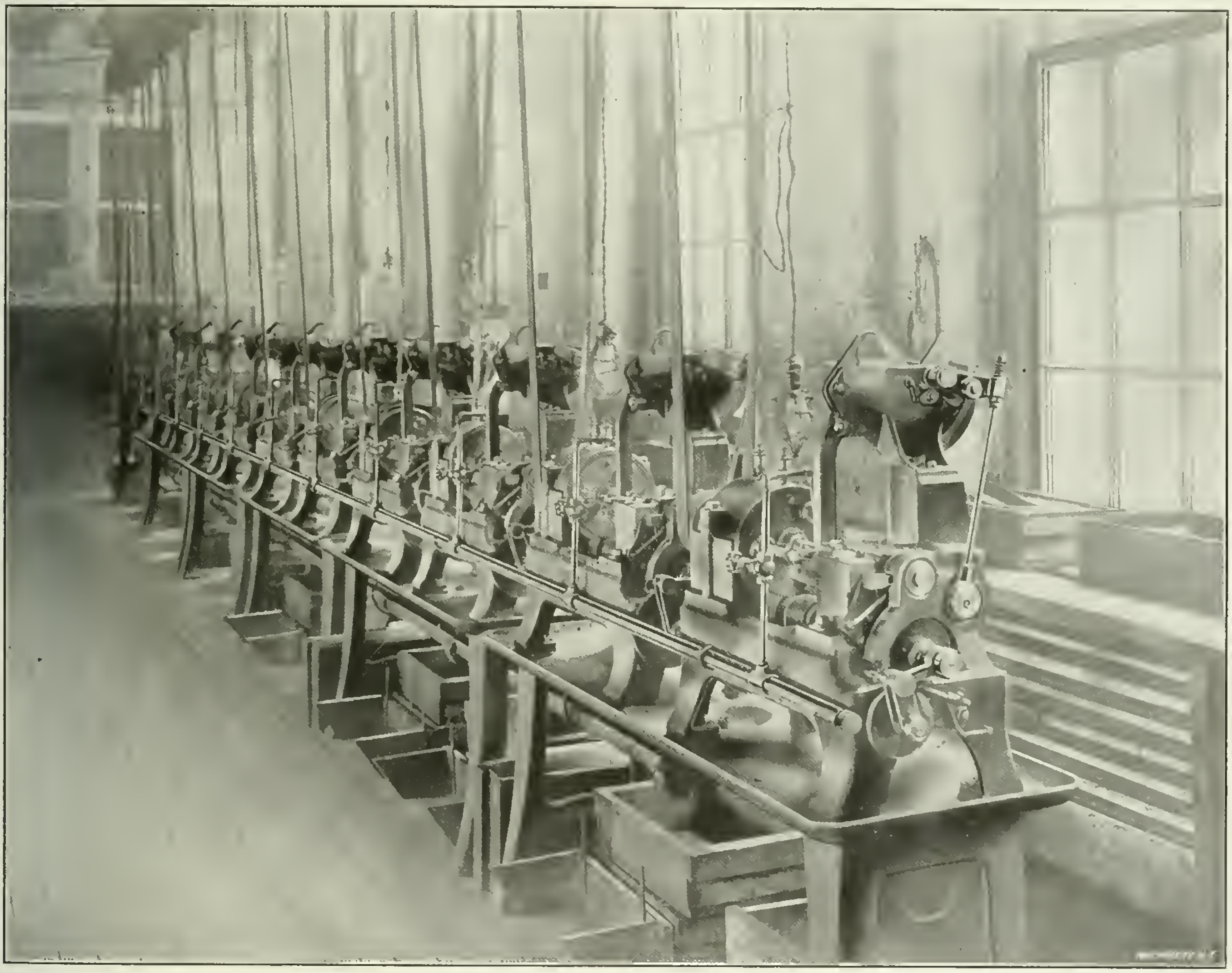
Each machine has three spindles and three taps, but only one spindle and tap is iu operation at once. The nuts are automatically fed to the revolving tap from the bottom of a hopper and when the tap shank is full, the turret automatically revolves, bringing the next spindle and tap into action. The operator loosens a set-screw holding the shank and unloads the tapped nuts, then replacing the tap in its spindle. There is no backing of taps out of the nuts, and consequent loss of time and stripping of threads. The operator's work is simply keeping the hoppers filled and discharging tapped nuts from the taps.

The National Screw & Tack Co. has fifty of these machines in use, thirty of which are the No. 1 size (3/16 to 5/16 inch capacity); eighteen of the No. 2 size (3/8 to 1/2 inch capacity); and two of the No. 3 size (5/8 to 1 inch capacity). Six more of the No. 1 size are now being installed, which will make a total of fifty-six.

A soap compound is used for cooling and lubricating the taps. This is pumped to the machines from a common supply through pipes and returns by gravity to the supply tank.

* * *

The following formula for making phosphor-bronze castings of a tensile strength as high as possible is recommended by *The Foundry:* Copper 90 per cent, tin 4 per cent, five-per-cent phosphor-tin 6 per cent.



Battery of Acme Non-reversing Automatic Nut Tappers in Plant of National Screw & Tack Co.

NON-FERROUS CASTINGS FOR HIGH PRESSURES*

The results of investigations covering over three years, which had in view the determination of the best non-ferrous alloys capable of withstanding high pressures, are contained in the following article:

The alloys commonly used come under two general heads: Gun metals consisting principally of copper, tin and a little zinc; or complex brasses containing mostly copper and zinc. Manganese bronze as applied to this latter class is misleading, it being really a brass composition with minor ingredients which in no case exceed two per cent. Gun metals have only a moderate strength and ductility, while this manganese bronze constitutes a considerable advance in both respects.

An example will illustrate the casting difficulties to be contended with: When the copper and tin are melted, dross or scum is formed by oxidation, and gas is dissolved in the melted alloy. At the proper temperature the zinc is added and the dross removed by stirring and skimming, and the metal is then poured through a gate designed to trap any dross into a sand mold, the temperature being enough above the freezing point to allow the metal to flow readily. This causes shrinkage which continues to the freezing point, below which contraction occurs. The solubility of the dissolved gas diminishes as the temperature drops, causing an evolution of gas at the moment of incipient solidification. The liquid being quite viscous, entraps these bubbles thereby causing sponginess in the castings. Blow-holes in the metal may be occasioned by the mold. Another source of unsoundness is caused by the segregation of tin-rich mixtures caused by the unequal rates of cooling. Faulty patterns are another cause

* Abstract of a paper on "The Production of Castings to Withstand High Pressures" presented before the December meeting of the Institution of Mechanical Engineers by Prof. H. C. H. Carpenter and C. A. Edwards.

of failure principally due to the changes in size not being gradual.

The plan of investigation outlined was as follows: To work out the conditions for success for the simplest cases and having this achieved, to introduce one complication at a time with the object of finally considering an ordinary industrial case. The castings contemplated were to have mechanical strength, homogeneity, soundness, freedom from deterioration and minimum corrodibility.

The first step was casting a cylinder in a chilled mold, in this way eliminating mold and pattern difficulties and also reducing to a minimum blow-holes and sponginess, the rapid cooling being one of the chief aids to the escape of gas. At the outset experiments were made with pure gun metal containing only copper and tin in the ratio of 85 to 15. Cylinders with ¾-inch bore and wall thickness also of ¾ inch could withstand 18 tons hydraulic pressure before bursting, no signs of leakage being apparent up to this point.

These same cylinders were next cast in both green and dry sand molds but the results were unsatisfactory, even though attempts were made to quickly cool the castings by imbedding blocks of metal in the sand. The failure was attributed to the segregation of tin-rich areas. These experiments were not continued further as it was learned that metals of this composition deteriorate with time.

Aluminum bronzes were next considered. From previous experiments these appeared to have the following advantages: Even though cast in sand there is no segregation owing to the small freezing interval; they possess considerable tenacity and homogeneity, the former falling, the latter rising as the aluminum is increased; and alloys of this composition are readily made and have but slight corrodibility. The first of these were cast in the chilled molds at 80 degrees above freezing point. While signs of dross were apparent, it was confined to the surface and did not affect the soundness of the material, as 18 tons pressure could be withstood without failure. Green sand castings of the same composition were not satisfactory as one-half of them failed in the preliminary low pressure test, while the others remained unbroken even after the wall thickness had been reduced purposely to ¼ inch. Experiments with a stiffer material were decided upon and cylinders were made containing from 9.5 to 11.5 per cent aluminum. Up to 11 per cent the qualities of the metal were improved, but beyond that point the bronze became brittle and remarkably inferior.

The next step was to produce castings in more complicated forms, a hydraulic valve block consisting of lug, barrel and base-plate, being chosen as an example. This proved unsuccessful, so with an idea of simplifying the problem, the base-plate was removed and only the barrel and lug cast.

Experiments were made to clear the fluid metal by the addition of deoxidizing agents, but unsatisfactory results were obtained. The fluxes used were magnesium, calcium silicide, sodium carbonate, manganese and a mixture of sodium carbonate and borax. Inferences drawn from these tests were that while these metals are very viscous in a liquid state, this is not due to the metal itself but to a tenacious film of alumina which invariably covers the surface. As the liquid metal would offer little resistance to the natural rise of the dross to the surface, it was concluded that the dross was in some way formed inside the mold. This is caused by the constant oxidation of freshly exposed surfaces when the metal enters the mold in ripples or waves, causing the formation of a large amount of dross which sticks to the mold. From this it follows that aluminum bronzes should be poured very quietly and any agitation of the metal avoided. Also the metal should enter the mold at the lowest possible point through a rather narrow opening, and in the case of green sand molds wet sand must be avoided particularly in the lower parts where the metal rests on the sand.

Microscopical examination showed that the structural constituents of aluminum bronze were the same no matter whether the casting is large or small within the limits of these experiments.

Test pieces of the same general size as the valve blocks when tested for strength gave an ultimate strength of 55,000 pounds per square inch, while similar tests made on pieces cast at a lower temperature failed much lower.

Tests with these bronze castings for high-pressure steam especially when superheated, are being conducted by experimenters but the results are not contained in this record.

* * *

TABLE FOR CALCULATING THE OUTSIDE DIAMETER OF WORM-WHEELS

By J. A. FUCHS*

The regular formula for calculating the outside diameter (to sharp corners) of a worm-wheel, as indicated in the accompanying illustration, is:

$$D = 2\left(A - A\cos\frac{a}{2}\right) + d$$

in which

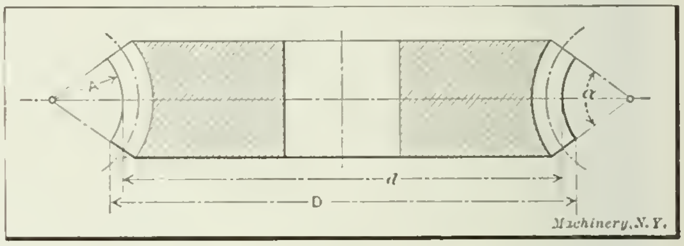
D = the outside diameter of worm-wheel to sharp corners,
A = the radius of the curvature of worm-wheel throat,
a = face angle of worm-wheel,
d = throat diameter of worm-wheel.

By writing this formula in the form:

$$D = 2A\left(1 - \cos\frac{a}{2}\right) + d$$

it will be seen that the expression within the parentheses can be tabulated for various face angles, and such a table is

TABLE OF FACTORS C USED IN WORM-GEAR FORMULA



Angle a, Degrees	Factor C	Angle a, Degrees	Factor C	Angle a, Degrees	Factor C	Angle a, Degrees	Factor C
30	0.034	46	0.080	62	0.143	78	0.223
31	0.036	47	0.083	63	0.147	79	0.228
32	0.039	48	0.086	61	0.152	80	0.234
33	0.041	49	0.090	65	0.157	81	0.240
34	0.044	50	0.094	66	0.161	82	0.245
35	0.046	51	0.097	67	0.166	83	0.251
36	0.049	52	0.101	68	0.171	84	0.257
37	0.052	53	0.105	69	0.176	85	0.263
38	0.054	54	0.109	70	0.181	86	0.269
39	0.057	55	0.113	71	0.186	87	0.275
40	0.060	56	0.117	72	0.191	88	0.281
41	0.063	57	0.121	73	0.196	89	0.287
42	0.066	58	0.125	74	0.201	90	0.293
43	0.070	59	0.130	75	0.207	..	.....
44	0.073	60	0.134	76	0.212	..	.....
45	0.076	61	0.138	77	0.217	..	.....

given herewith. By using this table and calling the values found in the table for various angles, C, the formula takes the simple form:

$$D = 2A \times C + d$$

in which C can be found in the table for any angle from 30 to 90 degrees.

* * *

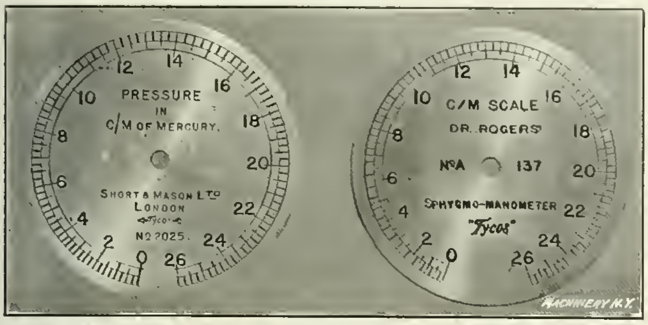
In a recent number of *The Mechanical Engineer*, the value of the pyrometer as an adjunct in steel hardening, is discussed. While an expert mechanic can usually distinguish small temperature differences from the appearance of the tool being heated, the actual temperature is usually more or less in doubt, and the results obtained on successive occasions are seldom exactly the same. By a pyrometer, the temperature can be adjusted exactly to suit previously determined best conditions. While pyrometers made of the rare earth elements are more sensitive, they are fragile; and a newer type constructed of the baser elements answers equally well for this work.

* Address: 39 Sayre St., Elizabeth, N. J.

ENGRAVING CALIBRATED CIRCULAR SCALES

The graduated circular scales shown in Figs. 1 and 2 are used on the sphygmo-manometer, an instrument employed by the medical profession to determine the blood pressure in the arteries. Each instrument is calibrated and its scale is engraved to suit. Comparison of the two scales illustrated shows considerable difference in the length of the graduated arc.

The graduation lines are radial, and the problem of cutting them to suit each calibration presents no special difficulties, but engraving the figures 0 to 26 inclusive is made difficult for



Figs. 1 and 2. Calibrated Disks Engraved after Graduation

the reason that the position of each number is changeable and its base must be kept parallel to the horizontal diameter. The Geo. Gorton Machine Co., Racine, Wis., lately fitted out a maker of surgical instruments with a Gorton engraving machine and a special fixture for the copy-holder for engraving these numbers, which has some interesting features.

The fixture shown in Fig. 3, provides copy for the graduation numbers, the name of the instrument, etc., and the serial number. The copy for the serial numbers is made of T-shape

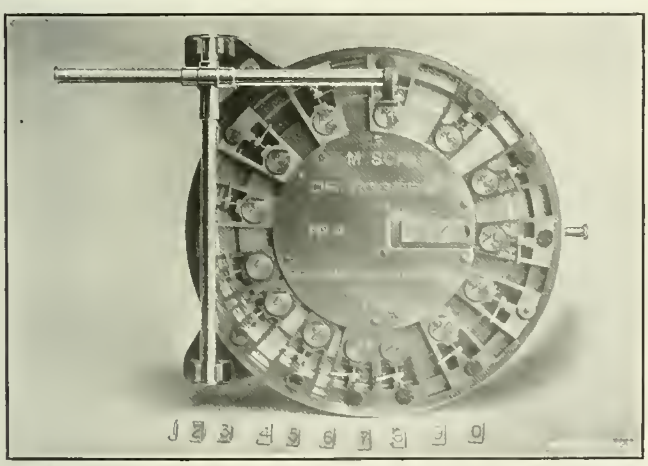


Fig. 3. Jig Copyholder for Adjusting and Holding Copy to suit each Disk

vertical section, as is shown in the illustration of "1" and "2" at the bottom. The copy for the figures is clamped in the slot by the thumb-screw at the right. The serial number part of the jig is simple, and no more explanation is necessary. The copy for the graduation numbers is on circular studs. Each stud can be twisted on its axis and each stud with its holder can be adjusted on the circle to suit the graduation of the

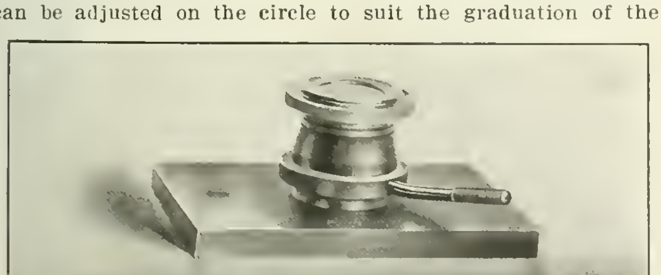


Fig. 4. Chuck for Holding Graduated Disk for Engraving

scale to be engraved. The method of using the jig is as follows:

The graduated disk to be engraved is held in the chuck, Fig. 4, and mounted on the work table of the engraving machine. The chuck, shown disassembled in Fig. 5, admits of adjusting the disk holder relative to the base of the chuck and the machine after the disk has been clamped. This feature is a necessary provision in order to set the disk so that the name, serial number, etc., shall be engraved on lines at right angles to the vertical axis of the circle drawn midway between the end graduations.

The operator clamps the engraved disk in the chuck and then twists the chuck around in the base until a line drawn through the extremities of the end graduations would be parallel with the horizontal axis of the copy holder, Fig. 3. The stud carrying No. 0 is loosened and the stylus point on the pantograph arm overhanging the copy is dropped in a prick mark in the stud-holder sector that can be seen between the stud and its clamp screw. Meanwhile, the set-screw holding the sector to the base has been loosened and the cutter in the work spindle is dropped into the first graduation. The sector is thus shifted to the correct place and is clamped by the set-screw to the base. The stud then must be squared, and this is accomplished by the sliding bar square, pivoted at the left, which provides for lateral and vertical adjustment of the small squaring blade shown over stud No. 14. Each stud has a cut across its upper face, thus making a face to square by. The stud is first lo-

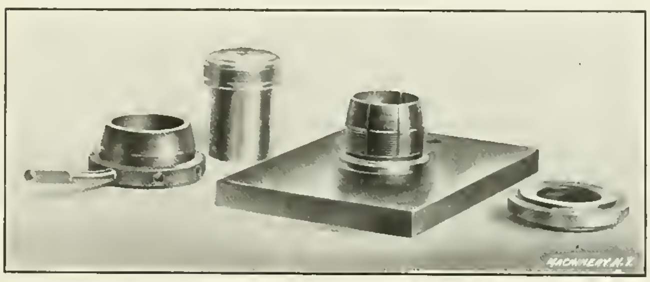


Fig. 5. Chuck Disassembled

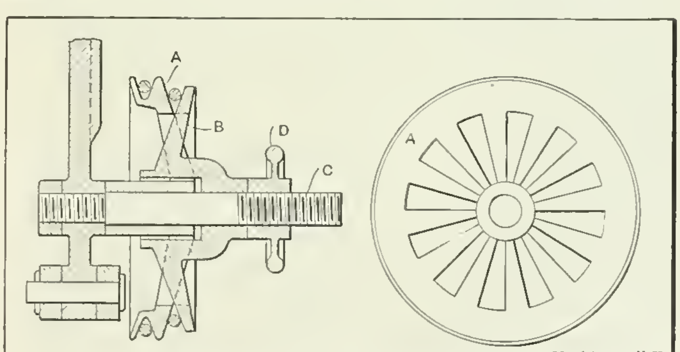
cated to correspond with the graduation on the disk to be engraved and then is squared and clamped in place.

After setting the studs, the engraving of the calibration numbers, serial number, name of instrument maker, etc., is done the same as any other engraving to which the Gorton machine is adapted. The copy just described is several times larger than the engraved disk, the latter being 1 7/16 inch diameter; the reduction of scale is accomplished by setting the pantograph reducing motion to the desired scale. F. E. R.

* * *

VARIABLE-SPEED MECHANISM

A construction embodying an old principle is dealt with in U. S. patent No. 975,869 (November 15, 1910) issued to John G. Jones, Rochester, N. Y. It provides for the transmission of small power from a driving shaft to a driven one in such manner as to permit the speed of the latter being varied easily, quickly and noiselessly when circumstances require.



Variable-speed Power-transmitting Mechanism

From the engraving it will be seen that it consists essentially of two cones *A* and *B* on a shaft *C*. The cone *A*, a face view of which is shown in the view to the right of the section, is secured rigidly to the shaft *C*, and is the driving member, its periphery being formed for a belt of any desired shape. Cone *B* is free to slide on the shaft, its movements being regulated by adjusting device *D*.

The two cones are so formed with radial slots that the one may fit into the other. This provides a circular V-shaped groove whose diameter can be adjusted at will, giving a wide range of speed ratios.

RAILWAY TERMINALS

The great railroads complain of the lack of terminal facilities, and most of the delays of freight transportation are laid to this limitation. Ways and means are being generally discussed for increasing yards and facilitating the movement of freight, but practically all the plans involve the expenditure of millions of dollars, and millions of dollars are not easy to get in these days of general distrust of railroad management. As the business of transportation increases, terminal congestion will become more and more acute if present methods are followed. In fact, it can be demonstrated that terminal yards of area in proportion to the tonnage that in all probability will be carried to the great lake and sea ports in 1950 will be a physical impossibility at points within a radius of ten miles of the centers of population. The theory that great freight terminals are necessary for great centers of population must be abandoned the same as it has been abandoned for heavy passenger traffic in a few cases. The Brooklyn Bridge and the loop of the Hudson & Manhattan R. R. are terminals for passengers but not for cars. Why should freight cars be held for days to discharge freight? It is easily possible to unload a 40-ton gondola of coal in four minutes, and equally as remarkable improvements in the unloading of general freight are perhaps possible. Let the railroad managers concentrate some of their energy on solving the terminal problem as it must eventually be solved, and not try instead to burden the country with vast investments in the present types of terminals that are so wasteful of time that the average daily movement of freight cars is only twenty-four miles, as has been shown by reliable statistics.

* * *

The problem of automatic stability of aeroplanes seems to have been solved, or at least to be nearing its solution. Lieut. J. W. Dunne, an Englishman, recently gave an exhibition with his automatic stability biplane in England. He made two flights of seven and eight miles each, and was able, as he flew, to take his hands off the control levers and to write notes while the machine continued on its course. The Dunne machine is a fairly heavy one and is shaped much like a snow plough with the sides open. It has neither tail nor rudder and depends for its steering power on two small flaps at the rear edge of the upper plane.

PRESS TOOLS FOR MAKING SMALL HINGES

By DESIGNER

Among the parts of the Fay-Sholes typewriter is a small hinge known as the short pressure plate hinge, shown in its finished form at *A* in Fig. 1. The tools for the manufacture of this hinge are shown and described in this article. In Fig. 2 is shown the blanking tool. The die *A* is made up of two pieces of hardened and ground tool steel, fitted together as shown, and fastened to the machine-steel die-block *B* by screws *C*, and located by dowels *D*. The stripper *E*, of machine steel, is fastened to the die-block by means of screws *F* which are

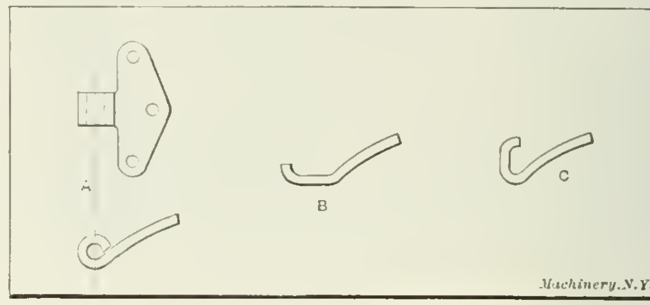


Fig. 1. Hinge to be made, shown in Natural Size, and Two Stages of Completion

tapped into it and also fasten the die-block to the base casting, the heads of the screws being countersunk in the latter. The dowels *G* locate the stripper on the die-block. A finger stop *H* is provided for locating the stock. This stop is actuated by a pin in the plunger casting.

The punch *I* is fitted tightly into the machine-steel punch-block *J*, and is backed up by a pack-hardened bearing plate *K*, to which it is fastened by a flat-headed screw *L*. The hardened plate is also screwed to the punch-

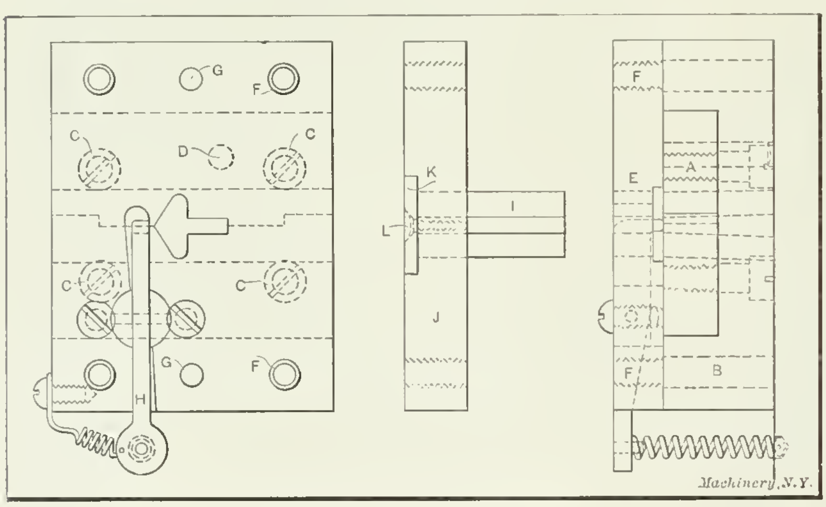


Fig. 2. Blanking Die for Hinge

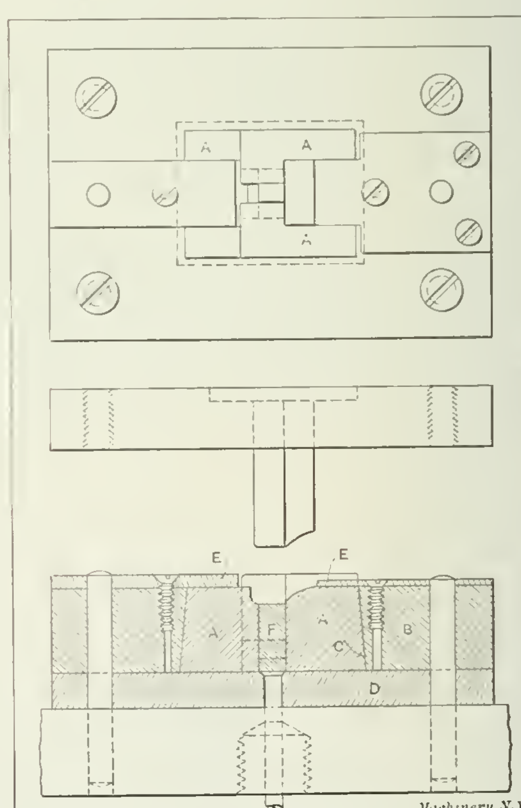


Fig. 3. First Bending Die

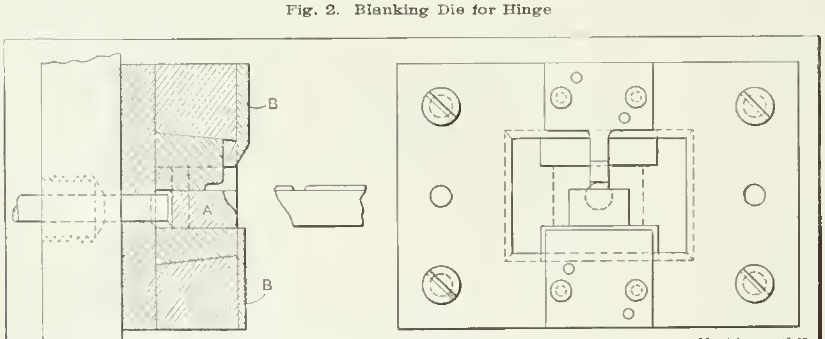


Fig. 4. Second Bending Die

block, and the latter is screwed to the plunger casting, the screws being tapped into the punch-block, and the heads countersunk in the plunger casting.

Fig. 3 shows the first forming tool. Fig. 1, at *B*, shows the shape of the piece after leaving this die, in which one end of the piece is bent up, and the curl started at the narrow end. The construction of this die is somewhat different from the former. The die in this case is made up of three pieces, *A*, fitting together and wedged into the die-block *B* by making

the sides with a taper of 5 degrees as shown at *C*. A hole is worked out in the die-block to receive the die, thus making the use of screws and dowels unnecessary. A machine steel pack-hardened backing plate *D* is provided under the die-block as a backing surface for the die. The punch is made as described for the first tool. Gage plates *E* of machine steel, pack-hardened, are provided for locating the work; the latter, when in position, rests on the pad *F*, which is shown depressed in the drawing, and which is returned to its normal position by

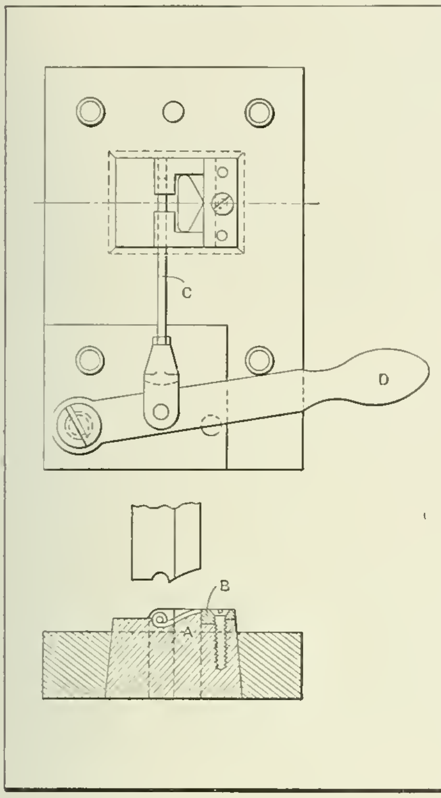


Fig. 5. Final Curling Die

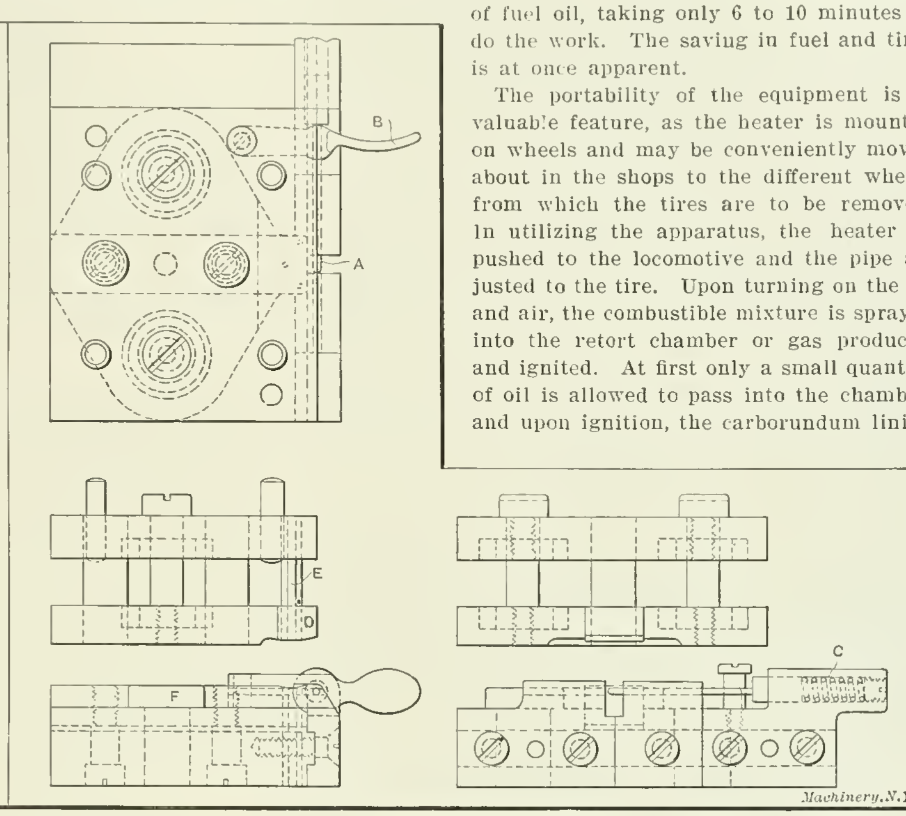


Fig. 6. Piercing Die for Holes

a spring-pressure device not shown in the illustration.

The punch and die in Fig. 4, which, in general construction, is similar to that shown in Fig. 3, performs the next step of further forming the curl at the narrow end. The piece after the operation is shown at *C*, Fig. 1. The work, located by gage plates *B*, rests on the pad *A*, and is carried down into the die on the pad on the down-stroke of the press until the bend is completed to the form shown in Fig. 1. It is then lifted out by the punch and falls back onto the die.

Fig. 5 shows the tool for closing in the eye partly formed by the previous operations. The piece after this operation appears as shown at *A*, Fig. 1, except that the holes have not yet been pierced. In Fig. 5, the piece is laid on the die *A*, and rests against the gage plate *B*. The arbor *C* is then pushed into position, being actuated by the lever *D*. The punch curls the projecting end around the arbor, completing the curl. The arbor is withdrawn from the finished piece by a reverse movement of the lever, and the piece is readily removed from the die.

Fig. 6 shows the punch and die for the last operation, that of piercing the three holes. The piece is located as shown, and is held by the arbor *A* which fits into the eye. The arbor is moved out of the way for the insertion of the work, by the handle *B*. When the piece is in position, the arbor is moved into place by the spring *C*. The stripper *D* holds the work firmly while the piercing punches *E* operate. The pieces *F* are bearing surfaces for the stripper to strike against.

* * *

HOW TO MAKE MONEY AT HOME!

A country boy desiring funds to complete his education took a correspondence course in mechanics and began to manufacture locomotives at home, sending out the completed work in neat cartons. He now supplies his engines to most of the big railroads. His example is worth following by those fond of light home work.—*Wex Jones.*

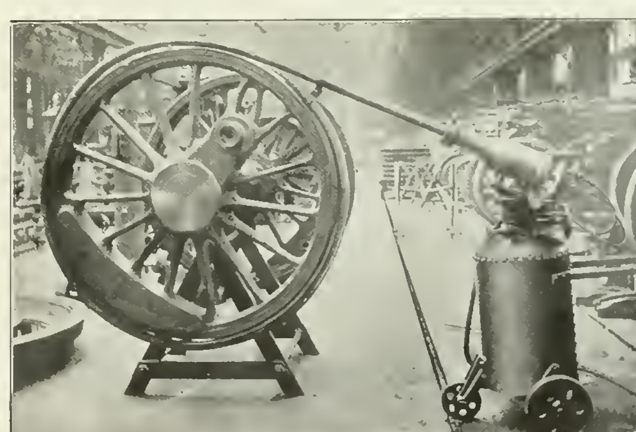
FUEL OIL LOCOMOTIVE TIRE HEATER

By FRANK C. PERKINS*

The fuel oil tire heater shown in the accompanying illustration is self-contained in its construction and simple in its operation. It is interesting to contrast the ordinary tire heater which uses three to four gallons of gasoline and takes from 20 to 30 minutes to remove a tire with this fuel oil tire heater, which is said to require only from $1\frac{1}{2}$ to $2\frac{1}{2}$ gallons of fuel oil, taking only 6 to 10 minutes to do the work. The saving in fuel and time is at once apparent.

The portability of the equipment is a valuable feature, as the heater is mounted on wheels and may be conveniently moved about in the shops to the different wheels from which the tires are to be removed. In utilizing the apparatus, the heater is pushed to the locomotive and the pipe adjusted to the tire. Upon turning on the oil and air, the combustible mixture is sprayed into the retort chamber or gas producer, and ignited. At first only a small quantity of oil is allowed to pass into the chamber, and upon ignition, the carborundum lining of the chamber is rapidly heated to a white heat, when more oil is then allowed to spray into the chamber; and this, coming in contact with the heated lining, is at once vaporized, the highly heated vapor or gas passing into the burner and issuing from the openings at which it is ignited.

It is stated that the vapor or gas burns with an intense heat at the openings; and, as these openings are placed close together and almost entirely encircle the tire the latter is



Apparatus for Removing Locomotive Tires, using Fuel Oil

quickly heated so that the time required for its removal is reduced to a minimum. The cost of the operation is thus materially reduced, and there is also a considerable saving in fuel as well as in the time required for the operation. It is maintained that this fuel oil tire heater produces no smoke, which renders it especially useful for indoor use; at the same time it is simple in construction, safe and easy to operate and very economical.

*Address: Erie Co. Bank Bldg., Buffalo, N. Y.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Fred. H. Moody,
Associate Editors

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

APRIL, 1911

PAID CIRCULATION FOR MARCH 1911, 26,045 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

VENTILATION OF DRAFTING-ROOMS

Good ventilation is a topic that is being discussed continually by those who would improve the general conditions in homes, factories, and public buildings. The subject is not of great importance in the general run of machine shops, as the construction, size of the buildings and mode of heating modern plants, generally provide plenty of fresh air; but in many drafting-rooms the conditions are quite different. Draftsmen require warm rooms in winter in order to work comfortably, and the tendency is to exclude fresh air when weather conditions are severe. The result is vitiated air, and the consequent lassitude that is a foe of the active mind and hand. Provision should be made for a plentiful supply of fresh air, warmed to a temperature of about 68 to 70 degrees F. and of the proper degree of moisture. The more moist the air, up to a certain degree, the lower will be the comfortable temperature. The air in a room heated by steam pipes tends to become very dry, and a higher temperature is required for comfort than when the air has absorbed the proper amount of moisture, which is about 70 per cent on the humidostat scale. The provision of moist air permits freer ventilation in cold weather without discomfort than is possible with very dry air.

* * *

CLEAN VS. DIRTY SHOPS

A man's surroundings react upon his ideals, mode of thought, and ways of working. The workman who comes from a slovenly home where meals are badly cooked, the house in a litter and things generally in a disordered state, will, in the natural order of things, be a slack and unsatisfactory workman. His moral stamina will be low and his ambition listless. The best workmen generally, are those having cheerful homes, good wives and happy children. They have something to live for and work for—ambition to some day, perhaps, hold a position of responsibility.

Granted that this is true, why should a manufacturer require his workmen to work in a dirty, ill-kept shop—where old waste and oil slip under a man's feet as he walks, and where the machines are coated with grease that never has been cleaned off since they were bought?

Cleanliness costs, and so does almost everything that is worth while; but it pays in the long run. It pays in the effect on the men, in tending to raise the standard of workmanship, in elevating moral standards, in reducing fire risk, and in saving machinery from abuse. By all means cleanliness pays, and the dirty shop is always a reproach to the management.

* * *

SPEEDS AND FEEDS

For several years it has been the fashion to provide a very wide range of speed and feed changes on machine tools. Gear boxes galore have been designed to facilitate changes, and the cost of machines has been considerably increased by features that some purchasers now regard as being of little use. Well-informed mechanics, foremen, superintendents and managers know that the working limits of most machines used in manufacturing are comparatively narrow. Probably ninety per cent of the lathes and drilling machines would be as efficient as they are to-day if one-half the speed and feed changes were eliminated.

Machine tool users are beginning to realize that when an engine lathe is bought having a range of speeds and feeds much wider than is ever required they are paying for something practically useless. Changes in machine tool design are being made to meet the demands for greater simplicity. In the words of one well-known maker it is, "back to the simple life" in machine tool design as well as in other avenues of activity. No one questions the desirability of providing convenient means of getting all needed changes on toolroom machines or machines used in jobbing shops, but these are a comparatively small percentage of the total output. The policy should be to build the machine to fit the average conditions and price it accordingly. Let those who want more order what they want and pay for it.

* * *

ECONOMY OF EFFICIENT FIRE PROTECTION

The annual fire waste in the United States is appalling, exceeding $100,000,000 by conservative estimate. This estimate is for the actual loss of property, there being no data, of course, for the loss of wages and profits, and indirect business losses generally. The fire insurance companies, as a matter of good business policy, have brought about many reforms in factory construction designed to greatly reduce the fire risk. The growing use of concrete is another factor that should tend to reduce the proportional loss, though it is doubtful if the aggregate fire waste will show perceptible diminution in the next twenty years, or until a large part of the present wooden structures have burned or been torn down.

Among the means for preventing destructive fires, the sprinkler system, which originated in the needs of woodworking mills, is the chief. There is little chance for a fire started in a building equipped with sprinklers as prescribed by standard specification, to become a destructive conflagration. The moment the temperature of the air surrounding the sprinkler head reaches or exceeds 180 degrees F., the fusible links melt and the flow of water automatically starts. If the fire spreads, more sprinklers go into action and unless the conditions are abnormal the flames are promptly extinguished.

The experience of a well-known machine tool builder of the Northwest is a good illustration of what this system means in saving insurance premiums. For several years the plant consisted of wooden buildings, and being outside the city fire protection zone, the insurance rate was high, the premium being about $3000 annually. A new building of semi-fireproof construction has been built and equipped with the sprinkler system throughout. The annual premium on twenty per cent more insurance is only about $200. Counting ten per cent interest and depreciation on the investment in the protective system, there still remains a large annual saving, and besides that the greatly added security of the business, which has required years of hard work to build up.

MAKESHIFT DEVICES

In many lines of manufacturing, special machines and appliances are required for economical production, jigs and fixtures and special tools being included in this generalization. These are generally made in the shops themselves, as the peculiar conditions and special features to be covered require specialists for the work, which is in the province of the toolmaking department.

How much further a purely manufacturing enterprise may go in turning out such work is open to question. Machines of a highly specialized nature are often built at home at heavy cost in order to keep the designs secret, and this class of work we are not considering. What we have in mind is the conversion of engine lathes into turret lathes, the adaptation of drill presses to odd and unusual uses, etc. In most adaptations of this kind the superintendent or manager is self-deceived in fancying that substantial savings have been made, and, although the converted tool may appear on the books at half, or less, of the cost of the manufactured tool, the chances are that it is of inferior design and capacity, and therefore an uneconomical machine.

However, the chief objection to the conversion of standard machines into special tools is that such work requires the time and thought of responsible men whose energies might more profitably be devoted to manufacturing economies. If a shop manager is designing special machines, he is using mental energy that, nine times out of ten, could be more profitably expended on his designs and in working out ways and means for increasing and improving the output. The general tendency of progressive manufacturers is to use standard machine tools on those lines of manufacture which are produced in comparatively small lots. Of course, where the production runs into thousands yearly, the saving effected by combination machines that drill, bore, ream, face and tap a casting at one setting is enormous. But if the equipment is to comprise such machines, they should be designed and built by men not directly responsible for the manufactured output.

* * *

OPPORTUNITIES IN THE MACHINE TOOL BUSINESS

In these days when "big business" and monopolies seem to be the rule, it is encouraging to the ambitious mechanic to be assured of the opportunity for individual success of the brainy man who elects to build machine tools. The man with experience and good ideas can build machines that will sell in competition with the largest concerns, with profit. He must perhaps act in the early years of his venture as designer, draftsman, superintendent and salesman, but the fact that he can combine these functions under one hat gives him some advantage over the top-heavy expensive organization in which the president and other responsible officials are so far removed from the atmosphere of the shops and its needs and are so harassed by the details of the administrative side of the business that their personality is not impressed on the product. Moreover the cost of administration puts the big business out of competition where the product is of a specialized character. Inventive skill combined with good judgment and business ability has many a good chance for success in machinery building, and the more of the small fry that become successful building special tools, the better it seems to be for the big concerns building standard lines.

* * *

INDUSTRIAL SAFETY ASSOCIATION

At a dinner given by Mr. David Williams at the Engineers' Club, New York, March 1, the plan and scope of the newly organized Industrial Safety Association were outlined by Mr. Williams and the president of the association, Dr. F. R. Hutton. Copies of the first number of the *Journal of Industrial Safety*, the organ of the new association, were distributed among the guests; this means of public expression is one of the reasons for the birth of the organization.

The Industrial Safety Association is closely associated with the American Museum of Safety, whose quarters are in the Engineers' Societies Building, New York, and although of later origin it stands in the relation of a parent body to the Museum. The objects of the association, quoting from the constitution, are:

To prevent accidents to life, limb or body of persons engaged in productive industry, or in the occupations contributory thereto in which mechanical or other sources of power are employed; and to promote the health and well-being of persons engaged in the wage-earning processes and other occupations of life, by disseminating knowledge of sanitation and hygiene. These objects shall be sought by the association through the gathering together of knowledge on these subjects and by its distribution among the members and the public generally, by means of publications, lectures and other educational processes. The methods to be used by the association shall consist in collecting models, photographs, illustrations and examples of safety devices and apparatus designed to prevent or lessen accidents in industry and other occupations; in collecting literature and other information on the subjects of accidents and industrial hygiene and the maintenance of a library for free public reference on these topics; the conduct of research work and investigations into the effectiveness and improvement of safety apparatus; the maintenance and support of collections of such safety devices and their exhibition in museums in New York, and other cities as may from time to time seem desirable; and the conduct in every way of educational work along the lines of diminishing accidents and promoting better sanitation and hygiene.

The membership is divided into eight classes, *viz:* patrons, supporting members, contributing members, league members, members, associates, honorary members and corresponding members. The annual dues are: patrons, \$500; supporting members, \$250; contributing members, \$100; league members, \$25; members, \$10; associates, \$5.

Dr. Hutton in his remarks expressed the thought that the Industrial Safety Association would be better fitted to promote safety work than any of the great engineering bodies, such as the American Society of Mechanical Engineers, as it could work with all the great associations and secure cooperation and agreement on measures to be recommended to manufacturers, etc., for promoting the safety of industrial activities generally.

The importance of progressive and intelligent work that will promote safety in manufacturing and other activities should be better appreciated by the engineering profession. In the salutatory published in the journal, Dr. Hutton wrote:

An accident in a factory or shop is followed by a train of increased costs borne by some one or several. These costs include:

First, the proper compensation of the victim, who, for a longer or shorter period is unable to earn wages.

Second, the cost of litigation which follows the accident where employer and employed are not in perfect accord respecting the responsibility for it.

Third, the diminished rate of production, which follows the nervous shock to everyone who witnessed the accident and ran to the help of the sufferer.

Fourth, the time to train a new operative to the skill and speed of the disabled one, and losses from defective work during the process.

These appear inevitably in the cost of the production, and every buyer of the article manufactured pays his share in unnecessary prime cost.

The community, too, is concerned as its resources are wasted when an accident is unnecessary or avoidable, in paying for an ambulance, the hospital expenses and the care of the dependent. These resources should go to relieve unavoidable illness, failing strength from old age, and the surgical requirements of the best and most healthy community. Indirectly also the community is held back because children of the disabled men are taken from school before they are fitted for their life work.

The officers of the Industrial Safety Association see three general methods open to promote its work: The first is by maintaining a museum or exposition, such as is now the American Museum of Safety. The second is by lectures illustrated with photographs showing safety devices, causes of accidents, sanitary improvements, etc. The third method is by the circulation of printed matter of which the *Journal of Industrial Safety* is an example. This will reach those unreachable by exhibition or lectures and perhaps will be fully as effective as the other two combined.

Further information regarding the association can be obtained from the assistant secretary, Mr. M. S. Hutton, 29 W. 39th St., New York.

SHRINKAGE AND FORCED FITS*—1

By WILLIAM LEDYARD CATHCART†

A shrinkage fit is a cylindrical or slightly conical joint between two machine members, as a crank-web and a shaft, in which the bore of the outer member or crank is smaller than the diameter of the inner member or shaft, so that the outer member must be expanded by heat before it can be set in place, while, in the subsequent cooling, it contracts and grips the inner member with a force which depends on the character of the metals, on the thickness of the outer member, and on the difference between the original diameter of the bore and that of the inner member. This difference is called the *allowance for shrinkage.* A forced fit is based on the same principle and is virtually of the same character, except that the parts are forced together when cold by hydraulic or other pressure. It is the object of the following article to present a few fundamental formulas for the design of shrinkage fits and to show their application, as well as to place on record some data relating to this matter, obtained from practice.

Lateral Contraction

A stress, tensile or compressive, has not only full effect in its line of action, but also produces compression in a direction at right angles to that line. This action is called *lateral contraction.* Thus, referring to Fig. 1, if the short length between the planes *ab* and *cd* of a rectangular bar be subjected to the unit tensile stress T at right angles to the ends *ab* and *cd*, the stress in planes parallel to the line of action of T will be equal to T; but the stretching of the metal in the direction of this line causes a contraction in the directions which are perpendicular to it. This contraction is equivalent to that which would be caused by a unit compressive stress P_1, acting on the sides *bc* and *ad*, and by a similar stress P_2 acting on the sides *ac* and *bd*. The magnitude of these induced compressive stresses depends on the metal. For wrought iron

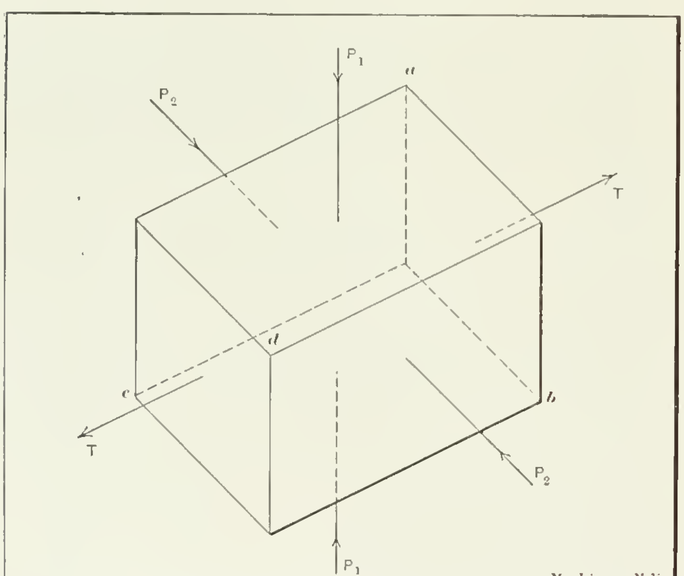


Fig. 1. True and Apparent Stresses

and steel, P_1 and P_2 are each taken usually as equal to 1/3 T; for cast iron, the ordinary values are about 1/4 T. This fraction, 1/3 or 1/4, is called the *factor of lateral contraction,* which factor will be designated by ϕ in the following.

If the unit stress T, Fig. 1, had been compressive instead of tensile, there would still have been compression on planes parallel to its line of action, but that compression would then act outward from, instead of inward toward, the axis of the body. The lateral effect would be to elongate, not to contract. So far as is known, the factor of lateral contraction has the same value in compression as in tension. Thus, in Fig. 1, assume that P_1 and P_2 are direct compressive stresses and that there is no direct tensile stress like T. Then P_1 and P_2 will each develop lateral and equivalent tensile stresses, so that, since tensile stresses are taken as positive and compressive stresses as negative, the actual unit stresses will be:

In the direction of T, $\phi\ (P_1 + P_2)$.

In the direction of P_1, $\phi\ P_2 - P_1$.

In the direction of P_2, $\phi\ P_1 - P_2$.

A stress thus developed by lateral action is identical in effect, with a direct stress of its direction and magnitude. The

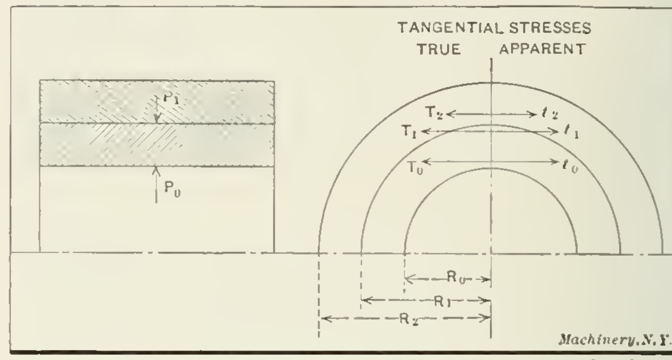


Fig. 2. Compound Cylinder consisting of an Outer Cylinder shrunk onto an Inner Cylinder

direct stress, which does not consider lateral contraction, if the latter exist, is known as the *apparent stress,* while the *true stress* is the algebraic sum of the apparent stress and the stresses in its direction due to lateral action. It should be borne in mind that the true stress is the actual stress to which the body is subjected and by which the deformation is caused.

Formulas for Compound Cylinders

The shrinkage fit is applied to a compound cylinder, *i. e.*, to two cylinders, one superposed on the other. The inner cylinder may be solid, as in the ordinary shaft, or hollow, as shafts and large crank-pins of steel are often made. Fig. 2 represents such a compound cylinder. There is no external pressure on the outer cylinder, except that of the atmosphere, which is negligible. In each member there exist a tangential or "hoop" stress and a radial stress. The latter is always compressive, and hence must be treated as negative when combined with other stresses. In the shrinkage fit, the metals of the inner and outer members may not be the same, and the tangential stresses at the contact surface also differ.

Let E = modulus of elasticity, outer cylinder,
E_1 = modulus of elasticity, inner cylinder,
ϕ = factor of lateral contraction, outer cylinder,
ϕ_1 = factor of lateral contraction, inner cylinder,
t_0 = apparent tangential unit-stress, inner surface of inner cylinder,
t_1 = apparent tangential unit-stress, outer surface of inner cylinder,
T_0 and T_1 = corresponding true tangential stresses,
p_0 and p_1 = corresponding apparent radial stresses,
t_2 = apparent tangential unit-stress, inner surface of outer cylinder,
T_2 = corresponding true tangential stress,
p_2 = corresponding apparent radial stress,
P_0 and P_1 = internal and external unit pressures.

Outer Cylinder

In a shrinkage fit, the only important stress in this cylinder is the true tangential stress at the inner surface, where that stress is a maximum. (See Fig. 3). The apparent unit-stresses in the outer cylinder at the inner surface are:

$$t_2 = \frac{P_1(R_2^2 + R_1^2)}{R_2^2 - R_1^2} \qquad (1)$$

$$p_2 = P_1 \qquad (2)$$

The true tangential tensile unit-stress is:

$$T_2 = t_2 - (-\phi\, p_2) = t_2 + \phi\ p_2$$

* In the present article, the mathematical proof of the formulas given has been omitted, it having been the object to present the data in as practical a form as possible. Those interested in the theoretical treatment are referred to MACHINERY'S Reference Series No. 89, "The Theory of Shrinkage and Forced Fits—With Tabulated Data and Examples from Practice," which will be published shortly. For further information previously published on this subject, see MACHINERY, July, 1909, "Machine Shop Practice—Shrinkage and Forcing Fits," and also MACHINERY'S Data Sheet Series No. 7, "Shafting, Keys and Keyways," pages 28, 29 and 31.

† Address: Gwynedd Valley, Pa.

$$T_2 = P_1 \left(\frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \phi \right) \quad (3)$$

Inner Cylinder, Hollow

This cylinder corresponds to a hollow shaft forming the inner member of a shrinkage fit. The stresses to be found are the true tangential stress at the outer surface, which is required to determine the allowances, and the similar stress at the inner surface, since the tangential stress in such a

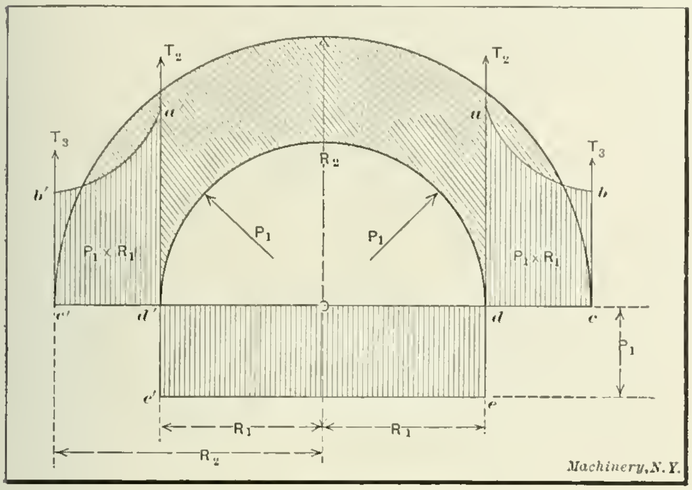


Fig. 3. Graphical Representation of Stresses produced by Shrinkage Fits

cylinder is compressive and reaches its maximum at the bore (See Fig. 4).

The apparent unit-stresses in the inner cylinder at the outer surface are:

$$t_1 = -\frac{P_1 (R_1^2 + R_0^2)}{R_1^2 - R_0^2} \quad (4)$$

$$p_1 = P_1 \quad (5)$$

The corresponding true tangential compressive stress is:

$$T_1 = -P_1 \left(\frac{R_1^2 + R_0^2}{R_1^2 - R_0^2} - \phi_1 \right) \quad (6)$$

For the inner surface the apparent stresses are:

$$t_0 = -P_1 \times \frac{2 R_1^2}{R_1^2 - R_0^2} \quad (7)$$

$$p_0 = 0 \quad (8)$$

The true taugential compressive stress is:

$$T_0 = t_0 = -\frac{2 P_1 R_1^2}{R_1^2 - R_0^2} \quad (9)$$

which is evidently greater, numerically, than T_1.

Inner Cylinder, Solid

If the inner cylinder be solid, the conditions will correspond with those of a solid shaft forming the inner member of the fit. The only stress of importance is the tangential stress at the outer surface, which is required in determining the allowances.

The apparent stresses at the outer surface are:

$$t_1 = -P_1 \quad (10)$$

$$p_1 = P_1 \quad (11)$$

The true tangential compressive stress is:

$$T_1 = -P_1 (1 - \phi_1) \quad (12)$$

The values given in Equations (10), (11), and (12) are valid for any point between the outer surface and the center of a solid shaft. In general, in a solid shaft subjected to a uniform external radial pressure, the true radial and tangential compressive stresses are equal at all points, and the intensity of each is uniform throughout.

Formulas for Stresses in the Hub

As shown in Fig 3, the tangential tensile stress in the hub reaches its maximum at the inner surface and decreases rapidly from that surface outward. The true stress at the bore is therefore of primary importance, since the metal is under its greatest stress there. This stress must not exceed the elastic limit, and is one of the factors which determine the "grip" of tho fit.

Let D_1 = nominal internal diameter of hub,
D_2 = nominal external diameter of hub,
ϕ = 1/3 for steel and 1/4 for cast iron.

Substituting in Equation (3):

$$T_2 = P_1 \times \frac{4D_2^2 + 2D_1^2}{3(D_2^2 - D_1^2)} \text{ for steel,} \quad (13)$$

$$T_2 = P_1 \times \frac{5D_2^2 + 3D_1^2}{4(D_2^2 - D_1^2)} \text{ for cast iron.} \quad (14)$$

Regarding the stresses in the hub, the following laws hold true:

It is impossible for the shrinkage-load on the hub to burst that member, so long as the true hoop stress T_2 at the bore does not exceed the ultimate tensile stress of the metal.

No unsupported cylinder can be made thick enough to withstand an internal pressure per square inch which is as great as, or greater than, the ultimate tensile strength of the metal.

If the internal pressure P_1 is equal to or greater than the sum $T + 2P_2$, of the ultimate strength and twice the external pressure, no thickness, however great, will enable the cylinder to resist the pressure.

With regard to the possible intensity of shrinkage stresses, it should be borne in mind that shrinkage fits are usually made on the working parts of machines, and hence that the stresses due to shrinkage may be increased by others developed by the external forces applied to the member when the machine is in operation. In such cases, the total stress which will exist at any time should be considered in determining the shrinkage-allowances.

Table I gives values of ratio $A = \frac{P_1}{T_2}$ for various diametral ratios. This ratio will be found of value later in computing shrinkage-allowances. If the true tangential stress T_2 is

TABLE I

Values of Ratio *A*.

Ratio of Nominal Diameters of Hub, $\frac{D_2}{D_1}$	Ratio A = $\frac{P_1}{T_2}$ Steel ($\phi = \frac{1}{3}$)	Ratio A = $\frac{P_1}{T_2}$ Cast Iron ($\phi = \frac{1}{4}$)	Ratio of Nominal Diameters of Hub, $\frac{D_2}{D_1}$	Ratio A = $\frac{P_1}{T_2}$ Steel ($\phi = \frac{1}{3}$)	Ratio A = $\frac{P_1}{T_2}$ Cast Iron ($\phi = \frac{1}{4}$)
1.5	0.341	0.351	2.8	0.615	0.648
1.6	0.382	0.395	3.0	0.632	0.666
1.8	0.449	0.466	3.2	0.645	0.682
2.0	0.500	0.522	3.4	0.657	0.695
2.2	0.539	0.565	3.6	0.666	0.706
2.4	0.570	0.599	3.8	0.675	0.715
2.6	0.595	0.626	4.0	0.682	0.723

known or assumed for any of the diametral ratios tabulated, the intensity of P_1, and hence the resistance of the fit to slip may be found by multiplying T_2 by the corresponding value of A.

Formulas for Stresses in the Shaft

The radial and tangential stresses in the inner member are both compressive. To both, the same principle applies: Each is a measure of the deformation in its direction only at the point where the given intensity of stress exists. If, for example, the radial stress varies from the circumference to the center, its intensity at any given point will not measure the deformation of the entire radius of the member, but only the amount of deformation at the point considered. The only stress which will cover both cases—solid and hollow shafts—and give the reduction in the external diameter of the member, is, therefore, the true tangential stress at the outer surface, since the circumference of that surface and its diameter must decrease together. As with the hub, the nominal diameters may be substituted for the corresponding dimensions of the compressed shaft.

Let D_0 = nominal internal diameter of hollow shaft,
D_1 = nominal external diameter of hollow or solid shaft,
ϕ_1 = 1/3 for steel and 1/4 for cast iron.

Solid Inner Members

Equation (12) gives the true tangential stress at the outer surface. From that equation:

$$T_1 = -2/3\, P_1 \text{ for steel} \qquad (15)$$

$$T_1 = -3/4\, P_1 \text{ for cast iron.} \qquad (16)$$

$$\frac{T_1}{P_1} = 1 - \phi_1 = B \text{ for solid inner members} \qquad (17)$$

This ratio is of service in computing the allowances. In a solid shaft, both the radial and tangential stresses are, as mentioned before, uniform in intensity from the outer surface to the center, and are equal at all points.

Hollow Inner Members

Equation (6) gives the true tangential stress at the outer surface. From that equation:

$$T_1 = -P_1 \times \frac{2\,D_1^2 + 4\,D_0^2}{3\,(D_1^2 - D_0^2)} \text{ for steel,} \qquad (18)$$

$$\frac{T_1}{P_1} = B \text{ for hollow inner members.} \qquad (19)$$

Equation (9) gives the true tangential stress T_0 at the inner surface. From (9) and (18):

$$\frac{T_0}{T_1} = \frac{3\,D_1^2}{D_1^2 + 2\,D_0^2} \text{ for steel.} \qquad (20)$$

This expression shows the marked increase in the tangential stress from the outer surface to the bore.

The values of B for hollow steel shafts of various diametral ratios are given in Table II.

Work Done in Compressing Solid and Hollow Shafts

The compressibilities of solid and hollow shafts differ, the solid shaft being the stiffer. In a solid shaft under radial pressure, the radial and tangential stresses are equal at all

TABLE II

Values of Ratio B for hollow steel shafts of external and internal diameters, D_1 and D_0, respectively.

$\frac{D_1}{D_0}$	$B = \frac{T_1}{P_1}$	$\frac{D_1}{D_0}$	$B = \frac{T_1}{P_1}$
2.0	1.333	3.0	0.917
2.5	1.048	3.5	0.844

For solid inner members, Equation (17), B = 2/3 for steel and 3/4 for cast iron.

points, as mentioned, and their intensity is uniform throughout. These relations are shown graphically in Fig. 4, where $Oa = cb = P_1 = t = p$. The diagram $Oabc$, therefore, represents the total apparent tangential stress in one-half of a solid shaft. Since this total stress is produced by the total stress in the left side of the hub, whose tangential value is represented by the diagram $cdcf$, the two stress-areas are equal, or $Oabc = cdef = P_1 \times R_1$.

Now, consider the hollow shaft on the right-hand side (Fig. 4), whose original diameter was sufficiently greater than that of the solid shaft to make the radius R_1 of the fit and the radial pressure P_1 on the latter the same as before, with the same hub and hub stresses, so that $ghkl = cdef$. The tangential stress increases rapidly toward the bore, where its magnitude is given by Equation (7). The area representing the total tangential stress is $lmnq$, Fig. 4, and, as before, $lmnq = ghkl = cdef = P_1 \times R_1$. The radial stress is no longer uniform as in a solid shaft, but is equal to P_1 at the outer surface, and decreases to zero at the bore [see Equations (5) and (8)].

It will be seen then, that if two shafts—one solid, the other hollow—when subjected to the same external radial pressure P_1, are compressed to the same radius R_1, the tangential stresses in the hollow shaft will be considerably greater than those in the solid shaft. The reason for this increased effect of P_1 on the tangential stress is that the hollow shaft lacks the support of the solid and compressed cylinder of radius R_0 which has been removed at the bore. In the solid shaft, at the layer of radius R_0, there is an outward radial pressure equal to P_1, while, in the hollow shaft, at this radius, the radial pressure is zero. The absence of outward radial pressure P_1 at the bore produces the total apparent tangential tensile stress in the hollow shaft shown by the area $qsvl$, and, if this be deducted from the area $lmnq$, the remainder will be the area $lwxq$, corresponding with that for a solid shaft between the radii R_1 and R_0. The deductions, as above, apply also to the

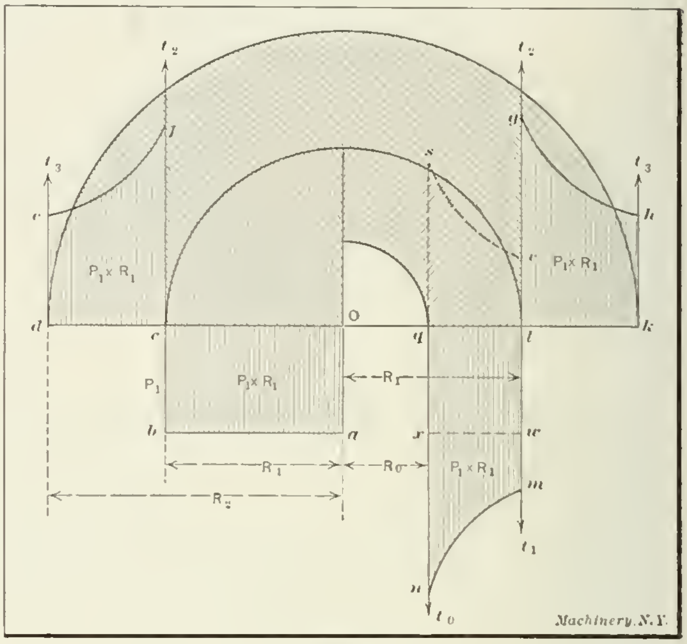


Fig. 4. Graphical Representation of Stresses produced by Shrinkage Fits

true tangential stresses, which are the same in kind as the apparent stresses, although differing in intensity.

Effect of Lateral Contraction

In the outer member of a shrinkage fit, lateral contraction increases the apparent radial and tangential stresses, each by an amount equal to one-third for steel, so that the true stresses are that much greater. In the inner member there is the same proportionate, but reverse, effect, which acts to reduce the intensity of the direct stresses. This action also develops secondary longitudinal stresses in both members, which, however, are negligible in a shrinkage fit.

Example of Use of Formulas

As an extreme example, take a steel hub shrunk on a solid steel shaft, the external diameter of the hub being 1.5 times that of the shaft. Let the shrinkage allowances be such as to produce a true tangential tensile stress of 30,000 pounds per square inch at the bore of the hub. From Table I we find that the unit radial pressure on the fit is 10,230 pounds. Applying the formulas in the foregoing, we have:

	Apparent Stress	True Stress
Hub at Bore:		
Tangential tensile stress	26,598	30,000
Radial compressive stress	10,230	19,096
Shaft at Outer Surface:		
Tangential compressive stress	10,230	6,820
Radial compressive stress	10,230	6,820

The stresses given in the table above were calculated as follows:

The true tangential unit stress T_2 at the bore of the hub, is 30,000 pounds, the ratio of the hub diameters is $\frac{R_2}{R_1} = 1.5$; from this ratio, $R_2^2 = 2.25\, R_1^2$. From Table I, when $R_2 \div R_1 = 1.5$, with both members of steel, ratio $A = 0.341$. Hence

$$\frac{P_1}{T_2} = \frac{P_1}{30{,}000} = 0.341$$

$P_1 = 30{,}000 \times 0.341 = 10{,}230$ pounds = unit radial pressure.

Hub at bore.—The apparent tangential tensile stress is:

$$t_2 = \frac{P_1 (R_2^2 + R_1^2)}{R_2^2 - R_1^2} \qquad (1)$$

Substituting the values of P_1 and R_1:

$$t_2 = 10,230 \times \frac{3.25}{1.25} = 26,598 \text{ pounds.}$$

The apparent radial compressive stress is:

$$p_2 = P_1 = 10,230 \text{ pounds.} \qquad (2)$$

The factor of lateral contraction ϕ, for steel, is $\frac{1}{3} = 0.333$.

The true tangential stress is:

$$T_2 = P_1 \left(\frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \phi \right) \qquad (3)$$

$$= P_1 \left(\frac{3.25}{1.25} + 0.333 \right) = 30,000 \text{ pounds.}$$

The true radial stress is:

$$P_2 = P_1 \left[1 + \frac{\phi (R_2^2 + R_1^2)}{R_2^2 - R_1^2} \right]$$

$$= 10,230 \left(1 + 0.333 \times \frac{3.25}{1.25} \right) = 19,096 \text{ pounds.}$$

Shaft at outer surface.—The shaft is solid. The apparent tangential (compressive) stress at the outer surface is:

$$t_1 = P_1 = 10,230 \text{ pounds.} \qquad (10)$$

The apparent radial (compressive) stress is:

$$p_1 = P_1 = 10,230 \text{ pounds.} \qquad (11)$$

The true tangential stress is:

$$T_1 = P_1 \ (1 - \phi_1) = 10,230 \ (1 - 0.333) = 6820 \text{ pounds.} \qquad (12)$$

The true radial stress is:

$$P'_1 = P_1 \ (1 - \phi_1) = 6820 \text{ pounds.}$$

It will be seen that the use of the apparent, in place of the true, stresses introduces errors which, with regard to the hub, may be serious even in less extreme cases than the above.

Resistance to Slip

The resistance of the fit to slip is theoretically equal to the product of the area of the contact-surface times the unit radial pressure on that surface times the coefficient of friction.

Let D_1 = nominal diameter of fit,
L = length of fit,
P_1 = unit radial pressure on fitted surfaces,
f = coefficient of friction,
Q = total resistance to slip.

$$\text{Then } Q = \pi D_1 \times L \times P_1 \times f \qquad (21)$$

Since slip begins with the parts at rest, the coefficient of friction for rest applies in computing the initial resistance. There is considerable variation in the values given for this coefficient. Reuleaux and Weisbach use 0.2. Rennie, in experiments on metals usually unlubricated, found the following values for f:

Wrought-iron on cast iron	0.28 to 0.37
Steel on cast iron	0.3 to 0.36

In experiments undertaken by Professor Wilmore the average value of this coefficient was 0.102 for cast-iron disks either forced or shrunk on steel spindles. The shrinkage fits were found to be 1.5 times, and the forced fits 1.3 times, stronger in torsion than in tension. This result was to be expected, if the resistance measured was not that to initial slip only, since, in torsion, the grip is undiminished during progressive slipping, while, in tension, the area under pressure decreased steadily as the spindles left the disks.

Let P = force acting to twist a solid shaft,
p = lever arm of P,
J = polar moment of inertia of shaft,
c = distance of most remote fiber of shaft from axis of latter,
S_s = shearing stress at distance c = maximum unit shearing stress,
D_1 = diameter of shaft.

Then:

$$P \times p = S_s \times \frac{J}{c} = S_s \frac{\pi D_1^3}{16}$$

and from equation (21):

$$\frac{QD_1}{2} = \pi D_1 L P_1 f \times \frac{D_1}{2}$$

Taking P_1 and S_s as constant, and equating, we have $L = KD$, in which K is a constant. Therefore with a constant radial pressure, the length of the hub should vary as the diameter of the shaft, in order to make the grip of the fit proportional to the torsional strength of a solid shaft. For both practical and theoretical reasons, it is impossible to make the grip equal to this strength. Hence, with diameters of 2 inches and upwards, keys should be fitted in addition.

* * *

MACHINE TOOL DEFINITIONS*

By OBERLIN SMITH†

It is currently reported that when Adam's descendants became rather numerous, he proceeded to give them each a name. We learn from Holy Writ that he had already named the animals; hence, he appears to have been the first industrial organizer. He probably also gave names to such buildings and tools as he may have accumulated. We do not know what these began with unless, perhaps, a pan for baking the apples that his wife procured for him, and a step-ladder that he might peep back over the wall after he retired from his estate. Thus, doubtless, began the first dictionary-making, for if things had names, these names, by reasoning backwards, of course had definitions.

The writer has sometimes thought that it would be a task of pleasurable excitement to build a mechanical dictionary. The more, however, he has studied the vagaries of human language, particularly English, with its numerous synonyms, and with certain words having several meanings, the less he feels inclined for such a task and the more pure joy there is in the idea that some other fellows will have the task to accomplish.

The recent discussions, extending back through months and even years, upon the meaning of the term "machine tool" would seem to indicate that even one correct definition requires much study and research and that after all this we cannot expect to perfectly define something that is so indefinite in the minds of so many people.

Referring to the article by Mr. Bentley on page 378 of MACHINERY for January, engineering edition, the definition marked *A* obviously does not define, while *B* is too long and yet incomplete. The definition *C* has already been proposed in this country and has been seriously considered by some of the tool makers, at any rate, as the basis for something better, and may therefore be worthy of a brief analysis. It reads as follows: "A machine tool is any hand- or power-driven unitary mechanism actuating cutters, tools, dies or other forming or shaping implements, to perform any process or operation in making tools, machines, structures or any part thereof from metal, in distinction from one for producing a special or specific article."

It is not necessary to speak of the kind of *power* and the act of *driving*, as the term "machine" itself embodies these ideas. Neither is it necessary to say that it is *unitary*, because the name itself is in the singular number. It is not necessary to limit its operation to *metal* because it is often used upon other substances; nor should it be limited to performing *general* work rather than *special*. If we do this, we would throw out car-wheel borers, special axle-lathes, driving-wheel lathes, and many special multi-spindle drillers, all of which are recognized in the machine tool trade as legitimate products.

Many years ago other limitations existed, machine tools usually being restricted to lathes, planers and drills, or to use a more definite word "drillers," thus not confusing the

*For previous discussion of this subject, see "What is a Machine Tool?" MACHINERY, January, 1911.
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machine with the tool it uses, as a twist-drill, etc. Now, however, the list has been very largely extended. The lathe class has been amplified with turret lathes, screw machines, pipe machines, vertical boring mills, etc. The planer class now includes shapers and slotters and some special portable planers, etc. The drillers now include radial drills (so-called) together with numerous horizontal boring machines and various kinds of multiple-spindle drills and tapping machines. Milling machines in great variety have come into the market since the writer can remember, and classed among them are the various rotary gear-cutters and also drill-slotters. Analogous in principle to millers, are grinders of various sorts, an abrasive wheel performing the same operation as would a milling cutter with a multiplicity of fine teeth. These, of course, are developments of the old-fashioned grindstone, which in ancient times was the nearest approach to a milling-cutter.

All of the machines in the above groups are but developments from those used in typical old-style machine shops. Other personalities more recently admitted to their family are foot-, screw- and power-presses in an almost infinite variety of sizes and designs, which are used for punching, shearing, cutting, forming, bending, drawing, redrawing and coining materials of numerous kinds, generally metals. Almost any of these machines can be made to do, and are often used for, similar work to that of a slotting-machine. It is true that shearing and punching is not exactly similar to the paring off of chips, although in some cases where a little scrap is sheared from the edge of a plate, or where a rough hole is re-punched or drifted, the operation is really exactly the same.

A logic which admitted these presses to the machine tool family of course, when carried further, was obliged to include another tribe of cousins, such as hydraulic presses, drop presses, steam hammers, power hammers, etc. Some of these machines are used for forcing operations such as putting on car-wheels and so forth, but these are only amplifications of the old-fashioned arbor presses long ago used in many shops.

Still later on, various forms of rolling machines seem to have been admitted into shop fellowship, especially straightening- and bending-rolls of both the horizontal and the vertical types. These, together with some of the more plebeian shearing and punching machines, have doubtless been allowed to associate with their more aristocratic brethren on account of their being needed in boiler shops, which are often so closely associated with machine shops. Especially is this the case where such machines as portable engines, etc., are produced.

In recent years other outrages have been perpetrated upon the feelings of old-fashioned machinists by thrusting upon them electric and pneumatic cranes and also air compressors to operate chipping hammers and other pneumatic tools, all as a part of the regular shop equipment. Furthermore, special steam engines and electric motors have been so combined as integral parts of some of the machine tools as to rank them commercially with the more legitimate factors of a modern plant.

A still greater innovation, to which all machine tool men are not yet reconciled, is the admission of wood-working tools within the sacred precincts heretofore devoted to metal working only. There is, however, no logical reason why machines for turning, planing, drilling and sawing woodwork, and which nowadays are built with very much the same appearance as their fellow iron-workers, should not all be placed in the same general class. Some of them indeed closely resemble their more rugged brethren in general design and they can readily be manufactured in the same shop and with the same tools as are the others.

Glancing over the large catalogues (almost dictionary size) of three of the largest machine tool dealers in this country, we find in two of them all sorts of woodworking tools, and in all three of them the various other machines mentioned in this article. Some of them also show a variety of other things of doubtful classification, such as blowers, pumps and those articles which might, perhaps, be regarded as transmission machinery, along with shafting, belting and similar apparatus.

From the foregoing, it would seem that we need to take a general view and contrive a very comprehensive definition for the compound word in question. A natural answer to the question: "What are machine tools?" asked of any intelligent layman, might well be: "Machines and tools used in a machine shop." The definition of this latter term might logically be: "A shop in which machines are made." Shop, in this connection, of course means a building, or any apartment thereof, in which mechanical work is performed. Considering, therefore, that the great variety of articles listed by the dealers referred to allows us much latitude, we are perhaps justified in treating the compound word philologically and combining the definitions of a machine and a tool, the one actuating the other.

Again we have trouble in getting any definite meaning from our indefinite English language. Looking for the meaning of "machine," we find it in the Century Dictionary to be:

"In mechanics, in general, any instrument for the conversion of motion."

In the Standard Dictionary we find it:

"Any combination of inanimate mechanism for utilizing or applying power."

And Webster's Dictionary puts it:

"In general, any combination of bodies so connected that their relative motions are constrained, and by means of which, force and motion may be transmitted and modified."

For a definition of the word "tool," we have in the Century Dictionary:

"A mechanical implement; any implement used by a craftsman or laborer at his work; an instrument employed for performing or facilitating mechanical operations by means of percussion, penetration, separation, abrasion, friction, etc., of the substances operated upon, for all of which operations various motions are required to be given either to the tool or to the work."

The Standard gives it:

"A simple mechanism or implement, as a hammer, chisel, plane, etc., used in working, moving or transforming material."

In Webster's, "tool" is defined as:

"An instrument, such as a hammer, saw, plane, file and the like, used in the manual arts to facilitate mechanical operations."

The term "machine tool" is said by the Century Dictionary to be:

"A machine driven by water, steam, or other power, for performing operations formerly accomplished by means of hand-tools, as planing, drilling, sawing, etc., and taking its special name from the kind of work performed, as planing-machine, drilling-machine, etc."

The Standard gives the definition thus:

"A machine for doing work with cutting tools, or one using minor tools in performing the actual work."

In Webster we find it:

"A machine for cutting and shaping wood, metals, etc., by means of a tool, especially a machine, as a lathe, planer, drilling-machine, etc., designed for a more or less general use in a machine shop in distinction from a machine for producing a special article as in manufacturing."

As usual, "the doctors disagree." The writer, as a layman in dictionary building, suggests some definitions as follows:

MACHINE, *A structure of multiple parts one or more of which have predetermined motions relatively to the others.*

TOOL, *An implement for measuring, handling or altering the shape of various objects.*

MACHINE TOOL, *A machine guiding and actuating tools, such as cutters, dies and other shaping implements, to perform processes or operations in the making of machines and other structures.*

* * *

The fireproof qualities of reinforced concrete construction were well demonstrated in a fire which recently occurred in the coal storage bins in the sub-basement of a large drygoods warehouse in Minneapolis. One day a strong odor of gas was noticed in the building; investigation proved that it came from the sub-basement where the coal was stored. It was found that the entire storage of coal, amounting to about 225 tons, was burning and had probably been burning for some days without perceptibly damaging the reinforced concrete partition walls or ceiling which formed the storage bins. The fire could not be extinguished until the coal was removed.

FILE-MAKING AT A SHEFFIELD WORKS*

By JOSEPH G. HORNER†

The earliest files were made of certain fish-skins; and even to this day some old-fashioned carvers use the skins of the dog-fish to smooth their work. In the prehistoric age, files of bronze were used, and in the Bible, 1 Samuel XIII, 21, mention is also made of files, for we read: "They had a file for the mattocks, and for the coulters, and for the forks, and for the axes, and to sharpen the pads." Steel files are of considerable antiquity; in the Eighteenth Century French Encyclopædia, there are numerous files illustrated which differ in no respect from the Sheffield products of to-day except that they are not finished quite so well. The Swiss files used by watchmakers and jewelers have for a long period enjoyed a high reputation.

Fig. 1. Cutting the File Blanks in the File-steel Warehouse, preparatory to Forging

Formerly nearly all files were cut by hand, and, in fact, this was the practice in the early days of men who are even now only middle-aged. But at present more than ninety per cent of the files made are machine cut. Although this is a recent development, the idea of machine cutting is by no means new. A file-cutting machine is described in a French work dated 1740; Raoul, a Frenchman, at the close of the eighteenth century, cut files by machine, and Captain Ericcson patented a machine in 1836, which was used by T. Turton & Sons, of Sheffield.

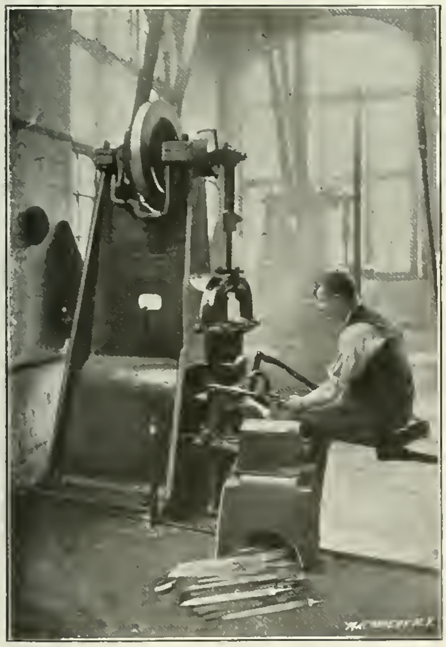


Fig. 2. Forging the Blanks by Quick-action Power Hammers superseding the Old Hand Method

The prejudices of users as well as those of the trade were for a long time almost wholly in favor of hand cutting, so that, a few years ago, in 1886, some of the Sheffield file makers put the question to the test. They had a number of files made, one side being cut by hand, the other by machine. Both of the trade interests were represented during the cutting and the hardening. Private marks were placed on the files, and they were distributed among firms located outside Sheffield, in Leeds, Manchester, Birmingham and elsewhere, with requests to use them and make a mark on the tang of each file on the side which they considered the better. No firm was informed as to which side was hand and which was machine cut, nor as to the nature of the contest. When the reports which came in giving results on cast- and wrought-iron, steel, and brass were collated, it was found that the averages proved nearly equal. The numbers were in the relation of ten in favor of machine cut, eight for hand cut, and five equal. Apprentices are no longer put to the trade of hand file-cutting, while girls can and do operate the smaller machines. A small portion of files are, however, still cut by hand; and since considerable sections of the manufacture involve processes which are not affected by the differences in cutting it may be interesting to offer some account of the older and the present practices.

Fig. 3. Annealing the Files previous to Grinding and Cutting

Fig. 4. Grinding by Hand, now superseded by Machine Grinding

The accompanying halftones represent the stages of the work of file-making as it is carried on by Messrs. Samuel Osborn & Co., Ltd., Sheffield, England. These illustrations are of further interest from the fact that the Clyde Steel Works of Messrs. Osborn is the home of the famous Mushet self-hardening steel. At the same works a new brand of Mushet high-speed steel is now made as a rival to other

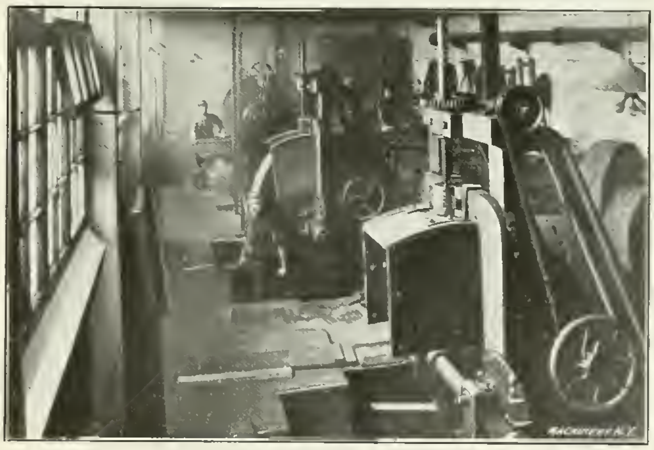


Fig. 5. Grinding by Machine, which takes the Place of the Older Method, giving Truer Surfaces

* For additional information on this subject, see the following articles published in MACHINERY: "Toolmaker's Files", January, 1911; and "Making Swiss Files in America," September and October, 1907.

† Address: 45 Sydney Buildings, Bath, England.

high-speed steels. The name of Robert Forester Mushet is familiar to students of the Bessemer process, for it was he who suggested the addition of manganese after the blow.

Sheffield is the Mecca of steel makers. It had achieved a reputation before Creçy and Agincourt. The English arrows of Sheffield manufacture "were so sharp that no armor could repel them." A Government order is on record of 5000 arrowheads at 15 pence per hundred. Chaucer, in "The Reeves Tale," describing the miller, (the "meller") says: "A Scheffeld thwitel bar he in his hose." (A thwitel is a whittle, or whittling knife.) And Sheffield in the fullness of time became the home of the cementation and the Bessemer and Siemens processes. From 1000 to 1500 tons of crucible cast-steel are now melted weekly in its furnaces.


Fig. 6. Stripping Smooth Files by Hand, a Method adapted for Fine Files to obtain an absolutely Level and Smooth Surface

Mushet steel was the result of an accidental discovery. In 1868 Robert Mushet found that a trial bar became hard after being heated without quenching in water. This property was found to be due to the presence of tungsten. In 1871 he became associated with the late Samuel Osborn, who took over the manufacture and sale of "R. Mushet's special steel," as it was called. Lathe and planer tools of this material were found to do two and three times the work of the ordinary carbon tools, and to endure much longer.

The next stage came with the introduction of the high-heat treatment of the steel manufactured by the old process. Mushet high-speed steel is now used for the same purposes as other high-speed steels, but requires different treatment from the original brand. It is forged at a good yellow heat, and is hardened at a white welding heat (2282 to 2372 degrees F.), and blown cold immediately in a blast of air. Twist drills, milling cutters, and reamers, as well as lathe and planer tools are made of high-speed Mushet steel.


Fig. 7. File-cutting by Machine, producing True and Accurately Formed Teeth

The operations of this firm are carried on at three distinct works in Sheffield: The Clyde works, the original home of the Mushet steel manufacture, where crucible steels are melted, hammered and rolled; the Brookhill works where files alone are made, being turned out at the rate of about 43 tons per month; and the steel foundry at the Rutland works, where all kinds of castings from a few ounces to ten tons are produced. The steel used for the files is melted in crucibles, cast into ingots, hammered and rolled into bars at the Wicker works and thence brought to the file steel stores at the Brookhill works. The first stage in manufacture is shearing off the bars to suitable lengths for forging. These are then heated in gas furnaces and forged under spring hammers. Any scale that falls on the anvil is instantly blown away by a jet of air which is constantly blowing over it; otherwise the scale would be hammered into the blank.


Fig 8. Inspecting the Files previous to Hardening

Before a file can be cut it must be annealed. Two furnaces are provided for this process, which occupies about twenty-four hours. The cooling-down is gradual, away from contact with the external air. The blanks have now to be ground. The machines used carry stones 5 feet in diameter by 12 inches in width. The files are placed eight or ten in a row and reciprocated under the stone in a water bath, the tangs being held by an iron bar while the points rest on a strip of rubber. A transverse movement is imparted to the grindstone in order to prevent grooving. The tangs are afterwards ground by hand. The foregoing method is only applicable to flat, hand, square, and three-square files; half-rounds and rounds are ground by hand with special hand stones.


Fig 9. Hardening the Files, a Lead Bath being used for the Heating

The machine-cutting of files is distributed among about sixty machines, which are disposed in three shops. The machine used, the "Weed" patent, is one made by this company for its own service, although it also supplies it to other firms. It is constructed in a range of eight sizes, capable of delivering from 720 to 1280 blows per minute. The head which carries the cutting chisel is inclined at an angle, and the chisel is operated by a camshaft driven by a belt pulley. Two strokes of the chisel are given during each revolution. The "blow" of the chisel is effected by means of the recoil of an India rubber or steel spiral spring, the pressure of which is regulated by means of a screw by a handwheel. The file blank is carried on a bed which fits into a half-round groove

planed in a V-slide, and this bed facilitates the adjustment of the blank in relation to the chisel. There is a presser immediately behind the chisel, which holds down the file and also assists in its adjustment. The V-slide is traversed by a screw. A stop can be set to throw out the action when the cutting is finished and move the driving belt to the loose pulley. One of these machines is designed for cutting the teeth of round files spirally; the difference is that one spiral cut produces the same result as several short cuts in the ordinary fashion.

The files now go into the hardening shops, and are placed vertically in pots containing molten lead (several files being placed in one pot) in which they float. A carbon composition is used to cover the files, and prevent the lead from choking the teeth. The heat is judged by the eye of the workman,

Fig. 10. Proving the Files, and Finally Packing

who, at the right stage, grips a file in the tongs, and plunges it into a saturated solution of common salt. When one file is taken out of the pot, another is placed in. Half-round files, having a variable section in the longitudinal direction, have a tendency to curve in cooling; this tendency is corrected by the hardener, who cambers the files before they are quenched. The half-round back is made concave by as much as 3/8 inch on a 16-inch file. The files are now cleaned off in a sand-blast and then dried, after having been placed in lime-water. Before the day of the sand-blast they were scrubbed by women. The tang is next tempered in another lead bath, and the file is then ready for the last process, *viz.*, brushing over

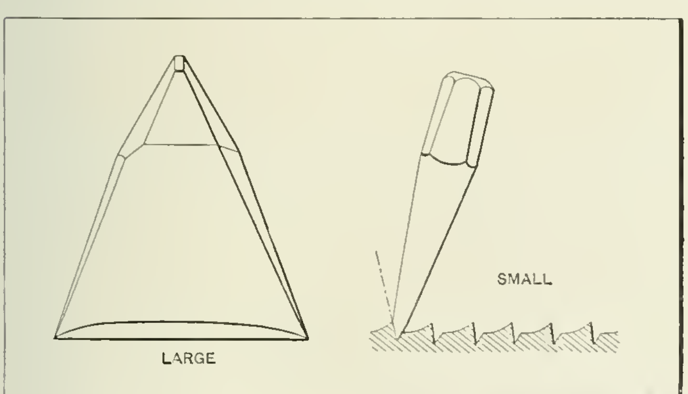


Fig. 11. Type of Chisel used for File-cutting by Hand—Wide and Narrow Examples

with colza oil. The inspection is as follows: First, the files are rung, the inspector judging by the sound if any incipient cracks are present. They are then tested for hardness, which is done by rubbing a round piece of hardened steel, called a "prover" down the teeth. After this they are tested for truth, straightness or flatness, and again for flaws. Finally they are wrapped in paper and packed in cardboard boxes.

It may be of interest here to give a brief statement of the methods of the hand file-cutters in Sheffield and Lancashire as they have been practiced for a century. Much of this work was until recently done in the kitchens of dwelling houses, and the regular shops were a disgrace before official regulations came into force to control them. The large file blanks are ground, and the smaller ones filed to shape, and slightly greased before cutting. The cutter sits before a square stake on which the blank is laid with the tang toward him and the two ends held down by two leather loops which are pressed down by the right foot. Cutting is begun at the point and is done by a very short chisel, the edge of which is slightly blunted to indent rather than to cut the steel. The chisels used are shown in Fig. 11, one about 2½ inches wide for large files, the other about ½ inch wide for small files. The angles of the edges vary, the first being about 50 degrees, and the second 35 degrees. There are also differences in the angles at which the chisels are presented. For rough files, 12 degrees beyond the perpendicular, bastard files, 10 degrees; second-cut files, 7 degrees; smooth-cut files, 5 degrees; and dead-smooth cut files, 4 degrees.

The chisel driven at its angle by the hammer, indents and drives forward the soft annealed steel, throwing up a burr, as shown in Fig. 11. This burr becomes the guide for replacing the chisel for the next cut, and so on. The height of the burr controls the coarseness of the cut, and this is regulated by the force of the blow delivered, a heavier blow producing a higher burr. A file cutter will deliver from sixty to eighty blows per minute. The first course is cut and then the second at a different inclination. The half-round and round files are cut with straight chisels, and require eight or ten courses of cuts to complete them.

To cut opposite faces of a file the face first cut is laid upon a plate of pewter; triangular and round files are laid in corresponding grooves in blocks of lead. During these operations the files usually become bent. They are straightened while at a red heat before being hardened, being heated in a coke fire the temperature of which is adjusted by bellows. Protection is afforded to the teeth by drawing the files through beer grounds or yeast, and then through a mixture of common salt with roasted and pounded cows' hoof. The fusion of the salt indicates that the proper heat for hardening has been reached, which occurs at a cherry red. Just previous to this, at a dull red, the straightening already alluded to is done, across two blocks of lead with the use of a lead hammer. Then, the heat being raised, the file is quenched in water; in the details of this quenching there is room for the exercise of much skill. Before the files are quite cooled, they are corrected by pressure and when straightened are cooled in oil, which prevents them from rusting. The tangs are next softened by grasping them in a pair of heated tongs or by immersion in a bath of lead.

In comparison with these methods the file-cutting machines and the hardeners turn out from twelve to fifteen times the quantity of work that was done formerly in the "day's work" by hand.

* * *

TO PROMOTE DESPATCH OF BUSINESS

The commercial traveler encounters all sorts and conditions of business men from the crabbed stand-offish old school type, that regards all strangers with suspicion, to the modern kind, characterized by cordiality and polite consideration whatever the errand of the suppliant be. "Time is money" and one of the trials of those waiting at the gate is the time they sometimes waste to obtain a five-minute interview. As between the crabbed man who sees you instantly and sends you on your way, and the polite person who makes you wait an hour and then kindly turns you down, the odds are in favor of the first. But it is not always easy to give visitors immediate attention, and sometimes with the best of intentions one may be forgotten in the stress of other urgent business. The following notice posted in the entrance of one large machine tool building concern is intended to encourage the visitor to get his business done as quickly as possible, and is commended for the fine spirit shown:

> If you are not PROMPTLY waited on ring the bell. If you do not promptly see the party you wish to see DO NOT HESITATE to ask for him a second time. While we cannot always see you immediately, we want to save YOU as much time as possible.
>
> Gisholt Machine Co.

LIGHT-WEIGHT ALLOYS FOR AERIAL ENGINES AND AEROPLANES*

It is generally recognized that future improvements in aerial navigation will be greatly facilitated by a decrease in the weight of the machinery. With this end in view metals or alloys of low specific gravity are being eagerly sought to supplant the heavy metals generally in use. The field of investigation, however, is so far very narrow, it being at present limited to the two metals, aluminum and magnesium. The alloys so far developed consist of various proportions of these two elements, modified by small additions of heavier metals.

A number of alloys of this type have been experimented with and several have been patented. The best known are duralum and magnalium. One of the latest discoveries in this line is called duralumin, which is of German origin, as, in fact are most of the light alloys. Extraordinary claims are made for this alloy. It is stated that it has practically all the properties of steel, that it can be drawn, rolled, stamped, or forged, either hot or cold, that its tensile strength ranges from 30,000 to 88,000 pounds per square inch, according to its degree of hardness, and that these qualities are found in an alloy containing from 90 to 95 per cent of aluminum, so that the specific gravity is very nearly that of aluminum.

Duralum contains copper and phosphorus in addition to magnesium. The composition is given as 79 per cent of aluminum, 11 per cent of magnesium, and 10 per cent of phosphor-copper. The percentage of phosphor in the copper is very low—only 0.5 per cent. It is likely that the composition of this alloy, however, is slightly modified in practice, because 10 per cent of copper is exceedingly high, even in the absence of magnesium, and when the hardening effect of 11 per cent of this latter metal is taken into consideration, it would seem that an alloy of the composition as given would be too brittle to be of any practical value.

Magnalium is composed of aluminum and small percentages of magnesium, an analysis showing from 1.58 to 1.60 per cent of this latter element. It also contains small percentages of copper, nickel, tin and lead, the last-mentioned metal probably being an impurity. The specific gravity of this alloy varies from 2.5 to 2.57. According to Prof. J. W. Richards, the tensile strength of magnalium sand castings containing 2 per cent of magnesium is 17,900 pounds per square inch with an elongation of 3 per cent, while with 10 per cent magnesium the tensile strength is increased to 21,400 pounds per square inch, with a 2.4 per cent elongation. It will be seen that the addition of magnesium hardens the metal. Chilled castings of magnalium with 2 per cent magnesium have been found to possess a tensile strength of 28,600 pounds per square inch, with an elongation of 2 per cent, and 10 per cent magnesium alloy chilled castings have a tensile strength of 33,600 pounds per square inch, and an elongation of 3.40 per cent. This is a peculiar condition as compared with that of sand castings. The same peculiarity is found in water-chilled castings, where the 2 per cent alloy has a tensile strength of 40,000 pounds per square inch and a ductility of 1 per cent, while the 10 per cent alloy has a tensile strength of 61,100 pounds per square inch with an elongation of 4.20 per cent.

In another series of light-weight alloys aluminum is replaced by magnesium for the basic metal. This produces a lighter alloy, as the elements of high specific gravity with which the magnesium is alloyed exist only in small proportions. Alloys of this kind contain from 80 to 95.5 per cent of magnesium, the remainder being made up of other metals, principally aluminum. These alloys, it is claimed, can be readily machined, soldered, welded, forged and cast. An alloy of 92 per cent magnesium and 8 per cent aluminum has a specific gravity of 1.75 and is claimed to be equal in strength to the best gun metal, although the metallurgist may doubt this broad statement. The difference in general between gun metal or bronze and the light-weight alloys is that gun metal may combine high tensile strength with great ductility, while the alloys of low specific gravity are more of the nature of cast iron, and high tensile strength is obtained only at the expense of ductility. Various useful magnesium alloys have, however, been produced, such as electron, and ruebel-bronze. These will, no doubt, be found of great value in the construction of aerial machines, but there is a danger of their being discredited by extraordinary claims by the makers which will cause them to be used for purposes for which they are not suited.

There are a number of light-weight metals besides aluminum and magnesium, but there is no likelihood of their being used for practical purposes on account of their scarcity. Among these metals are lithium, rubidium and beryllium. Lithium is the lightest of all metals known, its specific gravity being only 0.57. It possesses, however, but few of the qualities usually associated with metals; it is very soft, and melts at a low temperature, and it is hardly likely that it can be used in sufficient quantity with other metals to appreciably lower their specific gravity in order to produce a light-weight alloy. Rubidium and beryllium, both having specific gravities of from 1.5 to 1.7, are too expensive to be of any commercial value at the present time. The last-mentioned metal has many qualities which would make it a desirable one for aerial work, but the ores of this metal do not occur in sufficient quantities to justify the prophecy that it will ever be used as extensively as aluminum, although this latter metal only a comparatively few years ago also was very expensive. It is, therefore, likely that nearly all investigations relating to light-weight alloys will continue to be based on combinations of magnesium and aluminum with small percentages of heavier common metals.

[In this connection it may be of interest to mention that a Birmingham (England) firm has discovered and patented a new alloy of aluminum which is called *clarus*. It is claimed that this alloy is 60 per cent stronger than aluminum, that its specific gravity is about 3, that castings made from it are not brittle, but can be bent cold, that the castings are free from blowholes and other defects, that it will take a high polish, that atmospheric surroundings do not cause it to tarnish, that it can be made into sheets, drawn into wire, and stamped, and in fact, that practically all operations possible with steel are possible with this metal. Although these claims may have to be accepted with some reserve, it is stated that the alloy has already been put to use in automobile and omnibus fittings in London. The cost of it is said to be but little more than that of aluminum.—EDITOR.]

* Abstract from an article in *The Foundry*, December, 1910.

* * *

The common two-stroke-cycle gas engine is a marvelously simple prime mover. Why has it not displaced the four-stroke-cycle type with its cams, valves, springs, lifters and other details of valve mechanism? Every other stroke of the two-stroke-cycle engine is, or should be, a working stroke, and its power should be theoretically two times that of the four-stroke-cycle engine of the same cylinder dimensions if of equal efficiency. Unfortunately its efficiency is lower at slow speeds and very low when running at high speeds. Many tests made by an engineer—a designer and builder of gas engines—show that the two-stroke-cycle type engine becomes practically a four-stroke-cycle engine at high speeds, every other working stroke failing to fire because of the large percentage of spent gases remaining in the cylinder. The power is cut down and the waste of fuel becomes excessive.

* * *

Contrary to the opinion of the misinformed, the bicycle business is in a flourishing state. The financial condition of the twenty-one concerns making bicycles is generally sound, and the prospects for 1911 business are bright. It is estimated that 600,000 wheels will be made and sold, many, of course, going abroad. The bicycle is no longer a fad; it is used generally for business—the necessary going to and fro of the multitude—and therefore, the enormous number in use is not so apparent, as eighteen or twenty years ago when the streets and roads swarmed with pleasure riders.

TURNING SHAFTS IN THE CLEVELAND PLAIN AUTOMATIC

A shaft-turning operation that is a striking example of the efficiency of automatic machine tools on work within their range, is shown in Fig. 1. The shaft illustrated is known as an "automobile countershaft," and all the operations indicated are performed in from seven to ten minutes, there being a difference in time because of a variation in the carbon content of the steel, which in some cases is 0.25 per cent, and in others from 0.40 to 0.50 per cent. This work is done in a Cleveland "automatic" of the plain type (built by the Cleveland Automatic Machine Co., Cleveland, Ohio), which, as those familiar with this machine know, has a single spindle and no turret. As will be noted by referring to Fig. 1, this shaft, (which is about 10 inches long), has a number of different diameters and shoulders, and a collar near the center. As the diameters decrease on the spindle side of the collar, the tooling arrangement which enables the work to be machined in the time specified and within a limit of 0.003 inch, is one of especial interest.

The general arrangement of the tools for performing the different operations is shown in the plan view, Fig. 2. The tools for turning diameters *a*, *b*, and *c* and centering the outer end of the work, are carried in a box-tool to the right; tool *A* finishing diameter *a*, tool *B* diameter *b*, and tool *C* diameter *c*. The end of the work is centered by tool *H* and chamfered by tool *U*. While the box-tool is at work, the stock is supported by steadyrest *I*. The diameters *e*, *f* and *g* are finished by tool *E* (Fig. 4), and form-tool *F*, the one being attached to a special overhead slide and the other to a front cross-slide. The latter also carries recessing and chamfering tools *J* and *K*, the arrangement of which is shown more clearly in Fig. 6. These tools are mounted one above the other; the lower tools *J* cut the grooves at the ends of the shoulders, for grinding purposes, and the tools *K* chamfer the sharp corners.

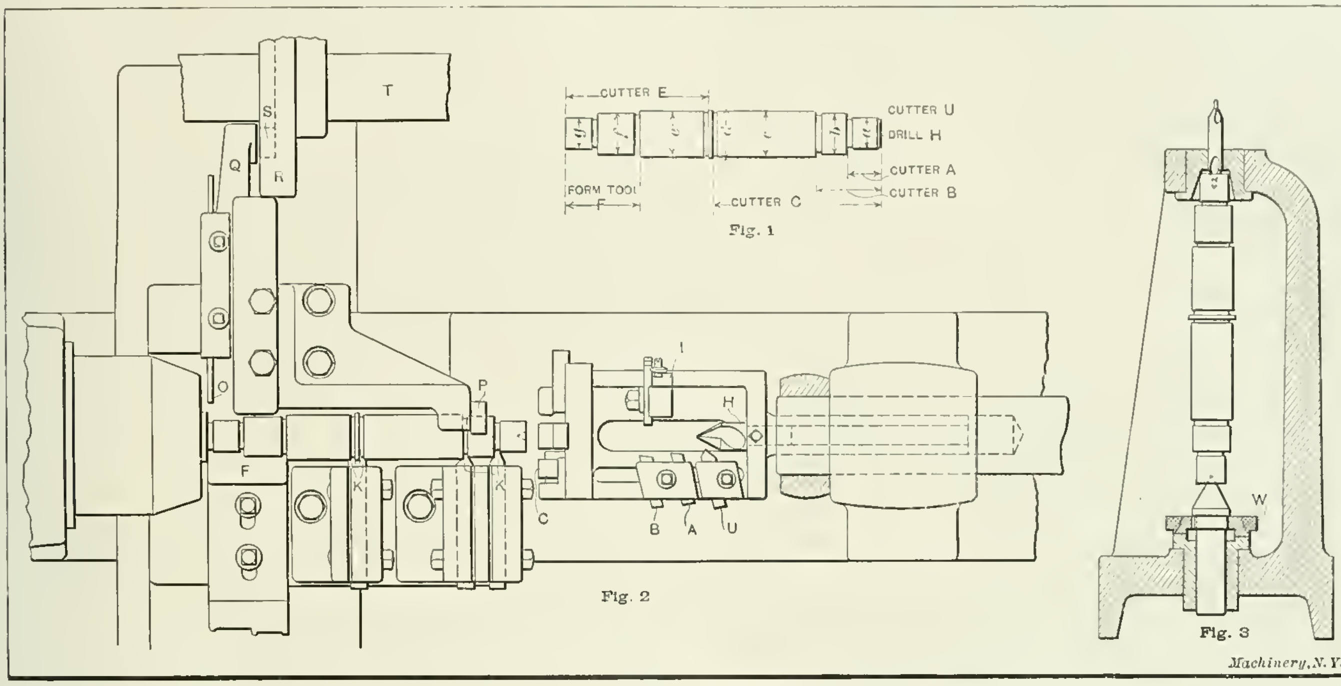


Fig. 1. Steel Shaft turned in from 7 to 10 Minutes in Cleveland Automatic, the time required depending on Carbon Content of Steel. Fig. 2. Plan View showing Arrangement of Tools. Fig. 3. Centering Fixture

The order of the operations is as follows: After the stock has been located by stop *L*, Fig. 5, the box-tool advances until tool *C* reaches the position occupied by tool *E* in Fig. 4. At this point, tool *E*, which is attached to the spindle carrying the box-tool, by connecting-rod *N*, has been sufficiently advanced to bring it into contact with cam *M*, Fig. 5, which feeds it in to the proper depth for turning diameter *e*; then as the box-tool continues to advance, connecting-rod *N* feeds tool *E* forward, thus reducing the stock to diameter *e*, from the central collar to the shaft end, as shown in Fig. 1. When the box-tool and the turning tool *E* have reached the end of their travel, diameters *a*, *b*, *c*, and *e* will have been finished and the end of the work centered. The tailstock spindle then recedes, returning the box-tool and tool *E* to their original

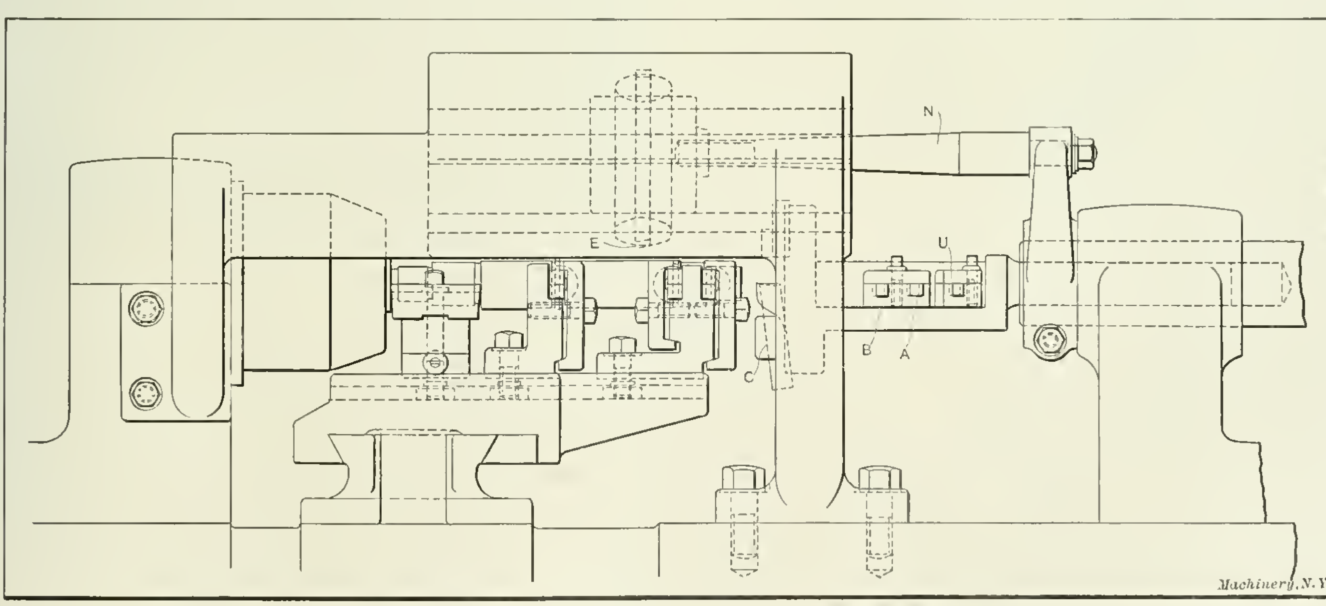


Fig. 4. Front Elevation of Cleveland Machine arranged for Turning Shaft shown in Fig. 1

positions. At this moment, the front cross-slide advances and forming tool *F* begins to remove stock on diameters *f* and *g;* the recessing and chamfering tools *J* and *K* are also brought into operation at this time. Simultaneously with this movement, the rear cross-slide, carrying cut-off tool *O*, and roller steadyrest *P* is moved forward, and the finished piece is severed.

The roller steadyrest supports the end of the work while the forming tool *F* and the recessing and chamfering cutters are at work. Were it not for the necessity of using a steadyrest, the cut-off tool could have been mounted on the regular cross-slide. The use of the steadyrest, however, made necessary a compound slide of special construction. The operation of this slide will be understood by referring to Figs. 1 and 6. The movement of the independent cut-off slide *Q* is derived from cam *R* on cam-shaft *T;* this cam engages a roller *S* attached to the independent slide, which is fastened to the regular slide. The regular slide carrying steadyrest *P* is moved forward by the regular drum cam (not shown) until the rollers are in contact with the work, in which position it is held while the cutting-off operation is being performed by tool *O*, which continues to advance until the work is separated from the bar. From the foregoing it will be seen that this combination steadyrest and special cut-off slide gives support to the end of the piece during the forming and recessing operations, which is absolutely necessary owing to the length of the shaft.

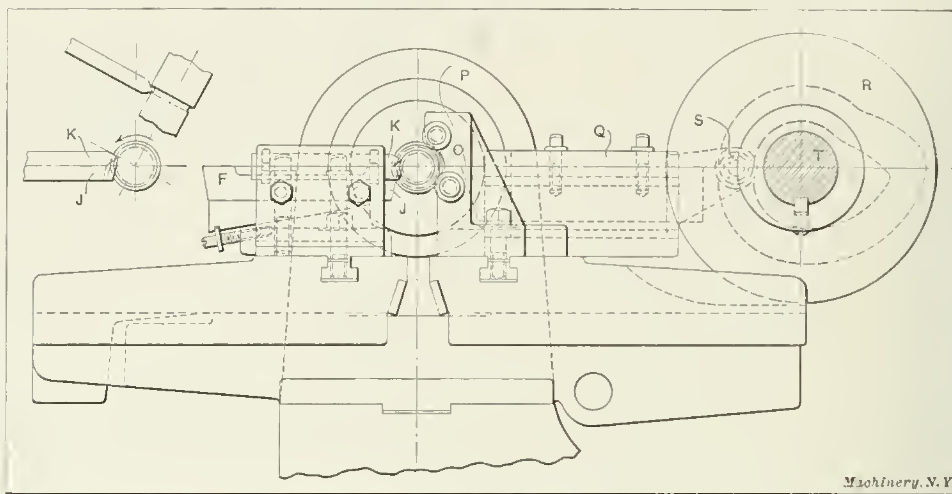


Fig. 6. Side Elevation of Front and Rear Slides for Forming, Steadying and Cutting-off Operations

The method of attaching the special overhead slide to the machine is shown in Fig. 4, one end being bolted to the spindle-head, and the other to the top of the bed. This construction gives the slide the rigidity which is essential for accurate results. In the end view, Fig. 5, the location of the tool with relation to the work and the method of governing its movement, is clearly indicated. This cam or guide-bar *M* is hardened, and the tool-holder is equipped with a roller that comes in contact with the cam, as shown, thus giving the tool a positive inward feed at the proper time.

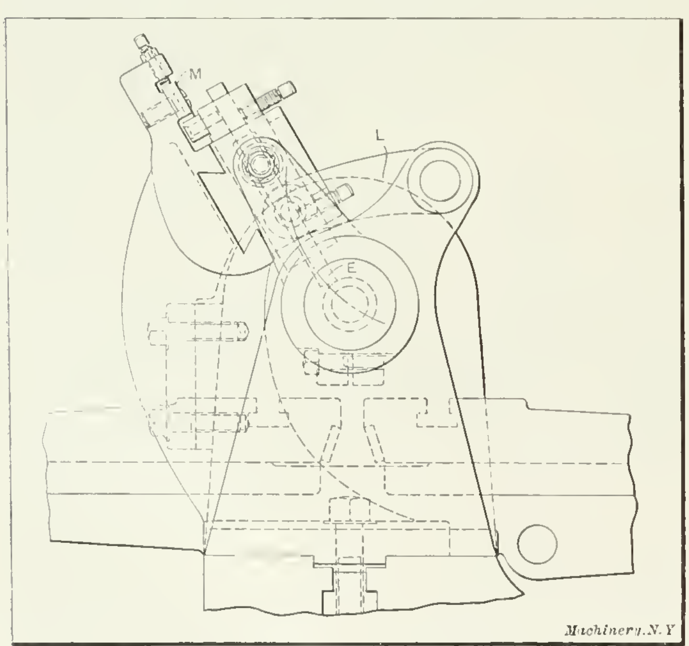


Fig. 5. Side View of Special Overhead Slide

The cost of producing this shaft when the low-carbon stock is used, is seven mills, whereas the cost per shaft with high-carbon material is ten mills, the time, as before stated, being seven minutes in one case and ten in the other, the difference depending upon the carbon content. When a machine is set up for this work, there is nothing special about the equipment with the exception of the overhead slide and the combined cutting-off and steadying attachment. The box-tool can be used for any purpose within its capacity, and the machine is capable of operating on various classes of work. The holder for the circular tool is a regular design, as is the holder for the flat forming tool. The cost of the machine and tools, the machine being of the plain type, is about the same as the cost of a turret machine for the same job but without tool equipment.

In Fig. 3 a simple and efficient fixture for centering the end of this shaft prior to hardening, is shown. As will be seen, the lower end of the work is supported by a center, and the upper end is accurately located by a conical bushing, having a central hole which guides a combination countersink and drill. As the lower center is supported on a cam surface which gives it a vertical movement of about ⅜ inch, one turn of the knurled collar *W* lowers the center sufficiently to permit the shaft to be inserted or removed. The point of this center has been ground rounding so that it will not mar the end of the shaft in any way. By this simple arrangement, a center is drilled in the blank end with sufficient accuracy for all practical purposes. This type of fixture could also be used to advantage for centering both ends, if this were necessary. When used in this way, the lower center would be replaced by a bushing, cupped out similar to the one at the top. One end of all the pieces would first be centered, after which the lower bushing would be replaced by the center while drilling the opposite ends. By using the cam form instead of a screw for the lower center, a quick action is obtained, and there is the further advantage that the upper bushing cannot be subjected to excessive pressure. This fixture, of course, is intended for centering the shaft illustrated, but it could be adapted to a wide range of work by mounting the center (and bushing when necessary) in a slide having a vertical adjustment.

* * *

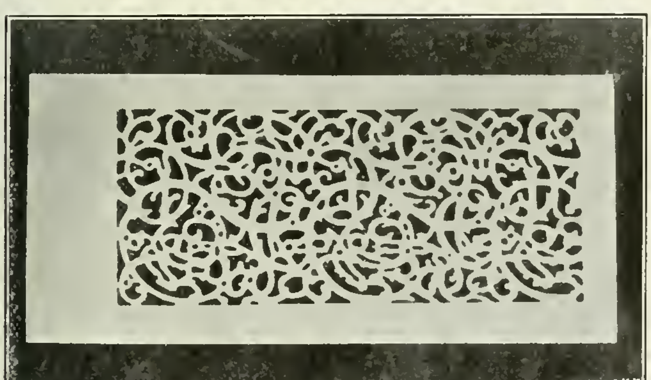
One of the large manufacturers of tapper taps finds it necessary to make up stock with the shank end unfinished because of the large number of patterns of shanks required by certain large users to fit the chucks of their tapping machines. One large corporation alone specifies over twenty patterns of shanks for its various plants. The taps are manufactured, except the shanks which are left blank, and put on the stock-room shelves covered with slushing oil awaiting requisitions. As these come in, the shanks are finished to conform to the requirements of individual orders. In this way the enormous number of combinations required if the taps were completed is avoided. The maker, of course, is helpless to correct the bad practice, but it would seem that the engineers in charge of these large plants would see the folly of keeping tapping machines in use with so great a variety of spindle chucks. The obvious reform would be to adopt a standard chuck and change all spindles to conform. The saving of clerical labor alone in ordering taps, to say nothing of the interest on the investment in taps rarely used, would pay for the change.

ETCHING AS A MEANS OF PRODUCING PERFORATED METAL DESIGNS

When an ornamental design such as shown in the accompanying illustration is to be produced in small numbers, it would not be economical to make dies; at the same time, drilling and filing the holes from a pattern scribed on the surface, is a tedious and expensive undertaking.

Etching is a method of producing a design in metal by eating away the rejected part with a chemical solution. This process it seems is adapted to the production of ornamental metal designs in small quantities when extreme accuracy is not required. According to *The Brass World*, there are four means in common use for preparing the surface of the work to be etched, in which a "resist" or "stopper" is used to cover the surfaces that are not to be etched, leaving the pattern on the plate exposed to the etching acid. The first method—the earliest used—consists in painting the design on the plate with a suitable resist material. This method is costly, involving the drawing of each design separately on the plate. The second, or the rubber-stamp method, is employed on the cheapest class of work, such as etching names on knife blades, and would not be adaptable for the case under consideration, as the etched design is very rough. With the third process—transfer method—the design lacks detail to a marked degree. It is transferred from a steel master plate to the metal, by means of transfer paper, and then etched, the resist being the material transferred. The last and best is the photographic process, the method by which nearly all fine work is done, and which is one peculiarly adapted to the previously-mentioned stamped-metal application.

In the photographic process, the design is first drawn on white paper, to any convenient scale, in black and white. A photographic negative is then made, this being procurable from photo-engravers who make a specialty of such work. The blacks and whites must be respectively, opaque and transparent. This negative is used to print the design on the work to be etched, the metal, in order to take the design, being



Sterling Silver Plate Pierced by Etching, illustrating the Application of the Process to Piercing Metal Plates of All Kinds

coated with a sensitized emulsion of bichromated albumen which has the property of remaining insoluble in water after exposure to light. The portions corresponding to the opaque parts of the negative thus wash out in warm water, leaving the bare metal. Just prior to the washing process, however, the surface is coated by means of a roller, with special lithographic ink. The design is now on the metal in the form of a bichromated albumen base covered with a sticky ink. The resist is further reinforced by sprinkling the whole surface with dragon's blood, and heating to melt the latter. This adheres to the resist already on the surface, but forms in a powder on the unprotected surface, which may be readily blown off. This resist is all right for etching that is not too deep, but for very deep work, special resists are used.

The prepared plate is now ready for the etching process. For brass and copper, a strong solution of perchloride of iron is generally preferred, as this does not attack the resist like strong acids, even though its action is quite slow. Nitric acid may be used with proper resists. While etching is usually only applied for cutting into the surface of the metal, it has been conclusively proved that the same process is applicable to piercing the plate, as shown by the illustration.

SPLICES FOR ANGLES*†

By A. L. CAMPBELL‡

It is often desirable to butt together and splice two angles, and usually the efficiency of the joint must be considered. Data on angle splicing, however, are very scarce, and it is, therefore, hoped that a discussion of this subject will be acceptable to many designers.

In order to splice together two angles of the same size correctly, we must first determine the amount of metal in each leg and the location of its center of gravity, and then we must place a sufficient number of rivets in each leg, symmetrically about its neutral axis, and provide ample metal in the splice plates.

Fig. 1 shows a section of an angle with a 6-inch leg, 3/4-inch thick. The total area of this leg is denoted by the shaded por-

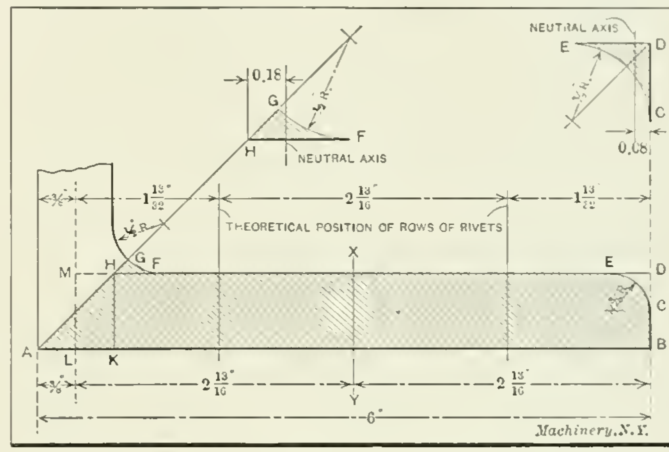


Fig. 1. Diagram showing Method used for Calculating Sectional Area

tion, *ABCEFGHA*, which may be considered as made up of the areas *HAK*, *KBDH*, *FGH*, and the negative area *CDE*. The center of gravity, or neutral axis, *XY* is located by adding the products obtained through multiplying each of the above areas by the distance of its center of gravity from one edge, as *BCD*, and dividing this sum by the total area of the leg. The quotient denotes the distance of *XY* from the edge chosen. If this calculation is carried out, following the dimensions given in Fig. 1, we find that the distance of *XY* from *BCD* is equal to 2.8 inches.

If only the area *ABCDEFHA* (or the equivalent area *LBDM*) is considered, it will be found that the neutral axis is 2.81 inches from the edge *BCD*. This indicates that the positive area *FGH* and the negative area *CDE* practically neutralize each other, and that they may safely be neglected, since the above results differ so slightly. If the leg were thinner, this difference would be a little greater, but in no case would it amount to as much as other errors caused by working conditions.

Having now located the neutral axis of the leg, the rows of rivets in the splice should properly be placed in the middle of each of the two areas into which line *XY* divides the leg. Each row should contain the same number of rivets, to avoid eccentric loading. If only one row of rivets is used in each leg, it should, of course, be located at *XY*. According to this, the two rows of rivets in Fig. 1 would be located 1 25/32 inch and 4 19/32 inches, respectively, from the back of the angle; but this leaves only one-half inch from the inner rivet centers to the edge of the fillet. The rivet heads would, therefore, ride up on the fillet if the rivets were driven from the back of the angle, and it would be impossible to drive them from the trough of the angle with a pneumatic hammer or power press. Hence, this row of rivets must be moved outward to about 2 inches from the back of the angle. If the other row of rivets be moved inward an equal amount, no eccentric loads will be created, and no bending moments will be imposed on the leg, but a small variation of the unit stresses will be created in it.

Splices are shown in the accompanying Data Sheet Supple-

* With Data Sheet Supplement.

† See MACHINERY, November, 1909, engineering edition: "Splices for I-beams and Channels." See also MACHINERY'S Data Sheet Nos. 123 and 125, and MACHINERY'S Data Sheet Series No. 18, "Beam Formulas and Structural Design," pages 36 to 42, inclusive.

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ment for the most commonly used angles with equal legs, from 8 to 3 inches, and for angles with unequal legs from 6 to 2 inches. In each case, a medium weight section has been chosen, since this will most nearly meet average conditions.

All computations are based on the following working stresses:

Tension or compression.......16,000 pounds per square inch.
Shear ....10,000 pounds per square inch.
Bearing ....20,000 pounds per square inch.

The general method of carrying out the calculations for each of the splices is outlined in the following. The calculation given refers specifically to the 8 x 8 x ¾-inch angle shown in the accompanying Data Sheet Supplement. The area of section of this angle is 11.44 square inches and the sectional modulus is 12.18.

The gross area of either leg is $\frac{11.44}{2}$, or 5.72 square inches. The approximate net area of each leg is found by deducting the area of one rivet hole, and is equal to 4.92 square inches. The allowable tension on this area is $4.92 \times 16{,}000$, or 78,720 pounds; and since the shearing resistance of a 1-inch rivet is 7850 pounds, ten rivets are required for each leg. Two 13/16 x 7¾-inch splice plates are used.

The bending efficiency of the rivets in the splice may be found by multiplying the total shearing value of all the rivets in either leg by the distance of their line of action from the

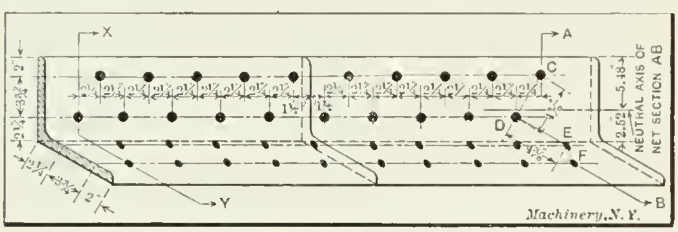

Fig. 2. Rivet Spacing in an 8 by 8 by 3 4-inch Spliced Angle

line of action of those in the other leg; and dividing this product by the allowable bending moment of a gross section of the angle. Since this is equal to the sectional modulus multiplied by the working stress per square inch, we find that the efficiency is equal to 166 per cent.

To find the minimum bending efficiency of the angle at the splice, it is necessary to find this efficiency for the net section AB of Fig. 2, which shows the spacing of the rivet holes in the splice. To do so, we must compute the sectional modulus of section AB with two rivet holes omitted from each leg. Then the ratio of this sectional modulus to the sectional modulus of the gross section will be the bending efficiency of the section. The rivets in the vertical leg of the angle above the vertical axis of the net section (load applied vertically, acting downward) do not lessen the sectional modulus since they are in compression, and the rivets are assumed to completely fill the holes.

The sectional modulus of the net section is equal to $\frac{\Sigma I + \Sigma C^2 A}{H}$, where ΣI is the sum of the moments of inertia about their own neutral axes, of all the areas into which section AB is divided; $\Sigma C^2 A$ is the sum of these areas multiplied, respectively, by the squares of the distances of their centers of gravity from the neutral axis of the net section as a whole; and H is the distance of this neutral axis from the top of the vertical leg. By carrying out the calculations, we find that the value of H, which is determined as in Fig. 1, is equal to 5.44; ΣI equals 12.97; and $\Sigma C^2 A$ equals 61.12. Finally, the sectional modulus of section AB is found to equal 13.6, and its bending efficiency is equal to $\frac{13.6}{12.18}$ or 112 per cent.

That the bending efficiency of this net section should be greater than that of a gross section seems like a paradox, but may be explained as follows: The moment of inertia of section AB, Fig. 2, is greater than that of a gross section because the diagonal distances CD, DE, and EF, with the rivet holes deducted, were used in its computation; also, the value of H is less than for a gross section, owing to the fact that deducting two rivet holes from the horizontal leg and only one from the vertical leg throws the neutral axis toward the top of the angle, from which point H is measured.

It is now evident that section XY of Fig. 2 will give the minimum bending efficiency of the angle. Proceeding as above, we find $H = 5.48$, $\Sigma I = 9.23$, and $\Sigma C^2 A = 57.05$. Its sectional modulus is then 11.55, while the bending efficiency is 95 per cent.

The efficiency of this splice for direct tension is also high. Twenty 1-inch rivets are available in each half of the splice, and their shearing efficiency is 86 per cent. The lowest tension efficiency of the angle is found at section AB, and is equal to 84 per cent. The efficiency of the splice plates for tension is equal to 89 per cent.

Below is given a table of efficiencies for angles with equal legs spliced as shown in the Data Sheet Supplement:

TABLE I. EFFICIENCY OF SPLICES FOR ANGLES OF EQUAL LEGS

Size of Angle, Inches	Bending Efficiency, Per Cent		Tension Efficiency, Per Cent		
	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Net Section of Splice Plates
6 x 8 x ¾	166	95	86	84	89
6 x 6 x ⅝	147	98	85	84	87
5 x 5 x ⅝	187	96	94	83	83
4 x 4 x ½	179	97	88	85	88
3½ x 3½ x ½	174	96	85	84	84
3 x 3 x ⅜	187	92	91	85	89

Two sets of values for H, ΣI, and $\Sigma C^2 A$ must be computed for each angle with unequal legs, since it has two values of the sectional modulus. This gives double bending efficiencies; otherwise the treatment is the same as for angles with equal legs.

The bending efficiency of the splice plates has not been computed, since it is always above 100 per cent. The lowest efficiencies are seen to be for the rivets and the net sections of the angles in tension. These efficiencies may be increased if desired by using smaller rivets, or more of them, or by respacing them; so that the minimum efficiency will be more than 85 per cent. The apparent weakness of the rivets in tension is balanced, however, by their being actually 1/16 inch larger than dimensioned. For a ¾-inch rivet, this difference amounts to 16 per cent.

TABLE II. EFFICIENCY OF SPLICES FOR ANGLES OF UNEQUAL LEGS

Size of Angle, Inches	Bending Efficiency, Per Cent: Long Leg, Vertical		Bending Efficiency, Per Cent: Short Leg, Vertical		Tension Efficiency, Per Cent		
	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Net Section of Splice Plates
6 x 4 x ⅝	108	95	157	93	83	85	90
5 x 4 x ⅝	117	96	142	98	85	85	92
5 x 3 x ½	100	94	155	96	88	87	90
4 x 3 x ½	124	94	160	96	85	83	84
3½ x 2½ x ⅜	142	94	193	97	92	82	91
3 x 2 x ⅜	120	90	175	92	89	84	90

When one of these splices is used in compression, the gross section of the splice plates and angle should be used in computing its efficiency, while the rivet efficiency will be the same as for tension. If used in a short strut, the shear of the rivets only need be considered; if, however, the splice occurs in a long compression member, its lowest sectional modulus must be used in the column formula chosen instead of the sectional modulus of the gross section, unless the splice is near one end.

Any or all of the rivets in these splices may be countersunk with a slight decrease in efficiencies, due to the extra amount of metal cut away. Either splice plate may be safely omitted if a floor plate, etc., is riveted to the leg of the angle in its place. None of the above splices has ever been tested to destruction. However, a set of similar splices has been used by a large Detroit firm for over two years in their construction work, and often loaded to the full working strength of the angles without any failures.

MANGANESE STEEL*

Manganese steel was first successfully produced by the Hadfields in England about thirty years ago, and was known as "Hadfield steel." It was first made in the United States by the Taylor Iron & Steel Co., of High Bridge, N. J. About five or six years ago other foundries in this country took up its production, but they soon discovered that it was a very difficult metal to produce successfully, and comparatively few foundries are to-day engaged in manganese-steel making. In fact, the manufacture in the United States is almost entirely confined to two companies, the one mentioned above, and the Edgar Allen American Manganese Steel Co. The latter firm has two foundries, one at Chicago Heights, Ill., and one at Newcastle, Del.

We might define manganese steel as a metal of the following composition:

	Per Cent
Manganese	11.00 to 15.00
Carbon	1.00 to 1.20
Silicon	0.25 to 0.40
Phosphorus	0.06 to 0.11
Sulphur	0.02 to 0.06
Balance, iron.	

Variations from the composition given above have been tried, and steel has been made containing anywhere from 8 to 35 per cent of manganese, but commercial manganese steel contains at present about 10 to 15 per cent of manganese and 1 per cent of carbon, these two constituents being the chief factors in manganese-steel making. Great care must be exercised in the manufacture so that the percentages of these two constituents are in the right proportion. Too much carbon and not enough manganese makes the steel brittle.

Manganese steel is considered a very hard metal, because of the fact that it cannot be machined as readily as ordinary iron or steel. In fact, it is practically impossible to machine it with even the highest quality of tool steel. Tests made on the scleroscope indicate a hardness of about 30 for Bessemer steel, from 40 to 50 for manganese steel, and from 65 to 70 for chilled cast iron; yet it has been demonstrated again and again that manganese steel will outwear chilled cast iron many times over. In general, it is safe to say that it will wear from four to eight times as long, depending upon the purpose it is used for and the conditions under which it works. The secret of the resistance of manganese steel to abrasive action seems to be due to its ability to "flow" or endure repeated distortion. Under abrasive action it simply moves away from one place to another, but does not actually wear off. One can take, for example, a square corner of a piece of manganese steel and peen it over, and then pound it back to a square corner, and keep up this operation without actually being able to remove any material.

Manganese steel is very sensitive to heat. A statement given out by the Edgar Allen American Manganese Steel Co. contains some interesting information on this point. Manganese-steel castings should never be heated, because if heated to a temperature of only 400 degrees F., they will lose their toughness and strength to a remarkable degree. This applies to castings of plain design; castings of irregular design do not even stand as high a heat as 400 degrees F. A casting which is in perfect condition and free from internal stresses at the time it leaves the foundry is very likely to break or crack if heated. The company strongly disclaims any responsibility for the breakage of any manganese-steel castings which have been heated after their shipment from the company's foundry.

Manganese steel will not become a permanent magnet; hence it is used for disks in magnetic hoists, as the smallest particle of iron or steel will not cling to it after the current is shut off. The tensile strength of early specimens, determined by Hadfield in England, was 150,000 pounds per square inch, with an elongation as high as 50 per cent. The average commercial steel of to-day, however, has a tensile strength of 82,000 pounds per square inch, an elastic limit of 45,000 pounds and an elongation of 30 per cent. Forged manganese steel will give better results, but there is very little commercial forged manganese steel made at this time.

The manufacture of manganese steel is carried on with a great degree of secrecy, and for this reason full information on some of the processes employed cannot be given. The steel is composed chiefly of a mixture of scrap iron and pig, this mixture being very carefully made up according to the predetermined composition of the steel. The mixture is melted in an ordinary cupola such as is used in any foundry, and is then run into a converter and blown quite similarly to Bessemer steel. This process, however, is carried out with great care and is directed by one man only, who operates everything from the central station or platform close to the converters. After the steel is blown, it is poured into large ladles from which the slag is removed. The manganese, which has previously been melted in graphite crucibles under intense heat, is then added. From the large ladles it is poured into sand molds which are practically the same as ordinary molds for cast iron.

One difficulty with manganese-steel castings is the excessive shrinkage when cooling. Manganese steel shrinks 5/16 inch per foot, which is nearly three times as much as the shrinkage of ordinary cast iron. All ladles and molds are kept very hot so as not to chill the metal before it is poured, as in this case a homogeneous casting could not be produced. After the casting process is completed, the castings are all subjected to a heat treatment, or both heat treatment and water submergence. This part of the process is kept secret by the manufacturers.

Manganese-steel castings can only be successfully made to certain sizes as regards length and particularly as regards cross-sectional area, the thickness being the prime factor. The greatest thickness of any section that has been successfully cast, up to date, is about 4½ inches. It is also very difficult to cast small or thin sections, the lower limit being about ⅜ inch for ordinary castings. The reason that the thickness is so important is because of the after treatment, which apparently will only penetrate to a certain depth. Thin sections are limited by the flow of the metal.

Owing to the fact that manganese steel cannot be cut by ordinary cutting tools, all machining on manganese-steel castings must be done by means of grinding. Sometimes steel bushings and other pieces of ordinary soft steel are inserted in the molds and cast into the casting, making it possible to bore out, drill or tap the casting at certain places. For example, the hubs for car wheels may be provided with soft steel bushings, and soft steel inserts may be provided for set-screws, etc.

The uses of manganese steel are not very extensive at present, due partly to its high first cost, and partly to the difficulty of machining the steel. It is used mostly for castings subjected to heavy strains and shocks and excessive wear, such as the wearing parts of steam shovels, ore and rock crushers, mining machinery, etc. It is also used to a considerable extent for safes. When rolled and forged, it is used for rails, frogs and crossings. The use of manganese steel has made it possible to cut down the maintenance cost for many machines very materially; the effect on the cost of rails in curves and for track with very heavy traffic has been referred to previously in MACHINERY, December, 1905, and June, 1909.

It may be of interest to emphasize the fact that manganese steel has proved itself efficient when used in cases where it is subjected to shocks. An idea prevails among railway engineers that this steel will not stand shocks. As an experiment, therefore, a manganese-steel frog weighing 800 pounds was bent under a drop weight. The frog was subjected to 165 blows from a weight ranging from 1250 to 2500 pounds and falling from a height varying from 3 to 23 feet, the total energy exerted being nearly 1,700,000 foot-pounds. No fracture or impairment of any nature could be discovered. There are hundreds of manganese-steel frogs and cross-overs now in use. At the Northwestern Terminal, in Chicago alone, there are 200 frogs of this kind installed.

* Abstract of paper by Mr. F. E. Johnson, read before the Association of Engineering Societies, October 21, 1910.

NEW METHOD OF METAL COATING

The new method of obtaining metallic deposits, recently discovered and developed by Herr U. Schoop, and which was reported by R. E. Mansfield, U. S. Consul General at Zurich, Switzerland, may be considered the complement of the galvanizing process. The method consists in projecting molten pulverized metal on such surfaces as it is desired to cover with a metallic deposit, the projection of the molten metal being effected by means of suitable nozzles employing certain gases or vapors at high temperatures and pressures. These gases play a double purpose according to the case, either as a purely physical means of pulverization, or as a chemical agent.

The inactive or reducing gases, such as nitrogen or hydrogen are principally adapted to the pulverization of the metal, especially if the metal oxidizes very readily when agitated. Considering the cheapness of nitrogen, which is a by-product in the manufacture of liquid air, it will doubtless be this gas which will be put to the greatest use in the future. However, superheated steam may be employed in certain cases.

The metal coming into the apparatus under pressure is reduced to an impalpable powder, and this being projected violently onto the surface of an article, the particles are deposited in the form of an extremely fine and compact coating, which has the same homogeneity throughout, presenting a fine appearance. The thickness of coating may vary from a thousandth to a considerable fraction of an inch, depending upon the duration of the treatment. It can be seen that the surface does not require to have conductivity, thereby making it applicable to the coating of non-metallic objects as well as metals.

A fact which is striking on first examination, is the low temperature of these metallic vapors, which vary between 50 and 140 degrees F., permitting this treatment to be applied to articles that are readily fusible or inflammable. The pressure of the gas is relatively high, running from 300 to 350 pounds per square inch. The expansion, which is produced at the opening of the nozzle, is principally in consequence of the initial temperature, which is from 400 to 550 degrees F. In consequence of the great pressure of the gas, the metal receives a tremendously high velocity.

The metals which are principally adapted to the Schoop process are those which become very fluid, (tin, lead, copper, aluminum alloys) in the state of fusion; the actual temperature of fusion on the contrary, which is raised more or less to deposit metal, plays only a secondary part. An interesting application of the process in this connection is that of depositing aluminum, which is the only metal now remaining refractory to the galvanic process.

The thickness and physical character of the metal film may vary within considerable limits, depending upon the duration of exposure and the conditions of the parts of the apparatus, such as orifice, nature of the gas used, temperature of fusion of the metal, and its initial pressure, etc. For thin coatings the deposit is made instantly, and for coatings up to 0.25 inch thick, from eight to ten seconds will suffice. The fact that thick coatings can be made has suggested the use of this method for replacing the electrotype process, which is only applicable to conductive surfaces. With a single stereotype negative, as many as 300 reproductions can be made in ten hours, for only a small fraction of the cost of the electrotype reproductions; at the same time they are in no way distinguishable from the latter. It is supposed that the structure of the metal coating by the Schoop process is not crystalline, but that it immediately assumes an amorphous form.

For the industrial application of the process there are two big classes of work to which this can be applied: First, for a permanent coating intended to improve the surfaces as well as to protect them against inclemency and other influences. Under this class come all sorts of metals, as well as plaster, ebonite, glass, paper, wood, celluloid, anatomical pieces, etc. It is even suggested that metal boxes of any desired shape may be made by applying a metal coating of the required thickness to a pasteboard or other pliable form shaped as desired. The second application is for coatings which are to be detached from the surface; these include electrotype impressions, the manufacture of small tubes without solder, and the making of hollow metallic articles. It can be seen from the foregoing that this new invention will tend towards a revolution in some of the industries mentioned.

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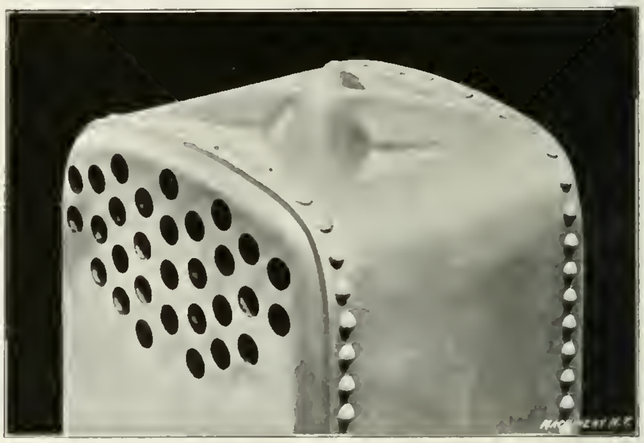
ENGLISH FIREBOX TOP FOR SMALL LOCOMOTIVE BOILERS

By FRANK C. PERKINS*

The accompanying illustration shows the construction of a novel English firebox designed and constructed at Gainsborough. It is claimed that the undoubted advantages of a locomotive boiler as a steam generator are sometimes offset by the troublesome necessity of frequently cleaning the boiler, especially when water of poor quality is used. One of the most difficult places in the locomotive boiler to clean effectually is the top of the firebox. The firebox is rectangular in shape and its four sides and top are usually reinforced by a



Small Locomotive Firebox with New Method of Bracing Top

number of stays. The top, having no adjacent sides to which to stay, is bridged over by several deep girders with suspending bolts supporting the flat plate. The girders make access for cleaning purposes difficult, and the bolts retard the mobility of the water and promote the deposit of scale. The result is not only a loss in heat transmission, but unequal heating is likely to occur, whereby the crown plate becomes unduly stressed in places and is liable to accident.

In order to obviate these drawbacks, Gainsborough English engineers have experimented for a long time with different forms of corrugated crown plates resulting in the firebox illustrated, which is held to be the strongest and safest crown plate of any of the various forms of corrugated tops which they tried. It will be seen that the corrugations spring from the opposite corners of the firebox, crossing diagonally in the middle, forming an exceptionally strong truss to the crown plate. These corrugations are obtained with the least possible stress in the material of the firebox, and their strength was proved by tests which were made, not only by hydraulic pressure up to 400 pounds per square inch, but also in actual steaming at a boiler pressure up to 180 pounds per square inch.

It is maintained that the shape of the corrugations enables them to steam freely, and the absence of cumbrous stays enables the top to be readily cleaned. The advantages possessed by this form include a slightly increased heating surface where the heating surface is of the most value, accessibility, and reserve of strength as well as economy in fuel, together with a decrease in weight of boiler. By abolishing the deep girders on the top of the firebox, it has been possible to simplify the staying of the end plates by dispensing with the heavy longitudinal stays and substituting stiffeners across the plates.

* * *

A man who minds his own business is a good man to have about, but the man who both *knows* and *minds* his business is better still.

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WHEEL-TURNING OPERATION IN CLEVELAND CHUCKING MACHINE

The method of machining the sewing machine handwheel illustrated in Fig. 1, in a Cleveland chucking machine (built by the Cleveland Automatic Machine Co., Cleveland, Ohio) will be described in the following: This work is done in a machine of the chucking type, as the design of this handwheel, with its numerous arms connecting hub and rim, makes

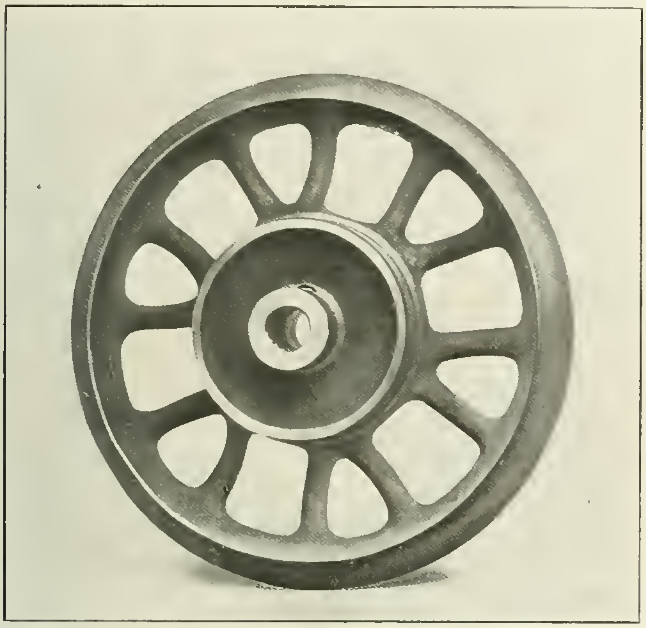


Fig. 1. Sewing Machine Handwheel Turned in Cleveland Chucking Machine

it impossible to use a magazine attachment. The mechanism on the turret end of the chucking machine is the same as that of the regular automatic type, but the spindle-head is somewhat different, in that it has a longitudinal adjustment to permit the use of large chucks for gripping castings of various shapes.

By referring to Figs. 2 and 3, which show the tool equipment for this particular job, it will be seen that a three-jawed chuck

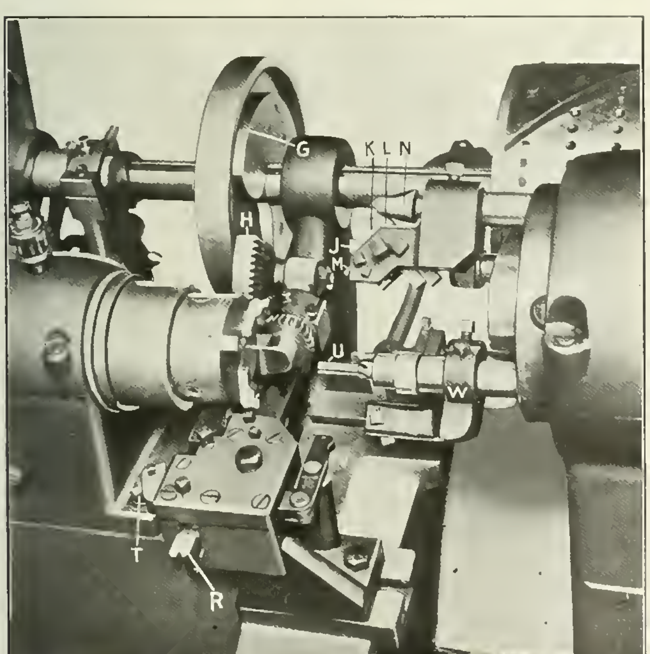


Fig 2. Cleveland Automatic Chucking Machine Set up for Machining Sewing Machine Handwheel

is used, which has special jaws formed to fit the rim of the handwheel on the inside. The advantage of locating the wheel by the inside of the rim is that it will be in almost perfect balance after the outside has been machined. The chucking of the work can be done very quickly, it being possible to remove one wheel and place another in position in about five seconds. One man can take care of from six to eight machines, the output per machine being about sixteen finished wheels per hour, allowing time for grinding the tools.

In turning this wheel, the following operations are performed: Roughing and finishing cuts are taken over the rim by means of a special, circular turning attachment; diameter B, (Fig. 4) is rough turned to remove the scale, prior to finishing the belt groove with a forming tool; hub C has roughing and finishing cuts taken over the outside, and it is drilled, bored, reamed, and faced on both ends. The inner face D is finished by a special attachment which has a bar passing through the machine spindle, carrying at its end a flat facing cutter.

During the first operation, the tools M, J, K, L, N, and the special rim-turning attachment, are all in action. The rim-turning tool is actuated by cam G which imparts a reciprocating motion to segment gear H that is in mesh with a bevel gear as shown. This bevel gear is attached to a steel frame or tool-holder carrying the tool which turns the rim. This holder is mounted in large bearings at each end which are bolted to the top of the bed in front of the spindle-head. The rim-turning tool travels through an arc of a little more than 180 degrees. The functions of the various tools which are used during the first operation are as follows: The tool J rough

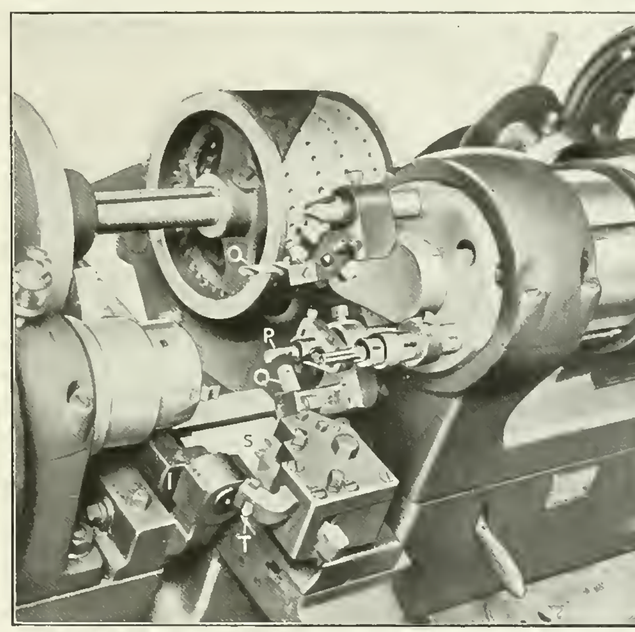
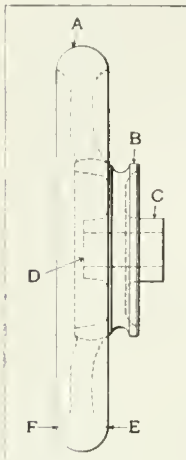


Fig. 3. Another View of Tool Equipment for Machining Handwheel

turns diameter B; K rough turns C; L faces hub C; M chamfers the sharp corner E; N spots the hub previous to drilling, and the tool in holder I turns the rim. During the second operation, a finishing cut is taken across the rim, and the hub of the wheel is drilled, the drilling and turning taking place simultaneously. To obtain the proper speed for drilling, drill O is driven by a high-speed drilling attachment which forms a part of the regular equipment. In the next operation, the hole in the hub is sized for reaming by boring-tool P which is held in an adjustable holder so that the tool can be properly located, regardless of changes due to grinding. Simultaneous with the boring operation, hub D is faced and hub C finish turned. In the fourth operation, the belt groove is finished by flat forming tool R, which also faces the outside of hub C, and turns diameter B. The hole through the hub is being finished at the same time by reamer U, and while this operation takes place, collar W comes into contact with lever V, swinging tool T into position for removing the sharp edge at F, which completes the operations. Tests on wheels finished by the method described showed that none was out of true more than 0.002 inch.

As one man can operate six of these machines, each of which has an output of sixteen wheels per hour, the cost of machining per hundred would be $37\frac{1}{2}$ cents, or a little less than four mills each, a wage rate of \$3.60 per day being assumed. This might be considered the maximum output under

favorable conditions, but if we assume that one man operates only three machines per day, which would be the minimum number under the most unfavorable conditions, the cost would be 75 cents per hundred, or a little less than eight mills per



	OPERATIONS
1ST.	Rough turn rim A Rough turn belt groove B Rough turn and face hub C Center for drill and remove burr on edge E of rim
2ND.	Drill hole with high speed drilling attachment and finish turn rim A
3RD.	Bore hole for reaming Finish turn hub C Face hub D with back facing attachment
4TH.	Form belt groove B Finish face hub C Ream hole and remove burr on edge F of rim

Fig. 4. Successive Operations on Sewing Machine Handwheel

wheel, the wage rate being the same as before. These figures will doubtless compare favorably with those obtained by any other method of doing this work, when the accuracy and excellence of the finish obtained is taken into consideration.

* * *

TROUBLES OF THE PATENT ATTORNEY

"In a town way down East," said Dobbins one day, "I used to know a patent attorney who was a mighty bright fellow and who came around the shop and helped us to frame up the claims for all our new schemes in such a way that when we read them afterward we did not know whether we were looking for a patent on a meat-grinder or a music-box. The claims were all right though, for we had one case taken to court on account of an infringement, and the lawyers wrangled over those claims for over two years; so sure enough, there must have been some substance to them. Well now, the reason why this particular patent attorney was so good and was able to put things through in the proper shape was because he was not only a patent attorney, but a mechanical engineer as well. If there was any fault to be found with him at all, it was that he was more of a mechanical engineer than he was a lawyer, and owing to that fact he was always unfortunate and lost his cases in court.

"I never saw him troubled over any mechanical contrivance but once. As soon as he saw the drawings he knew at once what we were driving at, and nearly always he had seen a similar device before. But one day Flannagin, over at our shop, got an idea of twisting a flat piece of stock so as to make a twist drill of it, something, by the way, that some one else did over in my father's shop forty years ago, but Flannagin twisted a shank to it, too, that would fit a Morse taper and he made a pretty slick job of it. Recognizing at once that here was an idea worthy of presenting before the wise men in the patent office down at Washington, he immediately called upon our friend the mechanical-engineer-patent-attorney, who gave due attention to the matter, framed up all the claims and made very nice looking drawings of the tool. To make sure before he sent them to Washington, however, he came over to Flannagin the other day and said, 'Say, Mr. Flannagin, about this twist drill, I would like to make sure that I understand it correctly. Now, which is the shank end and which is the drill end?' Well, Flannagin told him which was which and our friend said that was just what he thought, but he wanted to make sure!"

* * *

The total exports from the United States during 1910 represented a value of $1,864,491,644, and the total imports a value of $1,562,924,251. The volume of trade with the United Kingdom was greater than that with any other country. The exports to the United Kingdom amounted to nearly 30 per cent and the imports to about 18 per cent of the total exports and imports, respectively.

STREET CAR DESIGN

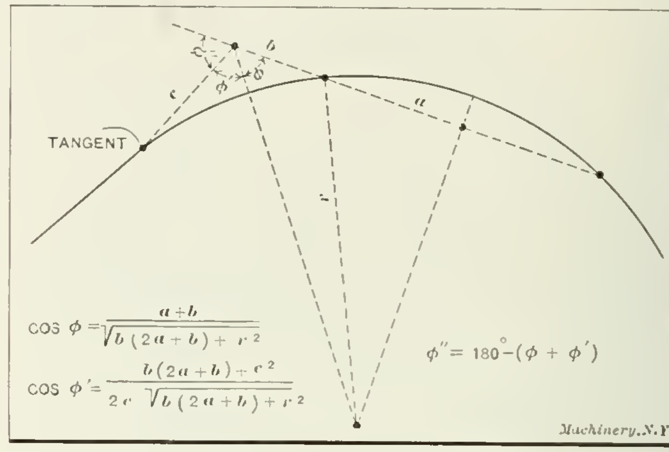
DRAW-BAR RADIATION AND MINIMUM WIDTH OF CAR BODIES

By WARREN M. SMITH*

The formulas given in this article have been developed by the writer to facilitate certain features of street car design, and have been successfully used for that purpose.

Draw-bar Radiation

Draw-bar radiation is the angle at which the draw bar stands with regard to the center line of the car, when the



$$\cos\phi = \frac{a+b}{\sqrt{b(2a+b)+r^2}}$$

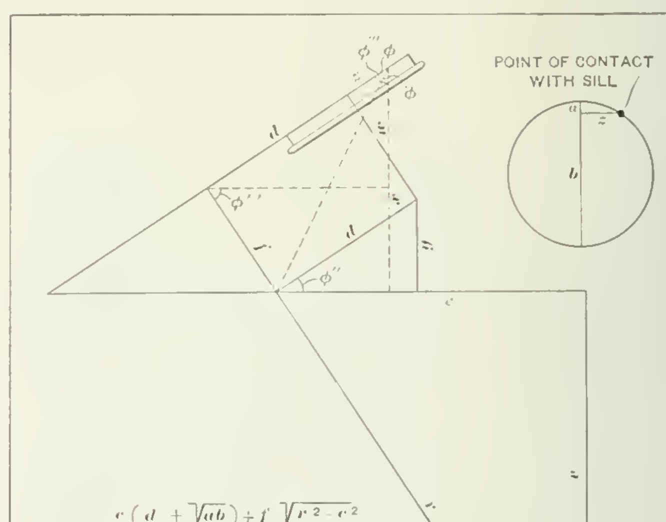
$$\cos\phi' = \frac{b(2a+b)+c^2}{2c\sqrt{b(2a+b)+r^2}}$$

$$\phi'' = 180^\circ - (\phi + \phi')$$

Fig. 1. Draw-bar Radiation Diagram

latter is on a curve. It frequently so happens that this angle is required for given radius of curvature, truck centers or other influencing conditions, and for that purpose the accompanying formula was developed. It will no doubt be found useful, especially on street railway and interurban work.

Except in the case of a reverse curve, when one truck is on each curve, the maximum degree of radiation will occur when the forward car is wholly on the curve and the draw-bar pin of the rear car is just striking the tangent. The angle increases up to this point, but beyond, it decreases. These conditions may be readily seen by reference to Fig. 1.



$$x = \frac{c\left(d+\sqrt{ab}\right)+f\sqrt{r^2-c^2}}{r}$$

$$\tan\phi = \frac{f}{d+\sqrt{ab}}$$

$$\cos\phi = \frac{x}{\sqrt{\left(d+\sqrt{ab}\right)^2+f^2}}$$

$$\phi'' = 90^\circ - (\phi + \phi')$$

$$c = r\sin\phi''$$

Fig. 2. Car Body and Truck Diagram to determine Minimum Car Width, Truck Radiation, and Bolster Centers for Given Curves and Wheel Sizes

While as before mentioned, the radiation is greater on a reverse curve, experience has proved that it is unnecessary to provide for the excess swing thus given, as it has been found in practice that the ordinary service curve on a line of

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railway is of such a character that if sufficient clearance were allowed for the radiation of the draw bar on the curve, two cars could very readily pass over any reverse curve on the line. It is the general practice to provide for sufficient radiation of the draw bar on the ordinary railway curve.

In Fig. 1:

a = half the distance between bolster centers;
b = bolster center to draw-bar pivot;
c = total length of two draw bars;
r = radius of curvature of the line;
ϕ'' = angle of radiation.

The lower end of the draw bar is shown just striking the tangent to the curve.

From an inspection of Fig. 1, it may be seen that

$$\cos \phi = \frac{a+b}{\sqrt{(a+b)^2 + (r^2 - a^2)}} = \frac{a+b}{\sqrt{b\,(2\,a+b) + r^2}}$$

Also from the trigonometric equation of the two sides and the contained angle

$$\cos \phi' = \frac{c^2 + (a+b)^2 + (r^2 - a^2) - r^2}{2\,c\sqrt{(a+b)^2 + (r^2 - a^2)}} = \frac{b\,(2\,a+b) + c^2}{2\,c\sqrt{b\,(2\,a+b) + r^2}}$$

From these equations, ϕ and ϕ' are found, and thereby ϕ'', the desired angle, is obtained, for

$$\phi'' = 180^\circ - (\phi + \phi')$$

This may be readily worked out as the two angles ϕ and ϕ' are in the three known terms a, b and r.

This formula cannot be used in connection with a curve of any other character than that ordinarily used in cities, or a curve that is of one radius from tangent to tangent; nor is it applicable to a curve unless it is a true arc of a circle.

Minimum Width of Car Bodies for Given Curves and Wheel Sizes

The general design of a car body, and therefore of the distance between the car sills, is influenced by the fact that the wheels have a tendency to strike the sills when taking a curve. This factor is dependent upon the amount of truck radiation, bolster centers, wheel-base, size of wheel, and radius of curve; all these influencing factors are interdependent. Fig. 2 diagrammatically represents these conditions.

In this figure

a = top of wheel tread to the bottom of the sill, for a loaded car;
b = top of track to bottom of sill for a loaded car;
c = half the distance between bolster centers;
d = half the length of wheel-base;
f = center of truck to the outside of the tread;
r = radius of curve;
x = center of car to point of contact on wheel, *i. e.*, half the distance apart of car sills;
y = center of car to center of axle.

From similar triangles

$$a : z :: z : b$$

therefore

$$z = \sqrt{a\,b}$$

Also

$$\cos \phi''' = \frac{c}{r}$$

hence

$$w = (d+z) \cos \phi''' = (d + \sqrt{a\,b}) \cos \phi'''$$

As

$$v = \sqrt{r^2 - c^2}$$

and

$$v : r :: x - w : f$$

then

$$r\,(x - w) = v\,f$$

or

$$x - w = \frac{v\,f}{r} = \frac{f\sqrt{r^2 - c^2}}{r}$$

therefore

$$x = (d+z) \cos \phi''' + (x - w) = \frac{c}{r}(d + \sqrt{a\,b}) + \frac{f\sqrt{r^2 - c^2}}{r}$$

$$= \frac{c\,(d + \sqrt{a\,b})}{r} + \frac{f\sqrt{r^2 - c^2}}{r}$$

or

$$x = \frac{c\,(d + \sqrt{a\,b}) + f\sqrt{r^2 - c^2}}{r} \qquad (1)$$

Also

$$\tan \phi = \frac{f}{d + \sqrt{a\,b}}$$

and

$$\cos \phi' = \frac{x}{\sqrt{(d + \sqrt{a\,b})^2 + f^2}}$$

and

$$\phi'' = 90^\circ - (\phi + \phi') \qquad (2)$$

hence

$$c = r \sin \phi'' \qquad (3)$$

Formula (1) determines the minimum width that a car body may be built, so that the trucks will not strike; formula (2), the greatest allowable truck radiation; and formula (3), the maximum bolster centers of the two trucks, and at the same time provides sufficient clearance for the truck when the width of the car is established.

These formulas may be used to determine the various measurements of the car body and its trucks for any of the eight variable factors previously tabulated.

* * *

SIMPLE CLAMPING DEVICE

The illustration Fig. 1 shows a fixture that was furnished with the engraving machine built by the Geo. Gorton Machine Co., Racine, Wis., for holding a certain long piece on

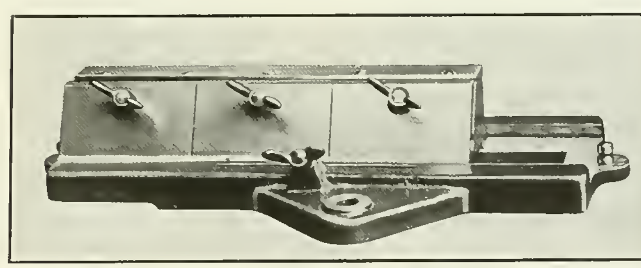


Fig. 1. Fixture used on Gorton Engraving Machine having Simple Clamps

which a line of letters is engraved. It was necessary to provide a clamp for holding the sliding block to the base.

Fig. 2 shows how Mr. Charles Rothweiler, the superintendent, made the clamp. The simplicity and ingenuity of the construction will be apparent with but little explanation.

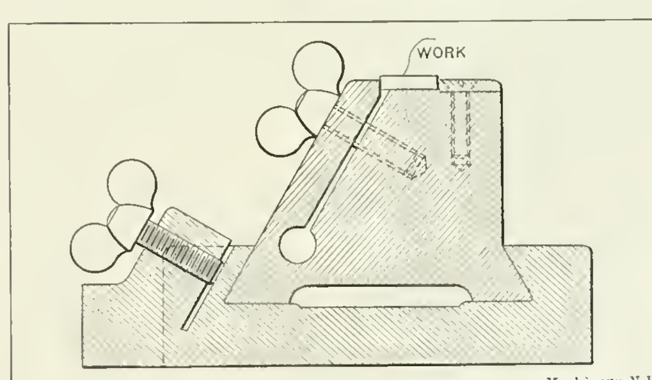


Fig. 2. Cross-section of Fixture showing Clamp Strip

A saw cut was made in the base about three inches long, shown in Fig. 1, back of the lower thumb-screw, at the same angle sideways as the side of the dovetail groove in the base. (See the cross-section Fig. 2.) The thread for the thumb-screw is tapped in the lug, and the end of the screw abuts against the thin strip of metal between the saw cut and the slide. A slight twist of the screw suffices to deflect the clamp strip and firmly clamp the closely fitted block.

ELECTRIC BLUEPRINTING

By H. W. WEISGERBER*

The essential thing in electric blueprinting is the paper. Sun paper cannot be used profitably for electric printing, so a special "extra rapid electric paper" is made for the use of artificial light. A paper that will print in about thirty seconds in bright summer sunlight, and which has good keeping qualities, will prove satisfactory.

Fresh paper prints more slowly than old, but washes more quickly; this means that the old paper prints more rapidly, but must be left in the bath for a longer period. The fresher the paper, the whiter the lines, while lines on old paper have a dull or grayish cast. In trying out new samples of paper, use small pieces along with one from the roll with which comparison is to be made, and place all of them over one tracing.

In damp weather the paper will wrinkle and cause poor contact, but this defect may be overcome by allowing the paper to expand before being placed over the tracing in the printing frame. This wrinkling is less troublesome in winter when artificial heat is used, than it is in summer. Paper as it comes off the roll is very dry, readily absorbing the moisture of the air, and must be given time to swell evenly, or a hit and miss contact will result.

Printing

To do good work the lamp must be hot, for in a cold lamp the carbons and rheostat offer too much resistance; consequently, the lamp must heat for several minutes before printing begins. After being in use for ten or more minutes, it has warmed up to normal, and the time of exposure can be shortened by increasing the speed. Overexposing is always preferable to underexposing, for the former can be remedied in the bath; yet the speeding of the lamp, as above suggested, should not be carried too far. It takes time to make blueprints, even in bright summer sunshine, and though the photo-engraving arc light is rich in actinic, or violet rays, it is slower than the sun, so do not expect a print in less time than is possible by sunlight.

The Lamp

Arc lamps are not infallible and should be no less carefully tended than any other machine, if satisfactory results are desired. A lamp that draws current from the same line as the shop motors probably suffers more from fluctuations than one that gets its current from a steadily loaded generator. The greatest annoyance is that due to "flicker" or "flaming arc." This can often be overcome by throwing the switch, and generally ceases as soon as the lamp becomes hot. The "creeping up" of the arc on the upper carbon is often caused by too long an arc, *i. e.*, the carbons are too far apart. An inch and a quarter arc made possible by adjusting the dash-pot-rod will give good results. A weak current, one below that for which the lamp is made, will also cause a short arc. Frequently a connection working loose will cause a loss of current and also make a short arc. If a lamp does good work, barring a little irregularity, it is advisable to leave well enough alone.

The printing rays of light emanate from the "point" of light on the hottest spot on the upper or positive carbon; consequently the printing rays extend downward rather than upward, and are on the side of the carbon that displays the "spot." If the carbon burns to a longer taper, the carbon point will cast a shadow on the opposite side and lighter colored prints will result. Neither the aureole nor the reflected rays have very great printing properties; it is the band of violet rays that does the work. A newly trimmed lamp must be allowed to burn clear before the machine is started, as it initially burns "yellow"—a color that will not print.

The lamp globes should fit snugly. At the same time they should not be so tight as to interfere with the expansion of the glass nor with the escape of the gases when the current is turned on. They should be handled carefully, for a chip out of the edge soon means a broken globe. A little milkiness (the white dust-like coating in the globe) is beneficial, for it diffuses the light and makes a better printing medium than clear glass.

Washing the Prints

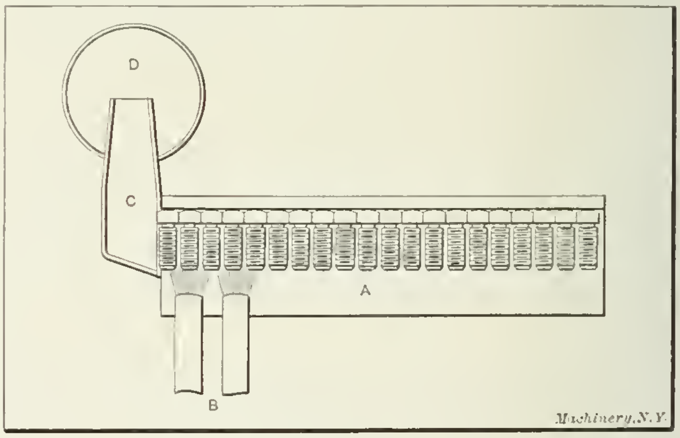
Many prints are spoiled in washing from insufficient soaking. The blue background must be "fixed," and this takes time; prints that are soaked from two to five minutes will remain blue longer without fading than those that are simply put in the bath and taken out. All prints fade somewhat when placed in direct sunlight, but the poorly washed ones turn white. There is no cure for an underexposed print, but an overexposed one, if not "cooked," can be developed with potash solution.

For the developer, use one-half ounce saturated solution bichromate of potash to each gallon of water in the bath. To use the potash economically, the bath water need not be changed every day, for by adding about two ounces of formaldehyde to a barrel of water as a deodorant, the water in the bath may be used for a week or two, even in "dog days," without any odor arising. This germicide also destroys all sliminess in the pan, and even at full strength it does not injure the prints. It is, however, a powerful astringent, and if too much is used it will be harsh on the hands. Wet prints should never be hung in the light near a window, for they fade more quickly when wet than when dry.

* * *

HARDENING SET-SCREWS

The illustration shows the plan of a simple outfit for hardening the points of set-screws used in the well-known Armstrong tool-holders made by Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago. The screws are laid on an inclined plate *A* with the heads against a ledge that keeps them from sliding off. Two Bunsen gas burners *B* are set so that the flames are directed against the points of four or five screws



Semi-automatic Set-screw Hardening Outfit

on the left end. At the same end of the plate is a chute *C* directed into a tub *D* containing the cooling bath.

The hardener places the screws on the plate *A*, beginning at the right and putting another screw on the moment the screw at the extreme left has reached the hardening heat. The action of putting on another screw punches off the heated screw into the chute from which it descends into the bath. The hardening process is thus semi-automatic; the hardener simply picks up the screws and puts them on the plate as fast as the screws in front of the burners become heated, and no other handling is required.

The method is highly efficient, the percentage of hard points being nearly 100, as is shown by the file test to which every set-screw is subjected. It is rapid, too, since four or five screws are heating at once, but as the heating is progressive, there is no confusion, and practically every screw is quenched at the right moment.

* * *

Extract from letter: "I wish someone would invent a plan whereby draftsmen could exchange places, get fresh ideas, and see new methods, and, incidentally, get some fresh air." Not such a bad idea, either! Suggestions are invited.

*Address: 321 Franklin Ave., Salem, O.

ADJUSTING STRIPS OR GIBS USED ON MACHINE TOOLS

By JOSEPH G. HORNER*

"Adjusting," "take-up," or "gib" strips, as they are variously termed, are used so extensively that it is but natural to find a great number of varieties, differing in form and manner of application. Different conditions are imposed by the sizes of the machines on which they are used, by the mass of certain sliding parts, and by the particular functions which they have to perform. The shapes of the slides have a modifying effect upon the strips, and the nature and direction of the strains

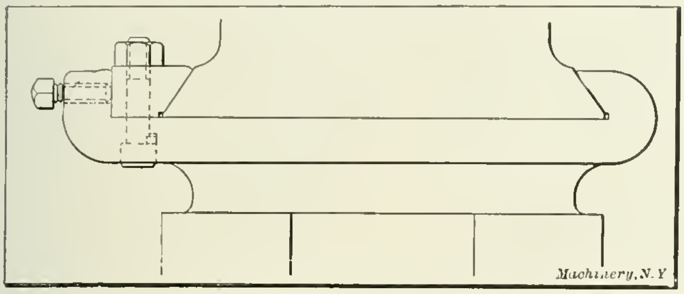
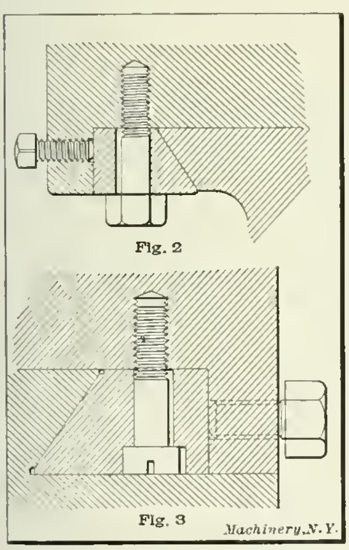
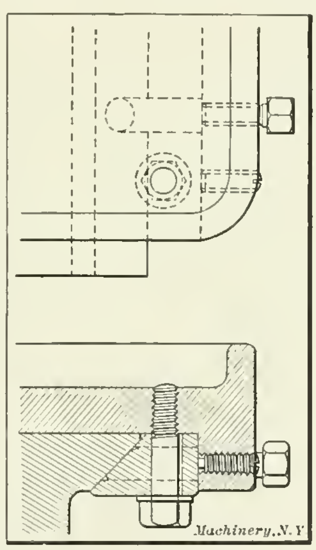


Fig. 1. Common Form of V-strip or Gib

on the slide must be taken into consideration. In addition to these questions, the matter of space or clearance often determines what class of strip shall be employed. In some kinds of slides there is complete freedom for the projection of adjusting screws, while in others the arrangements are necessarily so cramped and confined that various modifica-

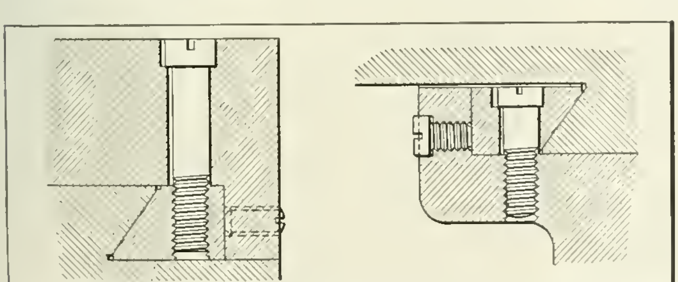




Figs. 2 and 3. Modified Arrangements of V-strips and Adjusting Screws

Fig. 4. V-strips with Clamping Plugs or Shoes

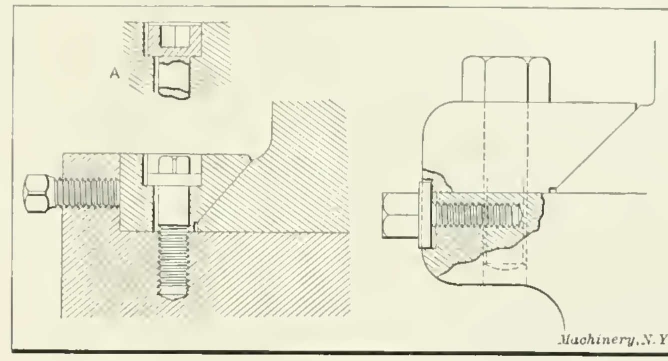
tions have to be made in order to accommodate the adjusting screws and to make them easily accessible. Cases are sometimes met with in which the adjusting screws of a gib or strip are most awkwardly located, when—by a little thought—another arrangement could have been adopted. Sometimes the substitution of a different kind of screw will make all the



Figs. 5 and 6. Strips with Different Types of Adjusting Screws

difference between facility of manipulation and extreme difficulty.

The problem of locking a slide is sometimes solved by fitting a lateral screw or screws to press upon the adjusting strip, but there are also several other methods. Usually the provision for locking does not affect the strip in any way, but there are instances in which a slideway is so weak and flimsy that the tightening of the locking screw or screws will spring the metal of the slideway inward, and so cause it to

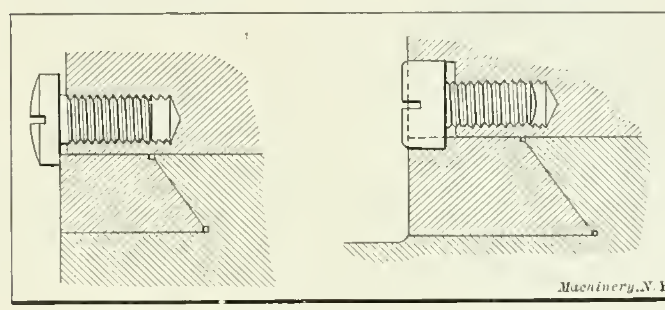


Figs. 7 and 8. Strips with Countersunk Square Heads and Collar-head Adjusting Screws

recede from the gib of the slide itself, thus producing slackness, and partially defeating the object of the locking.

Main Types of Gibs or Strips

Practically all adjusting strips belong either to the V-type or to the square-edged type, and all modifications are based upon these two classes. These types are further sub-divided



Figs. 9 and 10. Strips adjusted by Round Screw Heads

into three main groups, according to the mode of "setting-up" or adjusting:

1. Strips forced laterally by screws acting at right angles to the axis of the slide.
2. Angular strips pulled or forced sideways so as to have a wedge action between the slide and the slideway.
3. Strips tapered longitudinally and forced in that direction, thus having a wedge action.

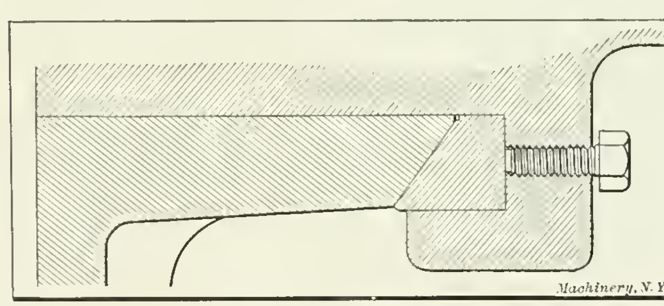


Fig. 11. Strip for Planer Bed

There is ground for believing that the last-named type will in the near future greatly supplant, if not oust, the first-named style of strip, and possibly also the second kind. The simplicity of the wedge adjusted endwise is obvious, and it is being employed more and more in new constructions, both on large and small slides.

The function of a take-up strip is to prevent slackness between the slide and its slideway, and to compensate for wear. While a strip may prevent lateral shake of a slide, it may or may not prevent the lifting which is likely to occur when the pressure of the cut tends to separate the slide from its way. In this case it will be necessary to employ another strip, if the arrangement of the adjusting strip does not provide for resisting the strain in both directions. On the other hand, many instances occur in which only one strip, or a pair of

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strips, is necessary to check the lifting tendency, and the shape of the slideways provides against lateral displacement. A lathe bed with V-ways affords such an instance; but in the case of square-edged slideways, the single lateral strip is insufficient, and it must be supplemented by a gib underneath,

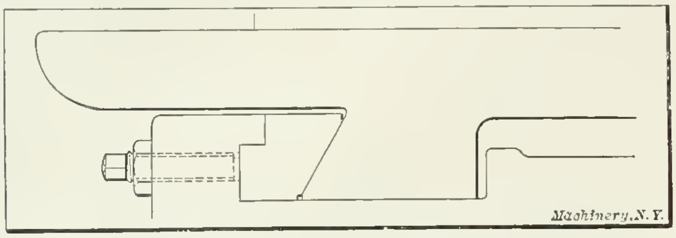
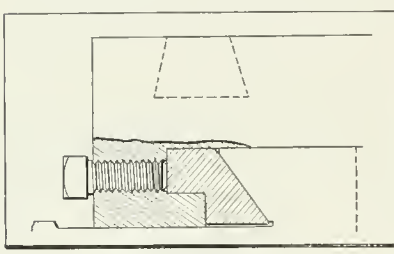


Fig. 12. Strip with Shoulder to prevent Lifting

or the latter must be combined with the former, and a right-angled strip used. The choice of either method is often a matter of convenience; in certain cases the combined form of strip is impracticable, on account of space restrictions or other requirements. Another condition is met with in the slides of certain grinding machines, which have one V and one flat



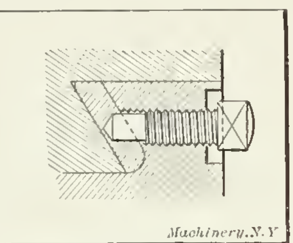


Fig. 13. Strip with Shoulder to prevent Downward Movement

Fig. 14. Flat Strip used on Dovetail Slide

way, and which do not require any form of gib for the prevention of either lateral or vertical movement. Again, when the heavy table of, for example, a planer runs upon two flat ways, it is only necessary to provide lateral strips; but if the machine is a light one, lifting must be guarded against either by fitting top gib strips to press downward, or by adopting another kind of slideway, such as an inverted V or dove-

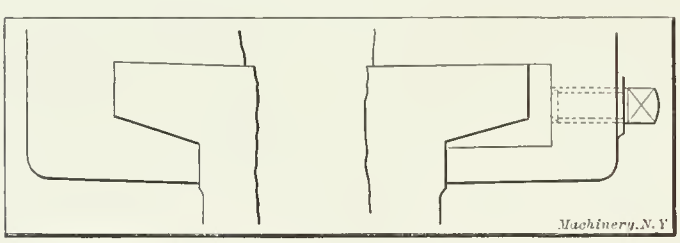
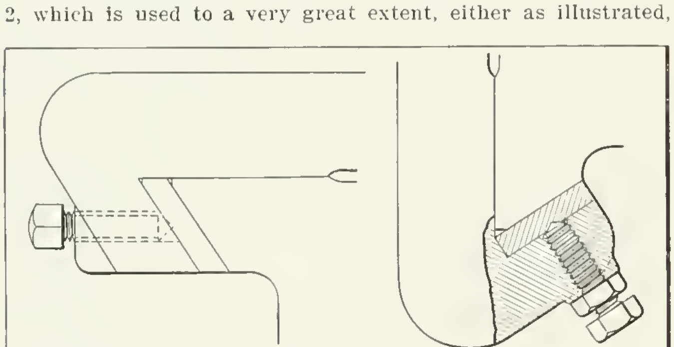


Fig. 15. Arrangement used on Link Grinder

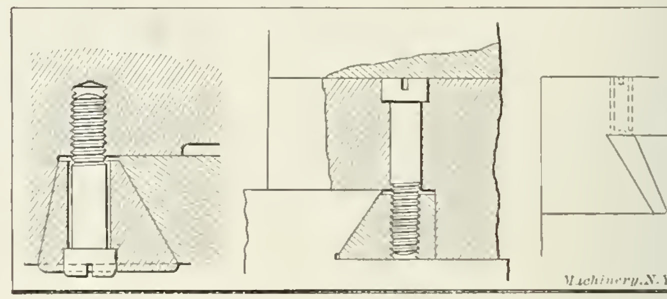
tail, or by putting gib strips underneath the ledge of the bed ways.

It is now proposed to briefly review various kinds of take-up strips, the examples shown in this article being taken from a wide range of machine tools made in different countries. Perhaps the most common type of strip is that shown in Fig. 2, which is used to a very great extent, either as illustrated,



Figs. 16 and 17. Different Methods of Applying Adjusting Screws to Flat Gibs

or with numerous slight modifications. It provides for lateral adjustment and for vertical take-up, and may be found on nearly all classes of lathes and machine tools. The other edge of the slideway is usually of V-shape, but sometimes it is cut to a square shape, in which case a flat strip at the bottom is required to prevent lifting at that edge. The precise arrangement of the adjusting screws depends upon the circumstances; sometimes bolts, see Fig. 1, are better suited for taking the weight of an overhanging knee (a milling machine in this case). Provision for locking the slide to the pillar is here made by fitting handles on two of the bolts, instead of nuts, so that the strip may be forced hard against the V-edge. Another means of clamping which does not utilize the strip, is that represented in Fig. 4. Here a circular plug or shoe passes through the strip and is pressed against the edge of



Figs. 18, 19 and 20. Different Types of Wedge Gibs

the slideway by a hexagon-head set-screw, the strip being adjusted by headless screws. The possible objection to this device—that the action of the screw has a tendency to force the table apart from its slide—does not apply to the arrangement in Fig. 1, where there is a truer clamping action.

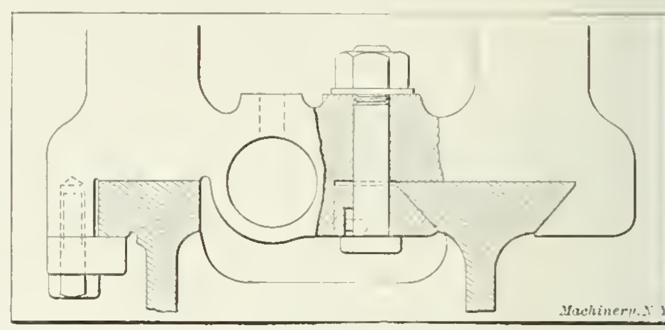


Fig. 21. Arrangement used for Gear-cutter Head

Modified arrangements of the adjusting screws are seen in Figs. 3 to 8. In Figs. 3, 5, and 6 are shown examples where the strip is closed in by the slide construction, so that while the adjusting or setting-in screws are not necessarily affected,

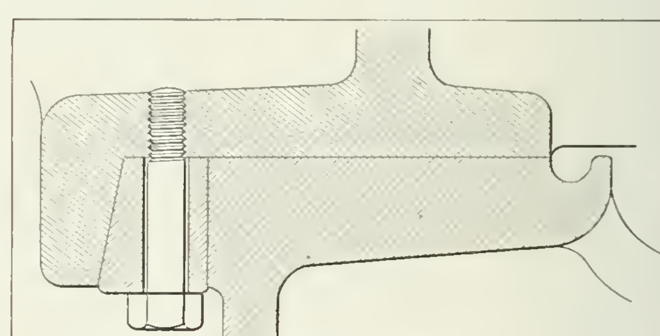
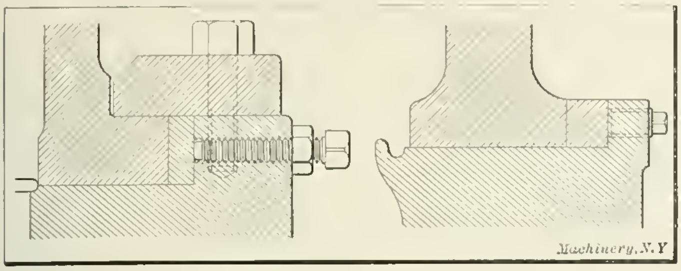


Fig. 22. Modified Wedge-strip Arrangement

the pulling-up screws are modified in various ways. In Fig. 3—showing the gib for a slide-rest—the pulling-up screw passes through the strip up into the top slide, while in Fig. 5 the arrangement is reversed, the latter design making the screw easier of access. The milling-machine slide gib shown in Fig. 6 has a screw sunk flush with the face of the strip to permit of the passage of the table. Other slight differences are made in regard to such arrangements, but it is unnecessary to illustrate all of these. An alternative to the use of a slotted screw-head is seen in Fig. 7; the head has a collar and a square for manipulation with a wrench, a method that is better suited for heavy strips than the use of a screw-driver; the head may also be of the hollow type, with a square inside, as shown in the detail at A, Fig. 7. In Fig. 8 is seen a modi-

fied form of adjusting screw, used when there is no metal outside the strip for the insertion of a screw, this example being taken from a shaper saddle. The set-screw has a large collar which presses against the back of the strip and forces it inward.

Another distinct class of strips is characterized by the absence of the pull-down screws shown in the examples hitherto



Figs. 23 and 24. Square-edged Gibs

illustrated. The friction of the setting-in screws is relied upon to prevent backward motion of the strip, and while this cannot always be depended on if the slide is subjected to much strain or to excessive vibration, it answers sufficiently well for many purposes, being frequently employed for the slides of small lathes and other machines. Fig. 9 is an instance of this, although the arrangement used in this case is not very workmanlike; that shown in Fig. 10 is to be preferred, both on the score of neatness and of durability, because the head is protected, and the close fit of the head in the counterbore helps to prevent the screw threads from loosening. The ex-

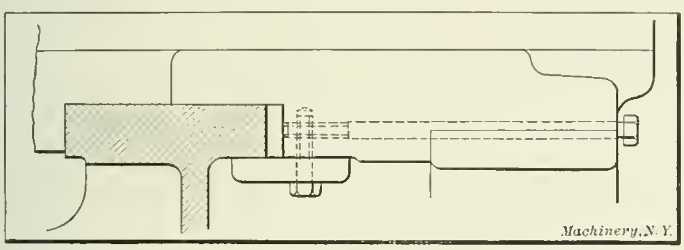


Fig. 25. Arrangement Requiring Abnormally Long Adjusting Screws

ample in Fig. 11 is taken from a small planer, and shows a V-strip set up against the inner edge of one bed-way, the other inner edge fitting as solid metal to metal to the table. The lip carried underneath the strip obviates the need for a second screw. A projecting lip on the strip is another means for checking its tendency to lift. An example of this is shown in Fig. 12; the shoulder keeps the strip in place, as is also the case in Fig. 13, although the strip is reversed in the latter case. A slight clearance under the bottom of the strip prevents it from being jammed onto the lower slide and binding this to the upper slide.

Fig. 15 is a strip for a link grinder, where the table saddle embraces the bed on one side, and a gib of corresponding form is adjusted by a row of screws on the other. A popular style of strip is that shown in Fig. 14; it differs from the examples previously shown in that it is of flat shape, although it is pressed against a V-edge. It is often used for light slides. A gib of similar design is fitted to a different kind

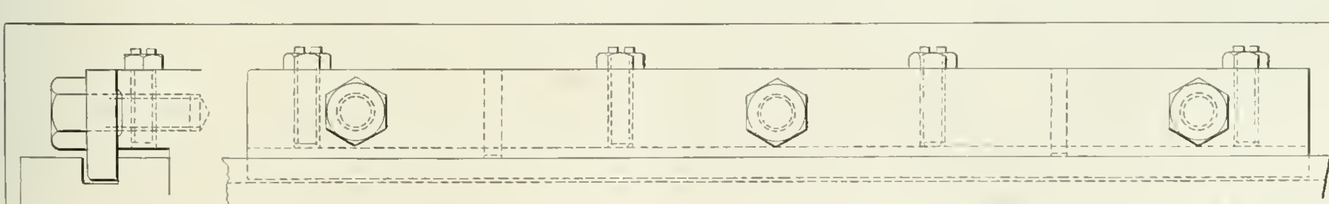


Fig. 26. Arrangement used for Turret Slide

of slide in Fig. 16; and in Fig. 17 the setting-up screws are located at right angles to the face of the strip.

After having reviewed these examples of gibs or strips fitted with setting-in screws but without pull-down screws, some of the opposite type, *i. e.*, those provided with pull-down screws only, will be shown. This method involves the utilization of wedge action, advantageous both from the point of view of simplicity, and because of giving solid metal-to-metal pressure, independent of any setting-up screws. Fig. 18 is a gib of this kind, while the gib in Fig. 19, an example taken from a slide-rest, acts similarly, but has its back cut perpendicular instead of beveled. The gear-cutter head, Fig. 21, is gibbed in a similar way, but with a bolt to pull up the strip. As the head is guided only by one slideway, there is clearance on the other way, and a flat gib only is required to prevent lifting. In slides where the strip is too thin to permit of the passage of a screw, the alternative shown in Fig. 20 is adopted, a row of screws forcing the strip down. As a last example of this character, Fig. 22 may be noted; although a wedge strip is utilized, the edge of the slide is square, as the lifting tendency is prevented by the weight of the table—that of a

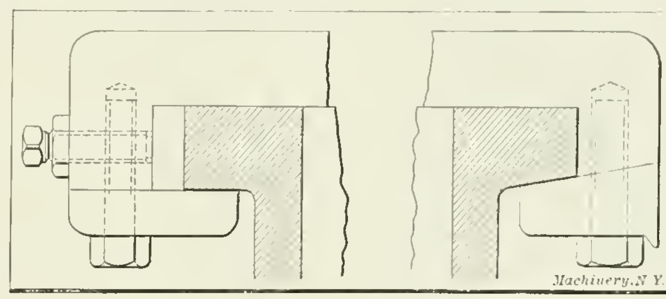
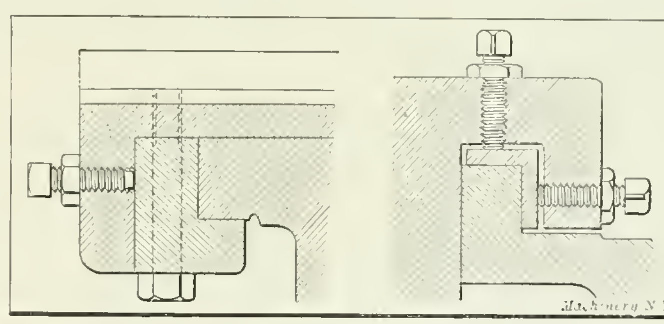


Fig. 27. Two Types of Gibs used on Grinder Saddle

planer. The strip is placed on the outside of the way, the outer edge of the companion way fitting against the solid shoulder of the table.

Square-edged Gibs

Some attention will now be given to square-edged gibs, of which various kinds are shown in the engravings Figs. 23 to 30. As with V-strips, the side-setting screw is commonly employed, as shown in Fig. 23 (an example taken from a shaper ram), and if lifting has to be prevented, the usual gib or plate, pressing downward, must be included. If no lifting



Figs. 28 and 29. Angle-strips with Adjustment in Two Directions

is to be feared, the plain strip, Fig. 24, is sufficient. This example is taken from a planer with two flat slides, the strip and screws being placed on the inner side of the left-hand way, while the other way has a solid shoulder. Fig. 25 is rather an unusual case of a lathe carriage in which the adjusting screws have been made of abnormal length in order to bring their heads to the front, the only location where access to them is possible. The front shear of the bed forms a narrow guiding way, and only a flat gib is required on the other shear to catch under the lip of the ledge. A strip and gib for a turret-lathe slide is illustrated in Fig. 26; it will be seen that the strip is prevented from moving endwise by two locating pins, and that the top surface of the saddle is recessed to facilitate scraping down, to lower the gib.

Fig. 27 shows a design which combines a square strip and gib plate on one side of a bed, and a solid square-edge, fitting

with a gib of moderate bevel, on the other. This construction is used on a piston-rod grinder saddle, and the beveled strip has a lip extending along its bottom edge to let the lubricant drop straight down into a trough below. The combination strip illustrated in Fig. 28 is often used in preference to separate strips, it being adjustable in two directions; when set

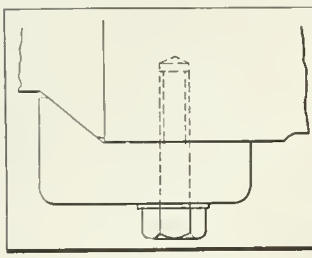


Fig. 30. Gib for Shaper Saddle

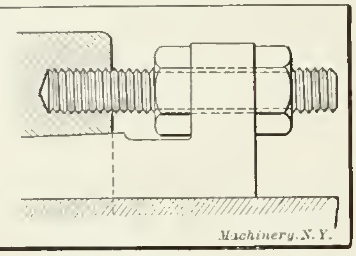


Fig. 31. Usual Method of Adjusting Taper Gibs

up vertically, it is of course necessary to scrape down the surface of the strip until it makes contact with the lower bearing surface of the bed. Another class of strip that can be adjusted in both directions, is shown in Fig. 29; it requires no scraping, and is used on the top portion of a side-planer tool-box, the other part of the slide fitting a V-shaped way. The arrangement is sometimes changed about, with the V

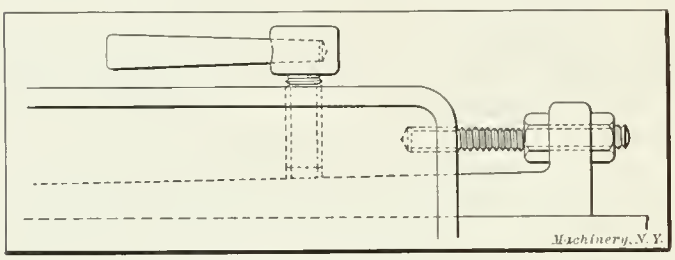
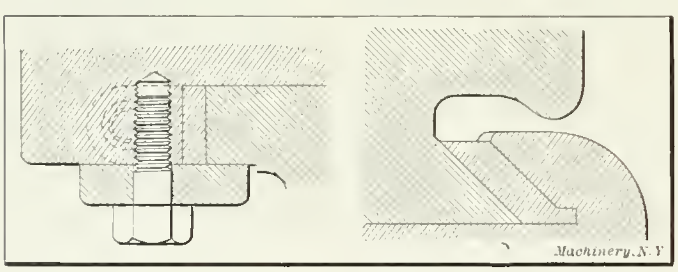


Fig. 32. Taper Gib with Clamping Arrangement

above and a square-edge below. A different form of V is also often employed, with a strip like that shown in Fig. 30, this being commonly applied to shaper saddles, with various slight modifications of style.

Taper Gibs or Strips

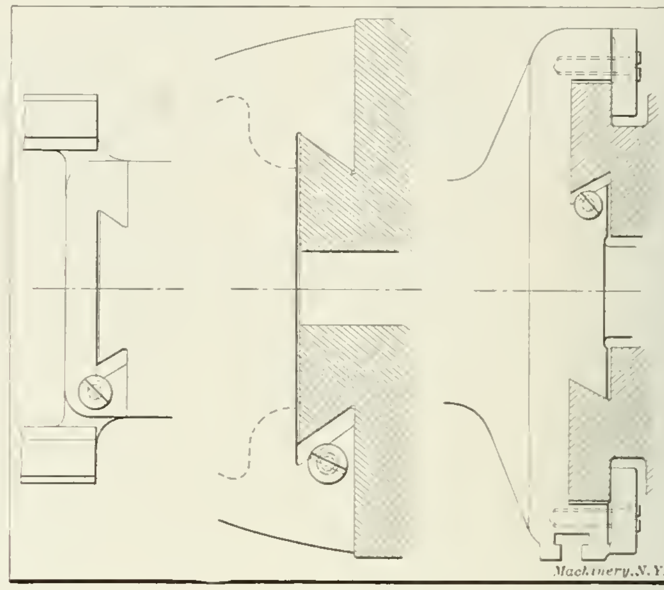
Finally we come to the gib which is tapered longitudinally and which has no side-setting screws. This, as previously



Figs. 33 and 34. Different Methods for Preventing Taper Gibs from Lifting out of Place

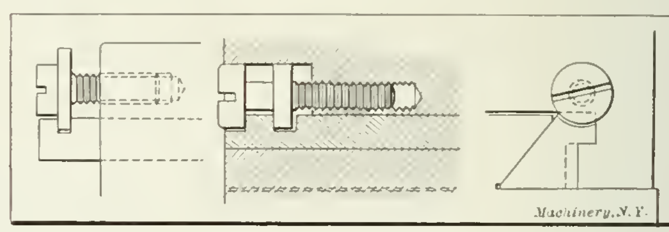
mentioned, seems destined to largely supersede other types of gibs, particularly for certain classes of slides. It is simple, the number of adjusting screws is reduced to one, the pressure along the side of a slide does not depend upon the variable pressure of a row of screws, and it binds against a solid mass of metal between the fixed and the moving parts, so that no springing action can occur except by the spreading or opening out of the metal in the saddle, or the closing in of that in the slideway. Its simplicity alone, however, has perhaps secured for it more adherents than any of its other advantages. There are many places where it is easier and simpler to accommodate the one adjusting screw of the taper gib at the end than to find space and means of access for the row of side-setting screws of the ordinary strip; and it leaves the designer with a freer hand to carry out ideas which would have to be more or less modified and restricted by the fact of a side-setting strip being fitted.

Fig. 31 shows the usual method of moving these strips, a stud being screwed into the slide, saddle or carriage, and,



Figs. 35, 36 and 37. Varying Locations of Taper Gib Adjusting Screws

passing through a hole in the head of the strip, allows the latter to be adjusted in either direction, and locked by the two nuts. The screw itself does not turn in this case, but as we shall see later, circumstances may require the employment of a different kind of screw. The clamping of a slide is sometimes effected by screw pressure, the screw acting on the



Figs. 38 and 39. Alternative Methods of Adjustment for Taper Gibs

strip, as seen in Fig. 32, or it may be done in other ways, independently of the strip.

When a taper strip is fitted to a square-edged slide, the lifting of the slide must be prevented either by means of an ordinary gib plate, as in Fig. 33, or by carrying the lip of the slide down underneath, and fitting another taper strip which will thus lie at right angles to the first. This is employed, for example, on the saddles of some planers, where the saddle fits the square-edged top portion of the cross-rail.

In the smaller strips, and where space is limited, the adjustment is more suitably made by ordinary fillister-head screws, pressing either on the ends, or being sunk in a short distance, to avoid undue projection. A screw at each end of the strip provides for movement in both directions, and checks the tendency to jam. The precise location of the screws in relation to the end of the strip is usually a matter of judgment, depending on the most convenient location. Figs. 35,

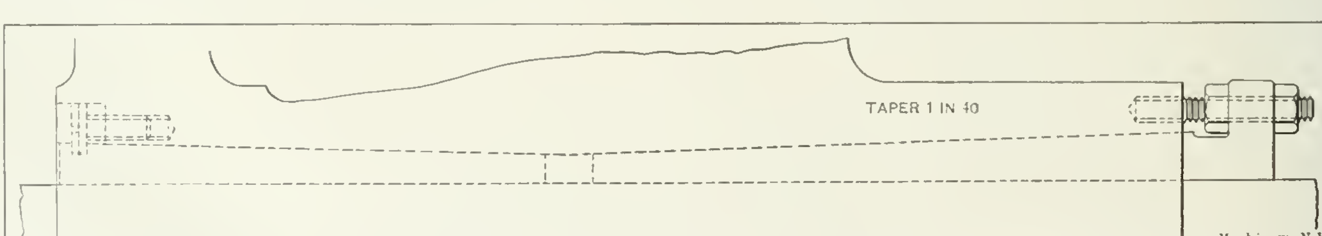


Fig. 40. Arrangement of Gibs on a Multiple-spindle Drilling Machine

36 and 37 show three common arrangements. In Fig. 35 the location of the adjusting screw is at the corner of the strip, in Figs. 36 and 37 it is placed at the side, and in many instances it is located at the bottom. Figs. 35 and 36 are complete without extra gibs, but in Fig. 37 a pair of strips bearing on the under ledges of the square lips is provided. These two latter examples are of milling-machine spindle heads.

Fig. 34 shows a modification sometimes made in taper strips, where there is nothing to prevent the strips from lifting. A small tongue is formed on the strip, and fits into a groove in the slideway (in this case the saddle of a milling

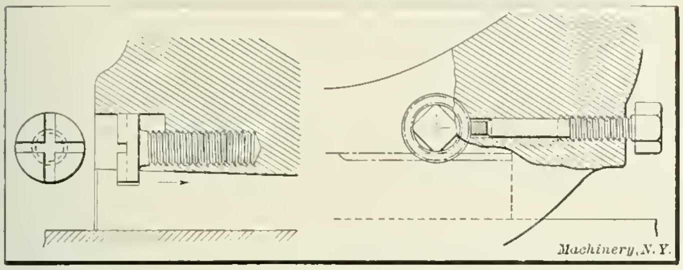


Fig. 41. Detailed View of the Adjusting Arrangement shown to the Left in Fig. 40. Fig. 42. An Unusual Arrangement: Taper Strip Adjusted by Rack and Pinion

machine). The tongue could only be dispensed with if the under face of the table came down flush with the top of the slideway.

A few different ways of adjusting taper strips are shown in Figs. 38 to 42. The collar-head screw, engaging in a notch in the strip, Fig. 38, is very common; it provides for adjustment in both directions, and does not take up so much space as the stud with its two nuts in Fig. 31. Another method which is still more compact is that shown in Fig. 39, where a double collar screw is used, sunk nearly flush with the face of the slide. The strip, as will be noticed, is shouldered to prevent its jamming down onto the slideway.

A rather peculiar combination is shown in Fig. 40, this being the gibbing arrangement of a saddle for a multiple drilling machine. On the right-hand or outer side there is no restriction, so that a strip with head and the usual stud and nuts is permissible; but on the left-hand side a different arrangement is necessary, because that side has to meet the corresponding face of a companion saddle so as to bring the drill spindles together as close as possible. The strip on this side is, therefore, fitted with a countersunk screw of the large-headed type; as shown in the detail, Fig. 41, the screw has two slots at right angles—otherwise the screw-driver could not be applied.

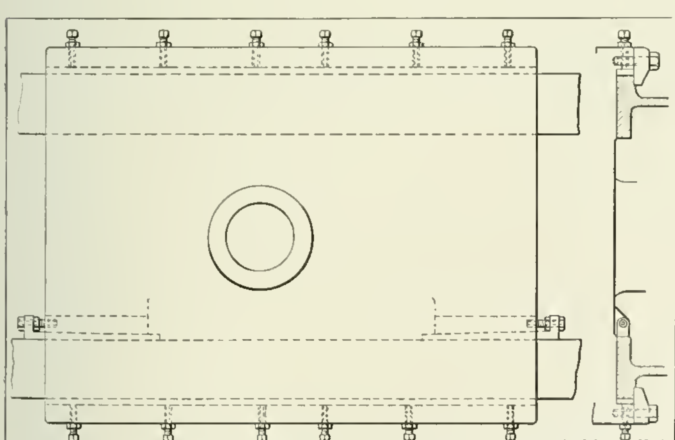


Fig. 43. Arrangement used on a Gear-hobbing Machine

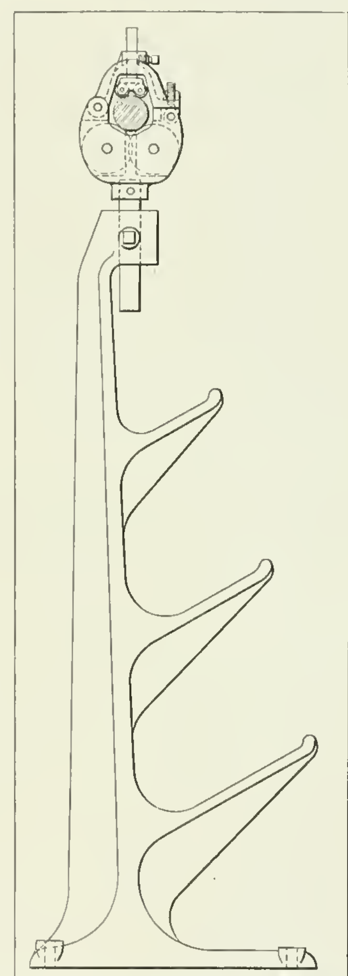
Another method of adjusting a strip is shown in Fig. 42, in which, owing to the construction, no other method is conveniently applicable. The strip has a few rack-teeth cut upon its end, and these engage with a pinion on the end of a spindle which comes to the front of the saddle (that of a radial drilling machine), and is turned by a wrench. After adjustment, the spindle is secured by clamping it with the set-screw and "shoe" at the side. An alternative method, occasionally employed, is to provide the strip with a couple of pins standing out at right angles, and use these as means of adjustment, by forcing them with set-screws in the one or the other direction; or a single pin can be utilized, bringing the points of the set-screws to bear on either side of it.

An interesting case of the employment of taper strips in combination with ordinary side-set strips is illustrated in Fig. 43. The saddle has a central boss and hole, which forms the receptacle for a work spindle (the machine being a gear-hobber), and as this hole must be maintained in a central position, three sets of gibs are fitted. By suitable adjustment of the wedges and the outer strips, the saddle can be kept in the precise position intended.

* * *

BAR SUPPORT AND STOCK RACK FOR THE SCREW MACHINE

The accompanying illustration shows an interesting bar support for an automatic screw machine, this combination support and stock rack being used in the Wells Bros. Co.'s plant, Greenfield, Mass. The principal feature is that the stand serves both as a support for the bar being worked upon in the machine and also as a stock rack for the bars to be subsequently fed to the machine. It is not unusual in screw machine shops to see the stock kept underneath the machine, supported by the brace between the legs of the machine, or placed on the floor behind or underneath the machine. This method of keeping the stock is not convenient, nor does it look neat or orderly.



A Convenient Bar Support and Stock Rack used in the Wells Bros. Co.'s Shop, Greenfield, Mass.

By using bar supports of the form shown in the illustration, the double purpose of providing a place where the stock can be kept near the machine in the proper manner, and of weighing down the bar support, so as to prevent that nerve-racking noise, due to the shaking of the supports, so commonly heard in screw machine shops, is obtained. The bar support itself is provided with two rollers supporting the stock as shown, and also with two rollers on the top to prevent the stock from chattering in the support. These upper rollers are held in an adjustable holder as shown, and the upper part of the bar guide is provided with a swinging joint, so that it can be swung out of the way by merely loosening the nut on the locking screw in the front, and swinging the bolt forward—a construction familiar to all jig designers. This type of stock rack and bar support has been found very convenient and useful in the shops mentioned.

* * *

The statement that England has a new lighthouse, all the mechanism of which is electrically controlled by the keeper, who lives on shore a mile away, conveys a world of meaning to the engineer. The accomplishment represents in a nutshell, so to speak, the great advances made in distant control of mechanism by electrical agency. Although the spread of the idea may rob the seashore of some of its romance, it surely will mean a great gain in the personal comfort of lighthouse keepers. Isolation of the most dreary sort will no longer be the lot of keepers of the beacons on the sea.

THE USE OF BARIUM CHLORIDE FOR HEATING STEEL FOR HARDENING

As is well known, high-speed steel requires to be heated to a much higher temperature for hardening than does ordinary carbon steel. While a heat of from 1400 to 1600 degrees F. is sufficient for tools made from carbon steel, a heat of from, at least, 1800 to 2200 degrees F. is required in order to satisfactorily harden high-speed steel tools. The ordinary lead bath commonly used for heating carbon steel tools cannot be used at such high temperatures as these, and as it is, in general, unsatisfactory to heat the tools in an oven furnace, owing to the difficulty of correctly determining the hardening temperature when the tools are heated in this way, some heating medium has been sought which could stand high temperatures and in which the pieces to be hardened could be immersed so as to obtain a uniform heat without danger of burning delicate points or cutting edges—a danger which is always present when high-speed steel tools are heated to a high temperature in an open heating furnace. It has been believed that a satisfactory heating medium had been found in barium chloride, and this medium has been, and is still, used to a considerable extent both in this country and abroad; but the results obtained have not been as favorable as was at first expected, and many users of barium chloride have abandoned its use on account of the difficulties met with.

It appears that tools heated for hardening in a crucible containing barium chloride have a soft scale or film of soft metal, perhaps about 0.003 to 0.006 inch deep, all over the surface of the tool. Careful experiments have been made to ascertain as nearly as possible the conditions which contribute to produce such unsatisfactory results. Comparison has been made between tools made from the same material of which some were hardened by heating them in barium chloride and some in an oven furnace. The results of these experiments are recorded in the following.

TABLE SHOWING THE HARDNESS OF HIGH-SPEED STEEL HEATED FOR HARDENING UNDER DIFFERENT CONDITIONS

Heat of Hardening Bath, Degrees F.	Heated in Oven Furnace			Heated in Barium Chloride			
				Left in Bath 10 Minutes		Left in Bath 18 Minutes	
	Time Test Piece was Left in Furnace, Minutes	Degree of Hardness on Scleroscope Scale		Degree of Hardness on Scleroscope Scale		Degree of Hardness in Scleroscope Scale	
		Face of Test Piece	Back of Test Piece	Face of Test Piece	Back of Test Piece	Face of Test Piece	Back of Test Piece
1700*	9½	Soft	Soft	Soft	Soft	Soft	Soft
1800	7	83.5	85	92	91	93	90
1900	6	91	86	93	91	91	92
2000	6	90	86	91	87	92	89
2100	5½	90	91	91	82	87	74
2200	5	93	91	88	82	86	70
2300	4¾†	93	93	73	64	74	62
2400	3½	92	93	65	65	63	57

* At this temperature the steel would not harden, and, therefore, no scleroscope tests were made.
† This sample was burnt and pitted, indicating that it had been kept in the fire too long.

In order to make the tests as simple, and at the same time as conclusive, as possible, pieces of high-speed steel, ½ inch thick, were cut off from one bar of steel. These pieces were hardened by heating some of them in a common oven furnace, and others in barium chloride melted in a graphite crucible placed in a gas furnace. The pieces were heated directly from the room temperature to the hardening temperature, no pre-heating being resorted to. The barium chloride used was chemically pure. The temperatures were recorded by a Bristol pyrometer, and the hardness tests were made on a Shore scleroscope. After heating, the pieces were immersed in a cooling bath consisting of cottonseed oil at a temperature of 100 degrees F. The temper was then drawn in an oil tempering bath at 500 degrees F., a temperature which is not too high for the higher grades of high-speed steel, although it would be excessive for ordinary carbon steel.

When the pieces were heated in the oven furnace, the operator, an experienced hardener of this kind of steel, used his own judgment as to when to remove the piece from the furnace and plunge it into the hardening bath, but the time required for the piece to acquire proper hardening heat was recorded, and is given in the accompanying table. The degree of heat as given, is the heat of the furnace as recorded by the pyrometer, but it is evident that in the case of a piece of steel heated in an oven furnace and removed according to the judgment of the operator, there may be a slight variation between the heat of the furnace and the heat of the piece itself. When the tools are heated in the barium chloride bath, the temperature of the piece and the bath will, of course, be the same, provided the piece is permitted to remain in the bath long enough, which was the case in the experiments described.

After the pieces had been hardened and tempered as described, an amount equal to 0.005 inch was ground off from one side of the pieces, which we will call the face, and an amount of 0.002 inch was ground off from the other side, the back. The surfaces presented to the scleroscope were thus perfectly smooth and uniform, but it should be noted that less of the soft scale, mentioned in the foregoing, was removed from the back of the pieces than from the face. The pieces were now subjected to scleroscopic tests, carefully recorded and repeated several times. The results of these tests are given in the accompanying table, the values given being the average of the several readings.

It should also be mentioned that the pieces heated in the barium chloride at 2100 to 2400 degrees F. were found to be pitted, and small beads of a metallic structure adhered to the pieces. Similar small pieces were found in the bottom of the crucible after all the test pieces had been hardened. This residue was chemically analyzed and was found to consist principally of ferro-tungsten, the analysis showing tungsten, iron and carbon to be present. The carbon content was about 3.3 per cent, tungsten 9.8 per cent, and iron 86.9 per cent.

Several interesting and instructive conclusions with relation to the heating of high-speed steel in an oven furnace, and the action of barium chloride as a heating medium for high-speed steel when hardening, may be drawn from the results recorded in the table. It will be seen that when heating in an oven furnace, the results obtained were almost uniformly better according to the heat at which the pieces were hardened. The higher the heat, the higher the scleroscopic test number. This result is in thorough harmony with the general principle that the higher the heat at which high-speed steel tools are hardened, the better their cutting and "standing up" qualities. When the pieces were heated in barium chloride, however, a result entirely different was obtained, and at temperatures of 2100 to 2400 degrees F., the results were, in general, very unsatisfactory. In the case where the pieces were permitted to remain 18 minutes in the heating bath it will be seen that the face of the piece is almost uniformly softer, the higher the hardening heat. This may be taken to indicate that there still was some of the soft scale left, even after having removed an amount equal to 0.005 inch by grinding. A file test on the surface, however, could not detect this scale, as the surface seemed glass-hard.

The feature which will particularly be noticed in studying the table is that in almost every case the back, where only an amount of 0.002 inch was removed, is softer than the face of the test piece. It is evident that this is due to the fact that the soft scale is deeper than 0.002 inch, and has not been entirely removed by the grinding on the back; whereas the face where an amount of 0.005 inch has been ground off, is practically freed from the soft scale, and hence shows a greater hardness when tested by the scleroscope. The influence of this soft film is especially apparent when the steel is hardened at a temperature of 2100 to 2400 degrees F.

Having ascertained through the tests mentioned that barium chloride had a detrimental influence upon the hardness of high-speed steel heated in it at high heats (2100 to 2400 degrees F.), tests were next made to ascertain the in-

fluence on the cutting qualities of tools hardened either by heating in barium chloride or in an oven furnace. These tests proved conclusively that the tools heated in the barium chloride bath did not stand as high a cutting speed as did those hardened by heating in an oven furnace. The ferro-tungsten found in the bottom of the crucible indicates that, particularly at high heats, some of the tungsten and carbon is removed from the tools into the bath, thus changing the structure of the surface of the tool being heated. When an amount of, say, 0.010 inch is ground off from the cutting edges of tools, the influence of the heating in barium chloride is less noticeable—in fact, sometimes not noticeable at all—but when the tools cannot be ground after hardening, barium chloride is not a heating medium which can be recommended under any circumstances. The change of the structure on the surface of the tool explains why tools heated in barium chloride cannot stand up at as high speeds as those heated in an open fire.

Another disadvantage met with in the use of barium chloride is that the residue of ferro-tungsten found in the bottom of the crucible seems to have a deteriorating influence on the crucible, "eating" through it in a comparatively short space of time. As a general conclusion it may be stated that whenever barium chloride is used as a heating bath, it should never be permitted to reach a temperature of more than 2050 degrees F.

Barium Chloride in the Electric Hardening Furnace

The difficulties met with in the use of barium chloride in a crucible heated in a gas furnace are still further accentuated when using an electric hardening furnace of the type employing a barium chloride bath as the heating medium.

When steel is heated in barium chloride in an electric furnace, the current apparently passes directly through the steel and the pieces are heated not only by the heat imparted to them from the barium chloride bath, but also by the resistance to the electric current passing through the steel itself. That this must be the case is indicated by the fact that tools heated in an electric furnace are brought up to the proper temperature for hardening in approximately one-third of the time which is required for heating them in a barium chloride bath of the same temperature contained in a graphite crucible heated in a gas furnace. As an example it may be mentioned that certain tools which must remain sixteen minutes in a barium chloride bath in a gas furnace can be heated in the bath in the electric furnace in from four to five minutes. The barium chloride bath in an electric furnace does not cool down to the same extent when the pieces to be hardened are immersed, as does the heating bath in the gas furnace. This also indicates that in the electric furnace the heat required for bringing the steel to a hardening temperature is only partly derived directly from the bath in the electric furnace; while all of the heat required must be given out by the barium chloride bath in the crucible in the gas furnace. These facts make it conclusive that there is an entirely different action in the heating of steel immersed in a bath of the same character in an electric furnace than there is when it is immersed in a bath contained in a graphite crucible. The rapidity with which tools to be hardened can be heated in an electric furnace has been quoted as one of its principal advantages, and so it would be were it not for the fact that the surface of the steel deteriorates under the action of the bath, the bath in turn deteriorating under the action of the electric current.

On tools which are ground after hardening, there does not seem to be any difference between the hardness of those which have been hardened in barium chloride in a crucible and those heated in the same medium in the electric furnace. The tools can be run at the same cutting speed and will stand up equally well; but when the tools cannot be ground on the cutting edges as in the case of formed milling cutters, knurls, taps, dies, etc., then the tools heated in the electric furnace are decidedly inferior, especially under certain conditions which will be more thoroughly explained in the following, there being a thin scale or film on the outside which is entirely too soft to possess proper cutting qualities.

Experiments have been undertaken in order to determine, to some extent at least, the causes of the difficulties met with in heating tools in the electric hardening furnace. No conclusive answers can, perhaps, be given to all of the questions which may be asked in this connection, but the results of the experiments give at least a clue to the cause of the trouble, and further experiments might be made which would give still more conclusive results; if methods can be developed which will remedy the defects and make it possible to heat steel in a barium chloride bath in an electric furnace without having to contend with the soft scale on the surface of the steel, the electric furnace would present the best means for heating tools in a bath of high temperature, on account of the decided difference in the time required to bring the tools to the proper hardening temperature.

It has been found that barium chloride when used in a graphite crucible in a gas furnace slightly deteriorates when it has been used for a number of days; but the difference in the results obtained when heating in a bath of entirely new barium chloride and a bath which has been in use for several days, say from six to ten days, is so small that ordinarily no attention need be paid to it. Some users of the barium chloride bath, however, have been in the habit of changing the bath every day, using new barium chloride at all times. This practice is, of course, very expensive, and the advantages gained are too small to warrant the added cost. When barium chloride is used in an electric furnace, however, it deteriorates very rapidly, so that it is practically useless for its purpose after a couple of days' use, and after having been used for a week it may be stated without exaggeration that it is entirely unsuited for any further use. Furthermore, the barium chloride which has been used in a graphite crucible has not retained its almost white color after several days of use, whereas that used in the electric furnace is of a dark gray color. This difference in color is apparently due to the fact that the barium chloride in the electric furnace dissolves the ferro-tungsten which, as previously mentioned, is found in the bottom of the crucible when heating steel in a gas furnace; or possibly the soft iron electrodes are partly dissolved by the barium chloride. The absence of a precipitate in the electric hardening furnace and the gray color of the bath would seem to make it safe to draw this conclusion.

As regards the deterioration of the barium chloride after a few days' use in the electric furnace, several interesting facts have been noted. When steel is hardened after having been heated in a bath consisting of new barium chloride which has been used but one or two days, it seems to acquire a satisfactory hardness, at least as satisfactory as when heated in the same kind of a bath in a crucible heated in a gas furnace. There is, of course, a very thin soft scale, the same as on all tools heated in a barium chloride bath, but this scale is so thin that it cannot be detected with a file test, and hence can be considered of no consequence. After the first day or two, the influence of the barium chloride in conjunction with the electric current on the surface of the steel is considerably augmented; and when the barium chloride has been in use in an electric furnace for about a week, a scale from 0.005 to 0.010 inch deep can be easily detected. A scale of this thickness, of course, makes it impossible to use this means for heating the steel in any case where the cutting edges of the tools cannot be ground off to a sufficient depth to entirely remove the soft outside portion. In the experiments made, the steel was heated to a temperature of about 2100 degrees F.

It was thought that possibly some other factors besides the barium chloride, which had been in use for a number of days, were the cause of the soft scale found on the tools. New barium chloride was, therefore, melted in the furnace, and a new set of tests made. In these tests the results obtained in the first series were entirely duplicated. During the first two days the steel hardened had no perceptible soft film or scale; but when the bath had been in use for about three or four days there was a pronounced soft scale, and after a week the scale had a thickness practically the same as in the first series of tests.

While, as already mentioned, no indications of the presence of ferro-tungsten were found in the bottom of the electric

furnace, a soft, dark gray precipitate was found in the bottom of the electric furnace pot when it had been run with the same bath for about a week. The electrodes of the electric furnace are made of soft iron, and it is likely that the precipitate found originates from the electrodes, as it proved to be a metallic substance similar to iron, and soft enough so that it could be easily filed, which, of course, would not have been the case had the precipitate consisted of ferro-tungsten.

Another interesting fact has also been noticed in connection with the electric furnace. The amount of barium chloride used in a given time is much greater in an electric furnace when the bath is heated to a given temperature, than it is in a gas furnace with a bath at the same temperature. For some reason the electric current passing through the bath seems to make it easier for the molten salt to volatilize.

The makers of electric hardening furnaces may undertake experiments which will give more complete data relating to the action of barium chloride in an electric furnace than those brought forth in the foregoing. At present, however, it seems that barium chloride is unsatisfactory for hardening high-speed steel in an electric furnace, and that it has only a comparatively limited application when used in crucibles and heated in a gas furnace. Some users of barium chloride baths for heating tools for hardening have, as mentioned, entirely abandoned its use after several attempts to make it successful, while others still continue its use for parts and tools on which a thin soft scale is not objectionable and can be removed by grinding.

One important question to be solved is whether the barium chloride after having deteriorated to a point where it is unfit for further use, can be easily and by some cheap method restored to its original condition. In this case the process using barium chloride would still have a considerable field. A satisfactory reason should also be found for the consumption of a greater amount of barium chloride in the electric furnace than in a gas furnace. The added consumption of the barium chloride adds considerably to the expense of running the furnace, although it must be admitted that this added expense is to a large extent compensated for by the rapidity with which tools can be heated in the electric furnace.

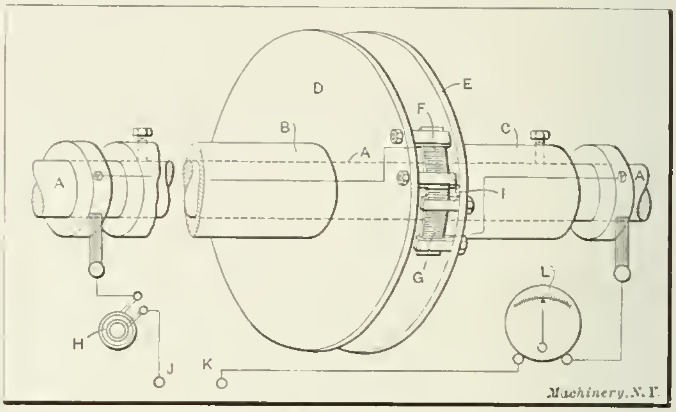
These questions, if they can be answered, probably will be answered by the makers of electric furnaces, and while some defects of the present methods of heating tools in furnaces of the type using barium chloride for a heating bath have been pointed out, it is not intimated that these furnaces cannot be made a success. It must be remembered that they have been on the market a comparatively short time, that the electric hardening furnace is a comparatively recent development, and that when enough time and energy have been spent on the thorough development of this device, it may prove satisfactory. It should also be noted that in speaking of an electric heating furnace, only those furnaces using a barium chloride bath for the heating medium have been referred to. Other electric heating furnaces are made, in which no heating bath is used, but the steel is heated in the air between two electrodes. This type of electric heating furnace is in a class by itself, and while it presents some difficulties, they are of a minor nature and do not come under the head of the present investigation.

It should also be understood that the electric hardening furnace, using a barium chloride bath, has a wide field of usefulness for heating ordinary carbon steel tools for hardening, as in this case hardly any of the objections mentioned in the foregoing, and which apply to the hardening of high-speed steel only, are present, except the increased consumption of barium chloride and potassium chloride, with which latter salt the barium chloride must be mixed when used for heating carbon steel. This mixture is necessary in order to obtain the lower melting temperature of the bath required for carbon steel. The advantages of the electric hardening furnace for carbon steel tools are the greater rapidity with which they can be heated and the clean white surface on the tools thus hardened. The cutting edges of the tools seem to be protected by the coating from the heating bath which falls off when the tools are dipped. When dipping in an oil bath, this coating is not entirely removed, but it always disappears when dipping in hot water or soda solution.

ELECTRICAL TORSIOMETER

An interesting application of the electrical transformer principle is the basis of U. S. patent No. 979,503 (December 27, 1910), issued to Chas. H. Johnson, Dumbarton, Scotland. The device, which is a torsiometer for measuring power, is diagrammatically represented in perspective in the accompanying engraving.

The torsiometer is mounted on a shaft *A*, it being desired to ascertain the power being transmitted by this shaft. On this shaft are two loose sleeves *B* and *C* secured at their outer ends by set-screws, as shown. On the inner ends of these sleeves are two disks *D* and *E*, to which are attached on their inner side the two electro-magnets *F* and *G*, respectively, the pole faces of these coils being in close proximity to each other. The coil *F* is electrically energized from a generator *H*, the circuit being completed by grounding the ends *I* and *J*. This generator may be either alternating or continuous; if it is



Patented Electrical Torsiometer

continuous, suitable means must be provided for breaking the current, thereby making it intermittent. In either case the coil *F* causes an induced current to flow in coil *G*, which may be registered by the meter *L*, the circuit being closed by grounding at *I* and *K*.

As the shaft revolves, its torsion causes the coils *F* and *G* either to draw further apart or nearer together, depending upon the direction of rotation. The current induced in coil *G* by coil *F* depends upon the size of the intervening air gap between the coils, so that for every torque, there will be a different current to be recorded by the instrument *L*. Also, if the generator *H* be connected in some way to the shaft *A*, its current will change with the speed, if properly wound. It can thus be seen that the instrument can be calibrated to not only indicate torque as represented by the torsion of the shaft, but also power, as the speed factor is introduced through the varying current generated at different speeds by the generator *H*.

The patent also covers the use of this principle in other applications, as, for example, the measurement of compression and elongation, and similar uses.

* * *

AUTOMATIC MACHINERY AS A CHEAPENING FORCE

The sewing machine is one of the great labor-saving inventions of the age. Hundreds of thousands are made annually and sold all over the globe. A recent editorial visit to one of the large sewing machine maker's plants demonstrated to what an extent the automatic screw machines have made possible the making of good sewing machines that sell for $15 to $20. In this factory there are three hundred screw machines and twelve hundred operatives. The daily product is five hundred machines. The fact that a sewing machine is produced with the labor of one person for two and four-tenths days is marvelous. With the labor equivalent of two and four-tenths days of an individual, a machine is produced that will sew more stitches in an hour than the hand operator can take in three days of ten hours each, and much better at that. The automatic machine is the chief contributing cause of this development of manufacturing that puts to shame the marvels of Aladdin's wonderful lamp.

ELECTRIC MOTOR SUPPORTS

By J. H. CARVER[*]

When installing a motor to drive a lineshaft, or as an individual drive to some machine, the style, and sometimes the dimensions of its support are among the questions to be decided upon. The following shows the practice of one of the leading manufacturers in regard to supporting motors:

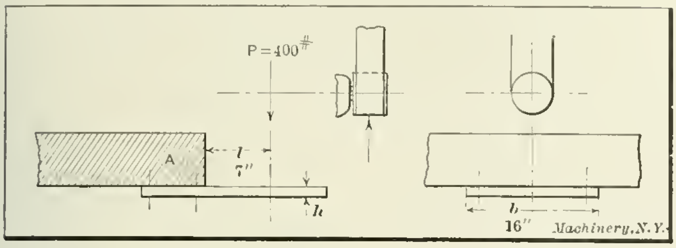


Fig. 1. Plain Sheet-steel Motor Support, Upward Belt Pull

Fig. 1 shows a plain steel plate where A is a machine part, a structural shape or any practical support for the plate. The dimensions of the motor feet and bolt centers, of course, determine the lateral dimension, and its thickness depends on

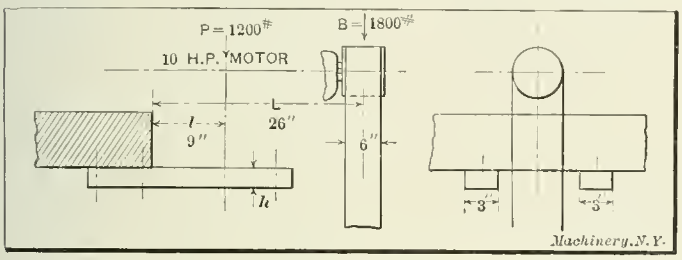


Fig. 2. Motor Support made of Machine-steel Bars, as Belt Pull is downward

the weight of the motor and the direction and size of belt. If the belt pull is upward as shown, the weight of motor need only be considered, as the belt tension lessens the load on the plate. With this condition the thickness of plate is found by the beam formula $M = SZ$ where $M =$ bending moment,

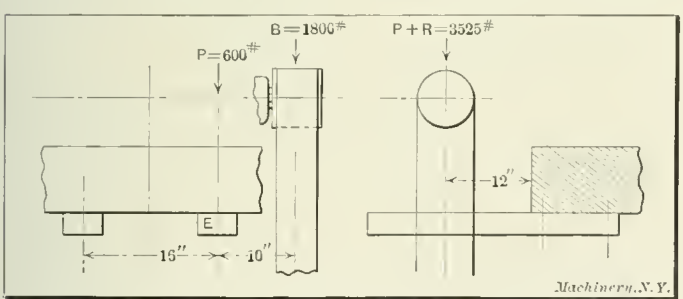


Fig 3. Motor Support of Machine-steel Bars, with Right-angle Drive

$S =$ unit stress, and $Z =$ section modulus. Here the beam is cantilever, and $M = Pl = SZ$.

$$Z = \frac{b\,h^2}{6}$$

for a rectangular section. Then

$$P\,l = \frac{S\,b\,h^2}{6}$$

or

$$h^2 = \frac{6\,P\,l}{S\,b}$$

If $P = 400$ pounds, $l = 7$ inches, $S = 8000$ pounds, and $b = 16$ inches, then

$$h^2 = \frac{6 \times 400 \times 7}{8000 \times 16} = \frac{21}{160} \text{ and } h = \text{say } \tfrac{3}{8} \text{ inch}$$

Fig. 2 shows the conditions with belt pull considered. If the belt pull is at an angle from the horizontal, tending to pull downward, it may be considered practically a downward pull and its value is the area of the two thicknesses of belt multiplied by the working stress on the belt, for which a good average is 400 pounds per square inch; this considers the tensions to be alike on both sides. For heavy motors, plates must be comparatively thick and are difficult to machine to size; so for this reason bars of machine steel are preferred. This gives as in Fig. 2 a cantilever with two concentrated loads. The pull of the 3/8-inch belt is $2 \times 6 \times \frac{3}{8} \times 400 = 1800$ pounds $= B$. As before $M = SZ$ or $BL + Pl = SZ$.

$$Z = \frac{b\,h^2}{6} \text{ and } B\,L + P\,l = \frac{S\,b\,h^2}{6}$$

or

$$h^2 = \frac{6\,(B\,L + P\,l)}{S\,b}$$

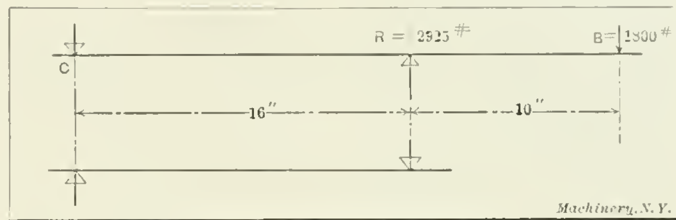


Fig. 4. Representation of Conditions existing in Fig. 3.

where $b = 6$ inches for both bars.

Then

$$h^2 = \frac{(1800 \times 26) + (1200 \times 9)}{8000} = \frac{576}{80}$$

say $2\tfrac{1}{2}$ inches as the thickness of each supporting bar.

Fig. 3 shows the same motor on bars as in the last case,

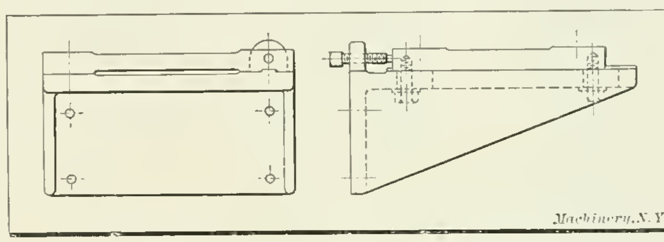


Fig. 5. Cast-iron Cantilever Bracket with Adjustable Sliding Plate

but with the motor placed at right angles. The bar E will receive most of the load as found by the method of moments shown in Fig. 4. Taking moments about C,

$$16R = 26 \times 1800 \text{ or } R = \frac{26 \times 1800}{16} = 2925 \text{ pounds}$$

and this added to half the weight of the motor gives the condition shown in Fig. 3 of a cantilever with load $P + R$ at a distance 12 inches from the support.

Fig. 5 shows an ordinary cast-iron cantilever bracket which is frequently used, the channel section shown having proved

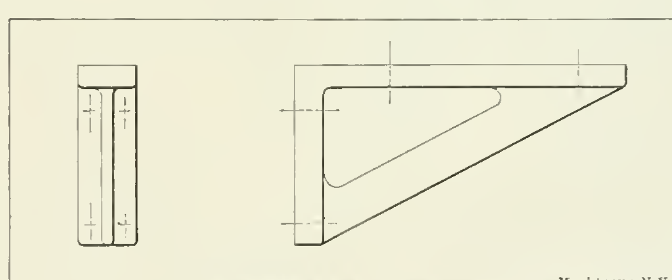


Fig. 6. Plain Cast-iron Bracket, to be used in Pairs, with or without Sliding Plate

to be the cheapest and strongest. The sliding plate takes care of belt tension and is provided with a tongue on one side only to preserve alignment, and has tapped holes to receive bolts through the bracket. The motor bolts are, of course, tapped into the sliding plate only. If provision for belt tension is not needed, the plate may be done away with, or it may be omitted and belt tension still cared for in the casting by machining slots in the bracket for through motor bolts.

Fig. 6 shows a bracket which may be used in pairs—alone or in combination with a sliding plate for belt tension adjustment. They have the advantage of being light and one pattern does for both castings.

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Fig. 7 shows angles used on a wooden or structural steel column. Suppose the motor is 3 horsepower, weighs 600 pounds and with its center of gravity 20 inches from the support. By this construction there are two angles used as cantilevers, each with a load of 300 pounds, 20 inches from

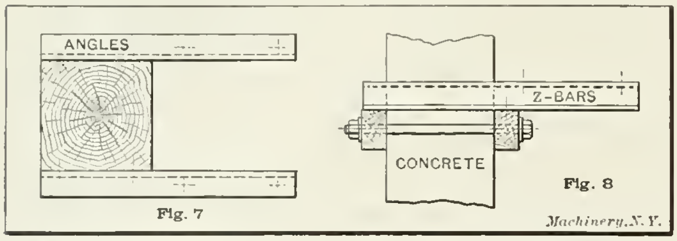


Fig. 7. Angle Support for Attaching to Wooden or Structural Steel Column. Fig. 8. Z-bar Support for Concrete Columns where Bolts are not Incorporated in Original Column

the support. First try 3-inch angles to suit the dimensions of motor feet. In a handbook can be found the value of $\frac{I}{e}$ for the lightest angle. This has equal legs ¼-inch thick, weighing 4.9 pounds per foot. Then

$$P\,l = \frac{S\,I}{e} \text{ or } S = \frac{P\,l\,e}{I}$$

where $S =$ unit working stress, which may be as much as

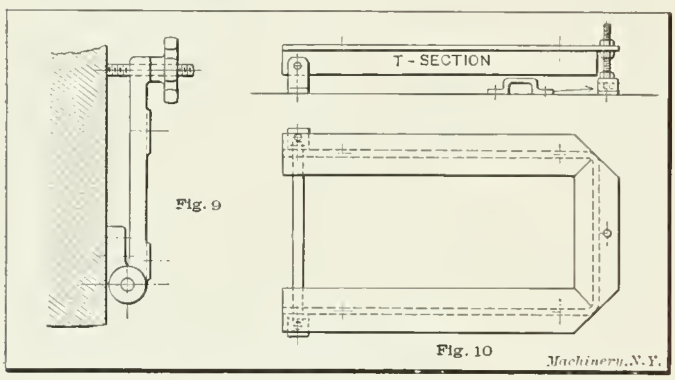


Fig. 9. Cast-iron Swinging Bracket for Attaching to Side of a Machine. Fig. 10 Swinging Bracket constructed of Structural Steel T-Sections

10,000 pounds per square inch on this sort of work, $P =$ load in pounds, $=$ moment of inertia, and $e =$ distance from neutral axis to outermost fiber.

If $P = 300$ pounds, $l = 20$ inches, $I = 1.24$ and $e = 0.84$, then

$$S = \frac{300 \times 20 \times 0.84}{1.24} = \text{say } 4070 \text{ pounds, which is a safe}$$

working stress.

Fig. 8 shows an arrangement of a support for light motors,

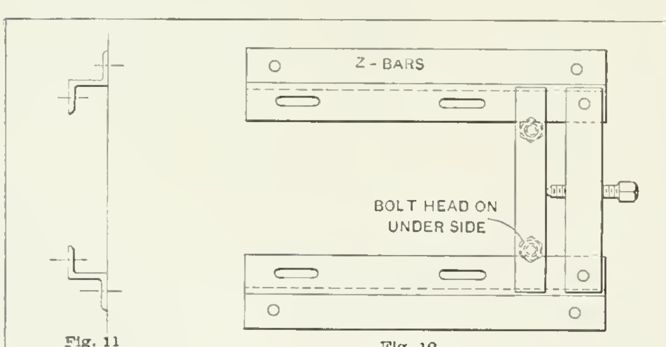


Fig. 11. Z-bar Method of Supporting Motor above the Floor. Fig. 12. Z-bar Method of Support similar to that in Fig. 11, only with the Adjustable Feature

say not over 3 horsepower on concrete columns, where bolts were not originally provided for the Z-bars.

Fig. 9 shows an arrangement for use on sides of machines with provision for adjusting belt tension.

Fig. 10 shows a swinging bracket of T sections of structural steel, bent as shown. Two triangular pieces must be cut from one leg to admit of bending. This bracket can be used to good advantage on any machine where a direct drive from floor to machine can be had. It of course takes care of belt tension. The U-shaped piece shown on the floor can be made from two short Z-bars, with lag screws to hold them down.

Fig. 11 shows a cheap method of keeping a motor off the floor, and permits of that part under the motor being kept clean. Two Z-bars whose sizes are determined by dimensions of motor feet are held by lag screws or other fastenings accord-

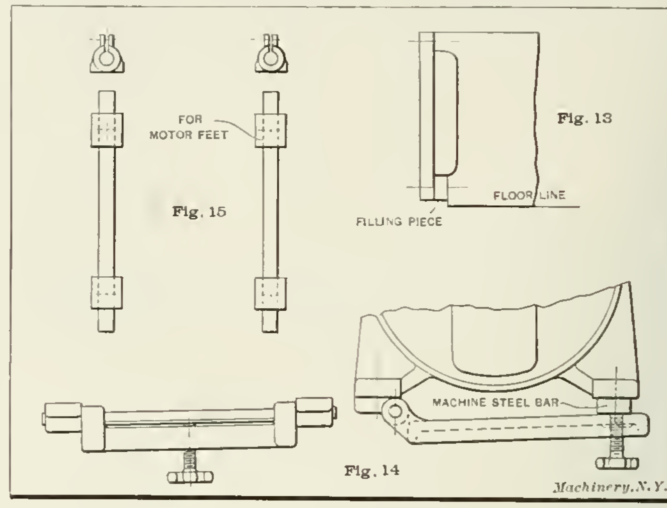


Fig. 13. Method of Bolting Motor to a Machine Tool. Fig. 14. Swinging Bracket for Use where there is Room for Handwheel. Fig. 15. Pipe Motor Support

ing to the nature of the floor material. Slots can be machined in them to take care of belt tension.

Fig. 12 shows the same arrangement with more attention given to adjustment, the Z-bars having two machine-steel bars on top, one bolted and the other movable, with adjusting screw as shown. The movable bar has two bolts screwed in

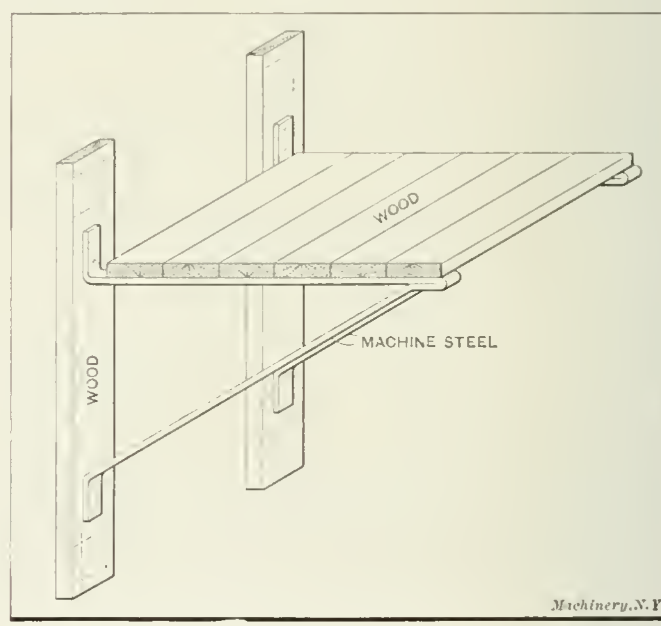


Fig. 16. Bracket for Brick Wall made of Bar Machine Steel and Wood, for Heavy Motors

from the under side with a snug fit in the threads, the bar and bolt heads running loose on the leg of the Z-bar. The bolts merely keep the sliding bar from falling off.

Fig. 13 shows a method of bolting a motor to the back of a lathe, or other machine tool, sometimes used when placing a motor drive on a belt-driven machine. Two bars of machine steel are used with the filling piece shown, if necessary.

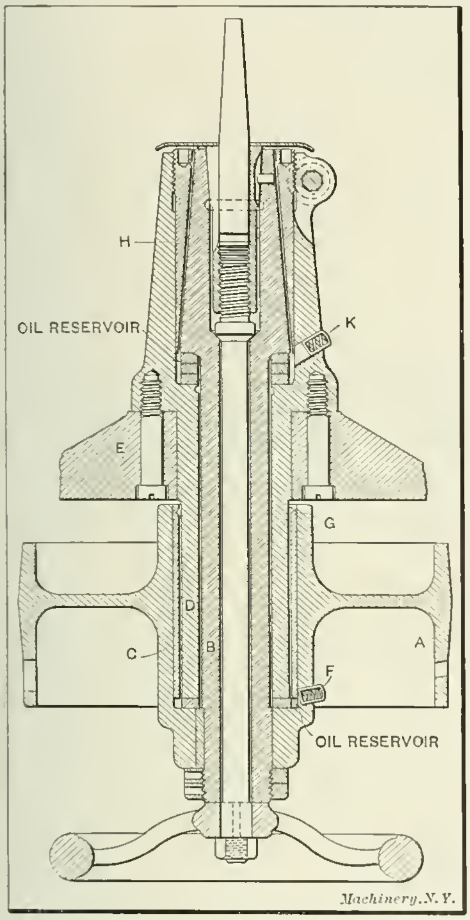
Fig. 14 shows an arrangement where room can be had for a small hand adjustment wheel. The bar of machine steel is bolted to two of the motor feet, and must be stiff enough to resist half the weight of the motor when belt pull is not considered.

Fig. 15 shows a method where pipes can be used on such places, as between machine legs, etc. One pattern does for the four castings which are cored a little above pipe size. They then require no machining and are held by set-screws, the castings being split.

Fig. 16 shows the construction of a brick wall bracket used for heavy motors. It is made up of bent machine steel diagonals and a wooden platform.

INTERESTING VERTICAL SPINDLE CONSTRUCTION

A machine made by the Billings & Spencer Co., of Hartford, Conn., and intended especially for milling the cutting edges of trimming and punching dies, was illustrated in the November, 1908, issue of MACHINERY. During a recent visit to the plant of this company, the writer's attention was called to the interesting spindle construction used on this machine, this construction being illustrated in the accompanying engraving. The difficulty met with in the design was that on account of the vertical position of the spindle, it was difficult to properly oil the bearings, the oil having a natural tendency to flow downward. By the arrangement adopted, this difficulty has been overcome, and a satisfactory means for oiling the vertical spindle bearings has been obtained.



Vertical Spindle Construction with Novel Features

In the illustration, *A* is the driving pulley which is keyed to spindle *B*. The driving pulley is provided with a bronze bushing *C*, and revolves upon the stationary sleeve *D*, which is fastened to the frame *E* of the machine. Clearance is provided between spindle *B* and sleeve *D*. The oil for lubrication between bushing *C* and sleeve *D* is introduced at *F*, where it enters an annular oil reservoir. A spiral groove is cut on the sleeve, the direction of the spiral being the same as the direction in which the pulley revolves, so that the oil is practically pumped up along the surface of the sleeve. At the upper end of the bushing a small half-circular groove is cut, as indicated at *G*. This groove acts as an upper reservoir for the oil, from which it has a constant tendency to descend by gravity. The two forces acting upon the oil—the one due to the pumping effect along the spiral groove upward, and the tendency to flow by gravity downward—seem to balance each other, so that a very satisfactory lubrication of the bearing has been obtained without excessive use of oil.

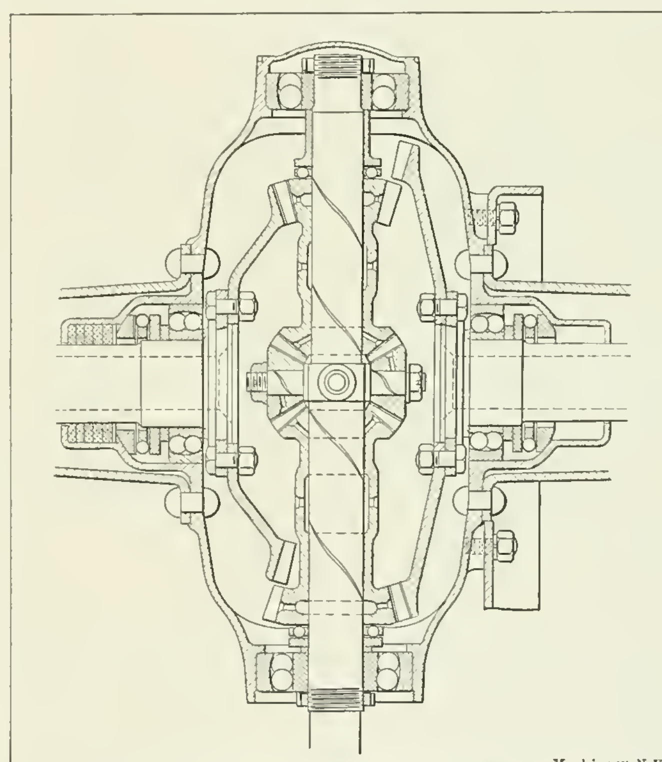
The lubrication of the bearing between the upper tapered end of the spindle *B* and the bronze spindle bushing *H* is accomplished in the same manner. The oil is introduced at *K*, and enters the reservoir; from here it rises by means of a spiral groove cut on the spindle, until it reaches the small annular groove at the top. It is, of course, necessary to remember that in constructions of this kind satisfactory results can be obtained only if the spindle rotates constantly in the same direction, because the spiral groove must be right-hand, for example, when the spindle rotates in a right-hand direction and *vice versa*. If the direction of the spiral of the oil groove were opposite to that of the direction of rotation of the spindle, the tendency would be to force the oil down instead of up, and the object sought would be entirely defeated. It is possible that in the case of a reversible drive, one right-hand and one left-hand spiral groove would prove satisfactory, but this arrangement has not been actually tried. The construction is an interesting one and may be found useful in many cases where difficulty has been experienced in oiling vertical spindle bearings.

* * *

AUTOMOBILE DIFFERENTIAL ON THE PROPELLER SHAFT

The illustration shows a departure in automobile transmission gear design brought out in the La Buire automobile (Lyons, France) a year ago that is of considerable general interest to machine designers, because of the principle developed. The differential mechanism is placed in the propeller shaft where it runs at a relatively higher speed than when mounted on the rear axle in the usual manner. The unit pressure on the differential gear teeth is proportionally reduced, making a lighter and more durable construction possible. The improvement has the disadvantage of making two large bevel gears on the axle and two bevel pinions on the propeller shaft necessary. The following description is taken from *The Car*.

"The propeller shaft, instead of terminating as usual with the small driving bevel pinion, is extended right through the differential case from end to end. Double ball races support the shaft at both extremities. In the center of the shaft, and therefore of the differential case, are four trunnions, which are made in one piece with the shaft. These trunnions carry four beveled satellites which transmit the drive to double



La Buire Automobile Differential on the Propeller Shaft

driving bevels, the latter being connected by sleeves running loose on the shaft. From the double driving bevels power is transmitted to two crown wheels, which are bolted onto the inner ends of each of the live axles. One of the double driving bevels and one crown wheel are smaller than the other bevel and crown wheel but are of the same ratio, so that each live axle is propelled at exactly the same speed."

* * *

The competition in the manufacture of small gas engines is keen and the need of specialized knowledge of machine tools and manufacturing methods is perhaps as great as in any other line, but "Fools rush in where angels fear to tread." A concern in the Middle West, making farm machinery recently began the building of gas engines. The manager canvassed some of the machine tool builders for certain machines required in his shop, and in the interview with one it developed that he had never seen or even heard of a micrometer!

HOLLOW SHAFTS

By E. HAMMARSTROM*

In the following article is given a simple method for finding the dimensions of a hollow shaft which can be substituted for a solid shaft of equal strength to resist bending or torsion.

Let $D_1 =$ diameter of solid shaft,
$D =$ outside diameter of hollow shaft,
$d =$ inside diameter of hollow shaft,

$$t = \frac{D - d}{2} = \text{thickness of metal of hollow shaft,}$$

$$k = \frac{d}{D} = \text{ratio of diameters of hollow shaft.}$$

As the hollow shaft is to have the same strength to resist bending as the solid shaft, the moment of resistance of both must be equal. Hence:

$$\frac{\pi (D^4 - d^4)}{32\, D} = \frac{\pi D_1^3}{32}$$

from which

$$D^3 - \frac{d^4}{D} = D_1^3 \qquad (1)$$

If $k\, D$ is substituted for d in Equation (1), we have:

$$D^3 - D^3 k^4 = D_1^3$$

from which

$$D = D_1 \sqrt[3]{\frac{1}{1 - k^4}}$$

and

$$\frac{D}{D_1} = \sqrt[3]{\frac{1}{1 - k^4}} \qquad (2)$$

In a similar manner, by substituting $\frac{d}{k}$ for D in Equation (1), we obtain:

$$\frac{d}{D_1} = k \sqrt[3]{\frac{1}{1 - k^4}} \qquad (3)$$

Further, as $t = \frac{D - d}{2}$, we get by substitution and simplification of the expressions:

$$t = \frac{D_1}{2} (1 - k) \sqrt[3]{\frac{1}{1 - k^4}}$$

or

$$\frac{t}{D_1} = \frac{1 - k}{2} \sqrt[3]{\frac{1}{1 - k^4}} \qquad (4)$$

In the accompanying table the values of the factors containing k in Equations (2), (3), and (4) are calculated for certain values of k. The bottom line of the table gives the weight of the hollow shaft in per cent of that of the solid.

It is evident that Equation (1) would be the same, if it were derived under the assumption that the hollow shaft had the same torsional strength as the solid one, instead of having the same strength against bending, as assumed. The table will therefore hold true for shafts subjected to bending or torsion or both.

Assume, as an example, that a solid shaft 3 inches in diameter is to be replaced by a hollow shaft, ratio k being 0.5. Then, by inserting the value found from the table in Equation (2) we have:

$$\frac{D}{D_1} = 1.0216 \text{ and } D = 3 \times 1.0216 = 3.065 \text{ inches,}$$

$d = 0.5\, D = 1.532$ inch.

* * *

In a series of tests conducted by Italian engineers it has been found that bearing bronzes containing a high percentage of tin are too hard for bearing purposes, and that only such bronzes as contain 10 per cent or less of tin are suitable.

* Address: 85 Third Place, Brooklyn, N. Y.

PRESSURE VS. LOAD

The boy who figured that he could lift himself into the clouds by exhausting the air from a small piece of gas pipe capped at the ends, because air pressure is fifteen pounds to the square inch, may have been "father to the man" in the following true story:

Mr. Jenks, the hustling "super" of Rann & Co., was sitting at his desk with a pad and pencil, lost in figures and thought. Suddenly he threw down the pencil, pulled his straw hat more firmly onto his head, chewed his cigar savagely, spat on the floor, and nervously ejaculated:

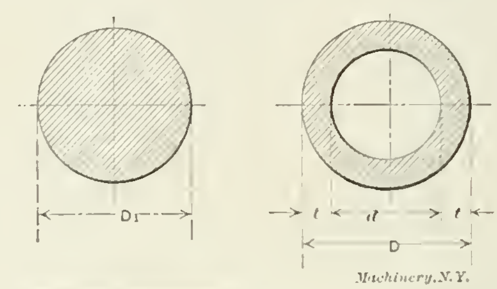
"Gee, that was a narrow escape!"

"What was a narrow escape?" said Rann, just then opening the door of Jenks' little office.

"Why, that hydraulic press you know is coming next week and we were going to put it on the third floor."

"Yes, what of that?"

TABLE OF FACTORS USED IN EQUATIONS FOR FINDING DIMENSIONS OF HOLLOW SHAFTS TO REPLACE SOLID SHAFTS



Expressions from Equations (2), (3) and (4)	Ratio k = d : D									
	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
$\sqrt[3]{\frac{1}{1 - k^4}}$	1.0216	1.0324	1.0473	1.0677	1.0959	1.1353	1.1920	1.2790	1.4273	1.7534
$k \sqrt[3]{\frac{1}{1 - k^4}}$	0.5108	0.5678	0.6284	0.6940	0.7671	0.8514	0.9514	1.0871	1.2846	1.6658
$\frac{1 - k}{2} \sqrt[3]{\frac{1}{1 - k^4}}$	0.2574	0.2323	0.2095	0.1869	0.1644	0.1419	0.1192	0.0959	0.0711	0.0438
Weight of Hollow Shaft*..	78.3	74.35	70.2	65.8	61.3	56.4	51.6	45.1	38.7	29.9

* Weight of hollow shaft is given in per cent of weight of solid shaft.

"Well, I've just been figuring up the floor load and ——"

"That floor will carry 200 pounds to the square foot safely and that two-ton press will stand in a space six by eight feet," said Rann. "I don't see what you're fooling away time on that for."

"Yes, I know what the floor will carry and the weight of the press all right, *but have you thought of the load when the press is in use?*" Jenks shot out triumphantly. "Why, man, this catalogue says that press can exert a pressure of fifty tons! Fifty tons—think of that! It would be just like some fool kid to pump it up to the limit some day and send us all crashing down into the cellar. I tell you, it ain't safe. We've got to put that press down in the basement on solid earth where nothing can give way. It's lucky I thought of that in time!"

* * *

ALUMINUM ALLOYS

The following aluminum alloys for making aluminum crank-case castings for small gasoline engines are recommended by *The Foundry:* 1. Copper, 5 pounds, aluminum, 95 pounds; 2. Copper, 2 pounds, zinc, 15 pounds, aluminum, 76 pounds; 3. Copper, 3 pounds, zinc, 25 pounds, aluminum, 72 pounds; 4. Scrap cast aluminum, 99 pounds, magnesium, 1 pound, zinc-chloride, 1 pound. In the last case the aluminum is first melted and the magnesium added. Then the chloride is thrown on the top and the mass is stirred gently and poured at a dull red heat. The various alloys are recommended in the order given.

EXTERNAL CUTTING TOOLS—4

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

This installment contains information on proportions for hollow mills of the solid type, and feeds and speeds for external cutting tools in general, such as box-tools, hollow mills and swing tools.

Hollow Mills

For roughing down work, especially brass work, a hollow mill is found to give very satisfactory results. Two hollow mills of the solid type are shown in Fig. 18. These hollow mills are ground for steel work, a rake being given to the cutting edge. This is found to give better results on steel work than having the cutting face of the blades parallel with the center line.

The proportions for hollow mills and the cutting angles for various materials are given in Table 1. The sizes from 0.065 to 0.462 inch given in column *A* are worked out for roughing mills for the A. S. M. E. standard and special screw sizes, an allowance of from 0.005 to 0.015 inch being made for finishing. Of course, these mills can be made to cut smaller

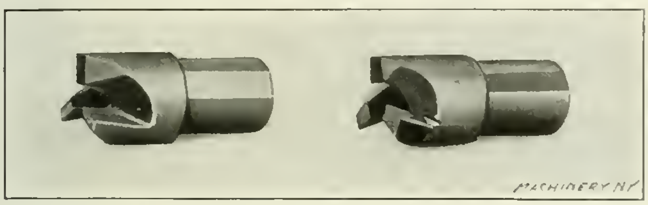


Fig. 18. Hollow Mills of the Solid-blade Type

by using a collar on them. In making these hollow mills, they should be reamed out tapering from the rear, so that the blades will clear and not drag on the work. A taper of from about 1/8 to 3/16 inch per foot is generally satisfactory. For steel work the cutting edge is set about 1/10 of the diameter ahead of the center, but for brass work it should be on the center line. These distances are given in column *F*. Hollow mills for cutting steel are, as a rule, made either from steel containing a very high percentage of carbon or high-speed steel. When high speeds are used, high-speed steel is preferable.

A hollow mill of the inserted-blade type is shown in Fig. 19. This is also the product of the Brown & Sharpe Mfg. Co.

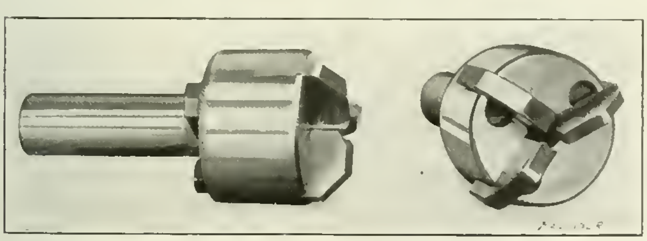


Fig. 19. Hollow Mill of the Inserted-blade Type

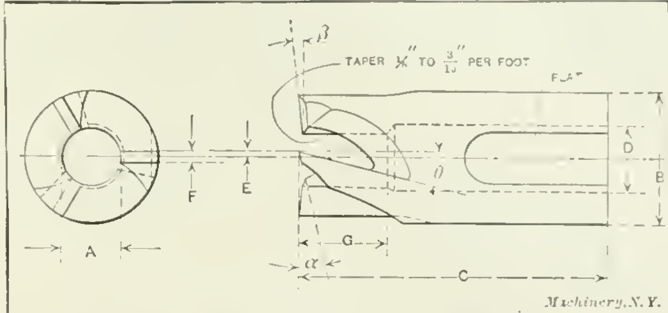
and is used extensively for screw machine work, its use being mainly for hand screw machines; but it is sometimes also applied to the automatics. This mill is provided with three cutting blades, which are held in the body of the holder by clamp-bolts fitting in the beveled slots cut in the blades. The clamp-bolts are held by means of nuts located at the rear of the body. The blades are sharpened by grinding on the ends, and can be adjusted for diameter by simply releasing the nuts, and moving the blades out or in by hand.

Hollow Mill Holders

When hollow mills of the solid type are used it is necessary to have a holder which can be set so that the mill will cut concentric. A holder which is used for this purpose, and which gives satisfactory results, is the standard floating holder made by the Brown & Sharpe Mfg. Co. This holder has been described in previous articles, so it will not be necessary to give a description of it here. In setting a hollow mill, the screws holding the floating part of the holder to the body proper are released and the mill is set concentric. It is desirable to turn a bevel on the end of the work to facilitate the setting of the hollow mill, as described in a previous article.

* Associate Editor of MACHINERY.

TABLE I. CUTTING ANGLES AND PROPORTIONS FOR HOLLOW MILLS



Cutting Angles for Hollow Mills

Angle	Brass Rod	Machine Steel	Tool Steel
α	8 degrees	15 degrees	10 degrees
β	8 degrees	5 degrees	3 degrees
θ	....	15 degrees	10 degrees

Proportions for Hollow Mills

A	B	C	D	E	F	G
0.065	1/2	1 1/4	1/4	0.007	0.020	1/4
0.078	1/2	1 1/4	1/4	0.008	0.020	1/4
0.091	1/2	1 1/4	1/4	0.009	0.025	1/4
0.105	1/2	1 1/4	1/4	0.011	0.025	1/4
0.120	1/2	1 1/4	1/4	0.012	0.025	1/4
0.135	1/2	1 1/4	1/4	0.014	0.030	1/4
0.148	1/2	1 1/4	1/4	0.015	0.030	1/4
0.161	1/2	1 1/4	1/4	0.016	0.035	5/16
0.174	1/2	1 1/4	1/4	0.017	0.035	5/16
0.187	1/2	1 1/4	1/4	0.019	0.040	5/16
0.200	5/8	1 1/2	3/8	0.020	0.040	5/16
0.226	5/8	1 1/2	3/8	0.023	0.045	5/16
0.252	5/8	1 1/2	3/8	0.025	0.045	5/16
0.280	5/8	1 1/2	3/8	0.028	0.050	3/8
0.305	5/8	1 1/2	3/8	0.031	0.060	3/8
0.332	5/8	1 1/2	3/8	0.033	0.065	3/8
0.358	5/8	1 1/2	3/8	0.036	0.070	7/16
0.385	1	2 1/4	3/4	0.039	0.075	7/16
0.410	1	2 1/4	3/4	0.041	0.080	7/16
0.436	1	2 1/4	3/4	0.044	0.085	1/2
0.462	1	2 1/4	3/4	0.046	0.090	1/2
0.480	1	2 1/4	3/4	0.048	0.095	5/8
0.515	1	2 1/4	3/4	0.052	0.100	5/8
0.578	1	2 1/4	3/4	0.058	0.105	3/4
0.640	1	2 1/4	3/4	0.064	0.110	3/4
0.703	1	2 1/4	13/16	0.070	0.115	7/8
0.765	1	2 1/4	13/16	0.077	0.120	7/8

TABLE II. FEEDS FOR ROUGHING BOX-TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

1/32-inch Chip				1/8-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/16	0.0020	0.0015	0.0010	3/8	0.0045	0.0030	0.0020
1/8	0.0030	0.0020	0.0015	7/16	0.0050	0.0035	0.0025
3/16	0.0040	0.0030	0.0020	1/2	0.0060	0.0040	0.0030
1/4	0.0050	0.0040	0.0025	9/16	0.0070	0.0050	0.0035
5/16	0.0060	0.0045	0.0030	5/8	0.0085	0.0060	0.0040
3/8	0.0075	0.0050	0.0035	3/4	0.0100	0.0070	0.0050
1/16-inch Chip				3/16-inch Chip			
1/4	0.0045	0.0030	0.0020	1/2	0.0040	0.0025	0.0015
5/16	0.0060	0.0049	0.0925	9/16	0.0045	0.0030	0.0018
3/8	0.0090	0.0060	0.0030	5/8	0.0050	0.0032	0.0020
7/16	0.0105	0.0070	0.0040	11/16	0.0055	0.0035	0.0023
1/2	0.0120	0.0080	0.0050	3/4	0.0060	0.0040	0.0025
9/16	0.0135	0.0090	0.0060	13/16	0.0070	0.0045	0.0028
5/8	0.0150	0.0100	0.0075	7/8	0.0075	0.0050	0.0030

Speeds for External Cutting Tools

The following speeds are for external cutting tools such as box-tool cutters, hollow mills, etc., made from ordinary carbon and high-speed steel, but do not apply to circular cut-off or form tools.

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM ORDINARY CARBON STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	170 — 180
Gun screw iron	70 — 80
Norway iron and machine steel	60 — 70
Drill rod and tool steel	35 — 40

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM HIGH-SPEED STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	250 — 270
Gun screw iron	100 — 120
Norway iron and machine steel	90 — 100
Drill rod and tool steel	50 — 60

The speeds given for high-speed steel are for tools made from Novo superior or other similar steels. Where a high-carbon steel, such as Styrian steel, is used, a slightly decreased speed should be employed.

Feeds for Roughing and Finishing Box-tools

In Table II are given feeds for roughing box-tools in which the cutters are made from high-speed and carbon steel, and in Table III are given feeds for finishing box-tools in which the cutters are made from high-speed and carbon steel. These feeds will give satisfactory results where proper discretion is used. The feeds for roughing, of course, could in some cases be increased if conditions would permit; but as a rule the feeds given are sufficiently high.

TABLE III. FEEDS FOR FINISHING BOX-TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

0.005-inch Chip				0.020-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/32	0.0020	0.0020	0.0018	3/8	0.0040	0.0040	0.0025
1/16	0.0030	0.0030	0.0020	7/16	0.0045	0.0045	0.0030
3/32	0.0045	0.0045	0.0025	1/2	0.0050	0.0050	0.0035
1/8	0.0060	0.0060	0.0030	9/16	0.0060	0.0060	0.0035
3/16	0.0070	0.0070	0.0040	5/8	0.0070	0.0070	0.0040
1/4	0.0080	0.0080	0.0050	11/16	0.0075	0.0075	0.0045
5/16	0.0100	0.0100	0.0060	3/4	0.0080	0.0080	0.0050
3/8	0.0120	0.0120	0.0080	13/16	0.0090	0.0090	0.0050
0.010-inch Chip				**0.030-inch Chip**			
1/4	0.0070	0.0070	0.0035	1/2	0.0040	0.0040	0.0020
5/16	0.0080	0.0080	0.0040	9/16	0.0045	0.0045	0.0022
3/8	0.0085	0.0085	0.0045	5/8	0.0050	0.0050	0.0025
7/16	0.0090	0.0090	0.0050	11/16	0.0055	0.0055	0.0028
1/2	0.0095	0.0095	0.0055	3/4	0.0060	0.0060	0.0030
9/16	0.0100	0.0100	0.0060	13/16	0.0070	0.0070	0.0035
5/8	0.0100	0.0100	0.0065	7/8	0.0080	0.0080	0.0040

Feeds for Turning with Swing Tools

Owing to the fact that swing tools are not so rigidly constructed as the ordinary box-tools, it has been found advisable to decrease the feeds slightly below those used for box-tools. Feeds which have been found satisfactory for straight turning with swing tools are given in Table IV. These feeds are about 30 per cent less than those used for box-tools.

Feeds for Taper Turning

For taper or irregular turning with swing tools, the greatest depth of the chip should be considered, and the same feed used as that given in Table IV. For taper turning with the Brown & Sharpe standard taper turning tools, the greatest depth should be considered, and the same feed used as given in Tables II and III for roughing and finishing cuts, respectively. Where the taper is greater than 1/4 inch per foot, it is advisable to use two taper turning tools, one for roughing, and the other for finishing.

Feeds for Hollow Mills

In Table V are given feeds for hollow mills which are made from ordinary carbon or high-speed steel. These feeds apply both to hollow mills of the solid and inserted-blade types, and are for taking a chip of from 1/16 inch to 1/4 inch deep. The feeds given are not excessively high, and in some cases could be increased, especially when the work is not exceedingly long, and where the tool would not be on the work for a considerable time.

TABLE IV. FEEDS FOR TURNING WITH SWING TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

1/32-inch Chip				1/8-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/16	0.0010	0.0008	0.0005	3/8	0.0020	0.0015	0.0010
1/8	0.0015	0.0010	0.0008	7/16	0.0025	0.0018	0.0015
3/16	0.0020	0.0015	0.0010	1/2	0.0030	0.0020	0.0018
1/4	0.0030	0.0020	0.0015	9/16	0.0035	0.0025	0.0020
5/16	0.0035	0.0025	0.0018	5/8	0.0038	0.0028	0.0022
3/8	0.0040	0.0030	0.0020	11/16	0.0042	0.0030	0.0025
1/16-inch Chip				**3/16-inch Chip**			
1/4	0.0025	0.0020	0.0010	1/2	0.0020	0.0010	0.0008
5/16	0.0030	0.0022	0.0013	9/16	0.0025	0.0013	0.0010
3/8	0.0035	0.0025	0.0015	5/8	0.0028	0.0015	0.0012
7/16	0.0040	0.0028	0.0018	11/16	0.0030	0.0018	0.0015
1/2	0.0045	0.0030	0.0020	3/4	0.0035	0.0020	0.0018
9/16	0.0050	0.0032	0.0025	13/16	0.0038	0.0022	0.0020
5/8	0.0060	0.0035	0.0028	7/8	0.0040	0.0025	0.0020

TABLE V. FEEDS FOR HOLLOW MILLS MADE FROM HIGH-SPEED AND CARBON STEEL

1/16-inch Chip				3/16-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
3/16	0.0045	0.0030	0.0015	1/2	0.0060	0.0045	0.0020
1/4	0.0050	0.0040	0.0018	9/16	0.0065	0.0050	0.0023
5/16	0.0055	0.0045	0.0020	5/8	0.0070	0.0055	0.0025
3/8	0.0060	0.0050	0.0025	11/16	0.0080	0.0060	0.0030
7/16	0.0070	0.0050	0.0028	3/4	0.0090	0.0065	0.0035
1/2	0.0080	0.0060	0.0030	13/16	0.0100	0.0070	0.0040
1/8-inch Chip				**1/4-inch Chip**			
3/8	0.0070	0.0050	0.0030	5/8	0.0050	0.0035	0.0015
7/16	0.0075	0.0055	0.0035	11/16	0.0055	0.0040	0.0018
1/2	0.0080	0.0060	0.0040	3/4	0.0060	0.0050	0.0020
9/16	0.0090	0.0065	0.0050	13/16	0.0070	0.0055	0.0025
5/8	0.0110	0.0075	0.0060	7/8	0.0080	0.0060	0.0030
11/16	0.0130	0.0090	0.0070	..	......	......	......
3/4	0.0150	0.0110	0.0080	..	......	......	......

* * *

Builders of machine tools are often requested to build special machinery to suit the peculiar needs of manufacturers, and most concerns do more or less designing and building of machinery out of their regular line. They are practically unanimous in the opinion that it does not pay, and more reluctance is manifested to engaging in any work that interferes with the routine of manufacturing than in the past. In the first place, the maker can hardly ever get a price that yields a reasonable profit on the actual work and pays for the designing. In the second place, the inventive genius of the concern is more profitably employed in designing jigs, fixtures and special machines for reducing the cost and facilitating the output of the plant.

MAKING A KNIFE-EDGE SQUARE

By C. H. WILCOX*

The easiest way to make a knife-edge square is to get an ordinary hardened square and remove the blade (which is soldered in place), grind it to a knife-edge on both sides, lap it true, then resolder the blade in the stock. The making of a knife-edge square by the method to be described requires a precision test-block, a lapping block, a true surface-plate, and a grinding arbor.

The precision block may be made from a piece of round steel by grinding and lapping it perfectly cylindrical and squaring the ends. The block is first bored for an arbor, as illustrated in Fig. 1, and the ends are counterbored to provide a clearance space for the emery wheel when grinding them square. The block is hardened and then placed on the arbor for grinding, the machine having been previously set by a test piece to grind as nearly cylindrical as possible. When the outside is ground to the same diameter at all points, the ends should be finished without disturbing the setting of the work. The work is then removed from the arbor and the ends made perfectly flat by lapping.

The lapping block used in finishing the beveled edges of the square blade, should be of cast iron and have a true plane

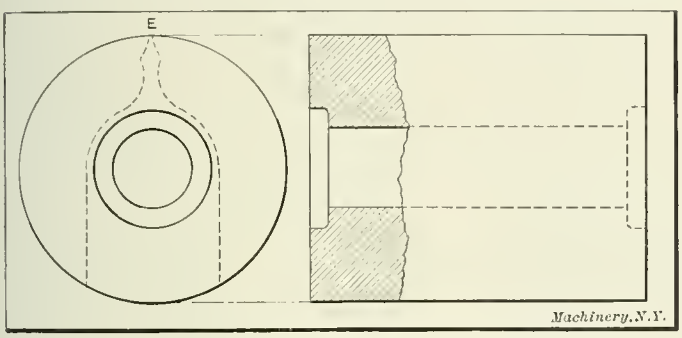


Fig. 1. Cylindrical Test Block for Squares

surface. This block should also have grooves cut into its surface as illustrated in Fig. 2. These grooves are 1 inch apart, about 1/16 inch wide, 1/16 inch deep, and at an angle of 45 degrees, as shown. They are important in that they allow the surplus emery to fall out of the way.

The first operation on the square blade is that of beveling the edges, which is done in a cylindrical grinder, as illustrated in the end view, Fig. 3. An arbor is first made, having a central milled slot long enough and of sufficient width to accommodate the square blade. A small hole should also be drilled in one end for the piece of drill rod *R*, which is supported by the table and locates the work in the correct angular position. The blade should be set central in this slot

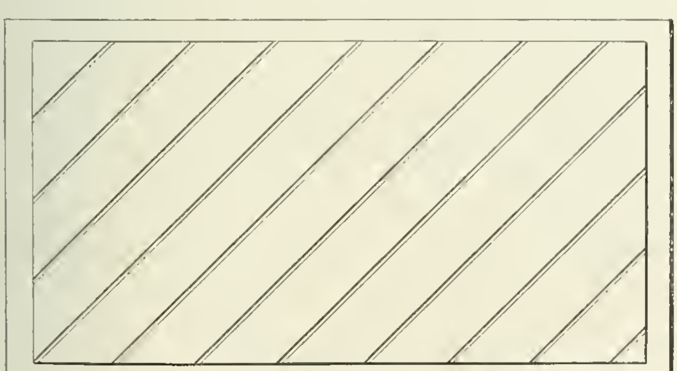
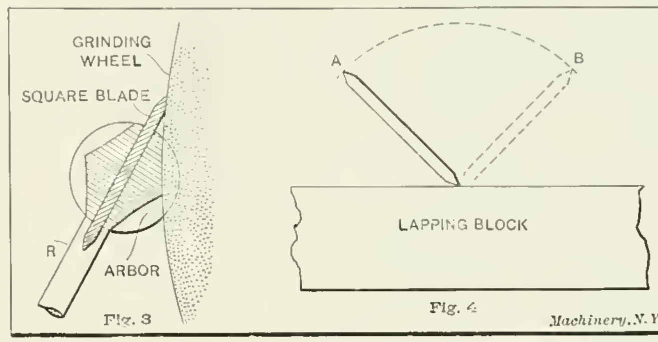


Fig. 2. Lapping Plate with Grooved Surface

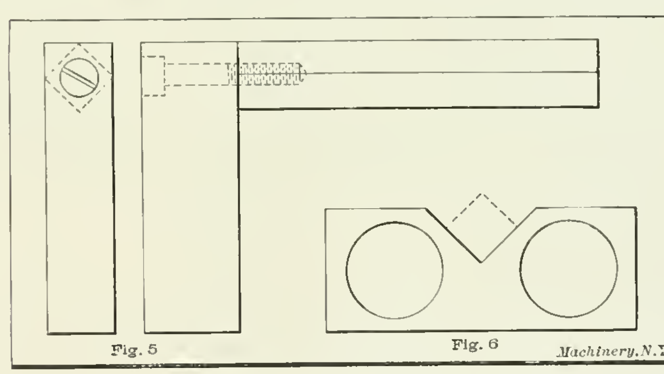
and then fastened by applying solder at the ends. Prior to beveling, the blade edges are ground round by revolving the arbor and blade between the grinding centers, which should previously be set for parallel grinding by the use of a test arbor. After this operation, the edges are beveled as indicated in Fig. 3. When one side has been beveled to nearly the center of the blade, the arbor is reversed on the centers, which brings the other side next to the wheel. The grinding is then continued until a knife-edge having a width of about 1/64 inch is obtained. Care should be taken to have this edge central by feeding the wheel in to the same position when grinding each side. By turning the arbor one-half a revolution, and changing the position of rod *R*, the opposite edge may be finished in a similar manner. The blade is then removed and both edges are lapped, which is an operation requiring great care and patience.

After charging the lapping block with flour emery, or carborundum, the edge of the blade is lapped by moving it side-



Figs. 3 and 4. Beveling Edges of Blade and Lapping

wise across the block. It should be held between the thumb and fore-finger, and, in addition to the cross-wise movement, there should be a gradual rotary movement through an angle of about 90 degrees, as indicated by the full and dotted lines in Fig. 4. Care should also be taken to use different parts of the lapping block surface, in order to distribute the wear and prevent the block from being worn inaccurate. The blade while being lapped in this manner should be tested at intervals by holding it in contact with a test bar. When making this test, the blade should be turned on its edge, as when lapping, to see if it shuts out the light when held in different angular positions. The lapping process should be continued



Figs. 5 and 6. Special Knife-edge Square and Lapping Block

until all light is excluded between the test piece and blade for any position of the latter between points *A* and *B*, Fig. 4. The stock should then be lapped.

A glass bar is the best for testing purposes, as it does not change in shape under different atmospheric conditions as does steel, but in case such a bar is not available, one may be made by lapping one edge of a bar of steel as nearly flat and true as possible. After the steel has been machined to shape, it should be allowed to "season" for at least six months before lapping it; during this time a slight change in shape will doubtless occur, which would destroy the accuracy of the bar if it were lapped without having a seasoning period in which to assume a more or less permanent shape.

After the blade is finished, that part which is attached to the beam should be carefully tinned and all surplus solder wiped off with a piece of waste. The blade is then set in the beam and positioned by using the precision test block. The outside edge may be tested by placing the square and test block on an accurate surface-plate and bringing the two into contact. The blade should be located with sufficient accuracy to exclude the light. When it is correctly set, it is fastened by placing a little soldering acid in the joint and heating it very carefully until the solder is melted. The square

* Address: 37 Parkwood St., Springfield, Mass.

is then removed and allowed to cool. If it is carefully handled during this operation, the blade and square will doubtless remain in the correct relation with each other, though it may be necessary to make several trials before obtaining satisfactory results.

In Fig. 5 a special type of knife-edge square is shown, the blade of which is ground square and held to the stock by a screw. It is essential that the inner end of this blade be lapped perfectly square, and when performing this operation a block such as shown in Fig. 6, should be used. This block has a 90-degree V-groove cut into one side parallel with the bottom. There are also two holes through the block to lighten it. When in use, the blade is placed in the V-groove, as indicated by the dotted lines, and the block and blade are moved back and forth on the lapping plate until the work, thus held in a right-angle position, is finished square on the end. This block is also useful for miscellaneous lapping operations.

A combination precision test block, straightedge and knife-edge square may be made by forming the block, Fig. 1, as shown by the dotted lines in the end view, the edge *E* being ground and lapped to a knife-edge.

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TO PREVENT DUSTING OF CONCRETE FLOORS

The *Engineering News* gives the following receipt to prevent dusting of concrete floors already laid as one recommended by Mr. Albert Moyer, associate member of the American Society of Civil Engineers:

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush, removing all dirt and loose particles. Allow the surface to dry. As soon as dry apply a solution of one part water-glass (sodium silicate), and three to four parts of water, the proportion of water depending upon the porosity of the concrete. The denser the concrete, the weaker the solution required. Stir well, and apply this mixture with a brush (a large whitewash brush with long handle will be found to be the most economical). Do not mix a greater quantity than can be used in an hour. If this solution is sufficiently thin, it will penetrate the pores of the concrete. Allow the concrete surface thus treated to dry. As soon as dry, wash off with clean water, using a mop. Again allow the surface to dry and apply the solution as before. Allow to dry and again wash off with clean water, using a mop. As soon as the surface is again dry, apply the solution as before. If the third coat does not finsh to the surface, apply another coat as above. The sodium silicate, which remains on the surface, not having come in contact with the other alkalies in the concrete, is readily soluble in water and can therefore be easily washed off, thus evening up the color and texture of the floor. That which has penetrated into the pores, having come in contact with the other alkalies in the concrete, has formed into an insoluble and very hard material, hardening the surface, preventing dusting and adding materially to the wearing value of the floor.

* * *

The time required for one rotation of the earth on its axis is arbitrarily divided into 24 hours. The hour is subdivided into 60 minutes and the minute into 60 seconds. To most of us a watch or clock is simply a mechanism for recording the flight of the hours, minutes and seconds—we think of it as a means for moving indicating hands synchronously with the turning of the earth, which, of course, it is. To begin at the other end of the time scale and conceive that a watch or any other escapement timepiece is simply a counting machine for counting seconds or fractions of seconds seems rather strange, but the conception is right. An ordinary American watch beats 18,000 times an hour, or exactly five times a second, if accurate. It counts every one-fifth second with unfailing regularity and precision night and day and registers the count in the larger units of seconds, minutes and hours. What else is that but a counting machine?

DRAWING A COLD-ROLLED STEEL SHELL

By A. C. R.

In the "How and Why" columns of the February number of MACHINERY, there was an inquiry by C. H. R. for information regarding the drawing of a cold-rolled steel shell. The following sizes of dies for the various drawing operations will be found suitable for making this shell:

Diameter of first drawing die = 9 1/8 inches,
Diameter of second drawing die = 7 1/2 inches,
Diameter of third drawing die = 6 1/8 inches,
Diameter of fourth drawing die = 5 inches,
Diameter of fifth drawing die for reducing shoulder = 4 inches,
Diameter of sixth drawing die for reducing shoulder = 3 1/4 inches,
Diameter of seventh drawing die for reducing shoulder = 2 9/16 inches,
Finished drawing die for shoulder = 2 1/2 inches.

All these drawing dies are of the same type as those used in a double-action drawing press. The dies are made from cast iron with hardened steel drawing surfaces, and the shell is shoved through and not returned, to avoid scratching, except in the operations for reducing the shoulder or lower part of the shell where it is necessary to remove the shell by the knock-out. In the drawing operations previous to reducing the shoulder, the shell is stripped from the punch by projection *F* on the die (see Fig. 2).

The first drawing die is shown in Fig. 1, where *A* is the cast-iron base, *B* the tool-steel face, *C* the punch, and *D* the double-action blank holder which has a steel face. The punch is provided with a vent hole, as is the case with all the other

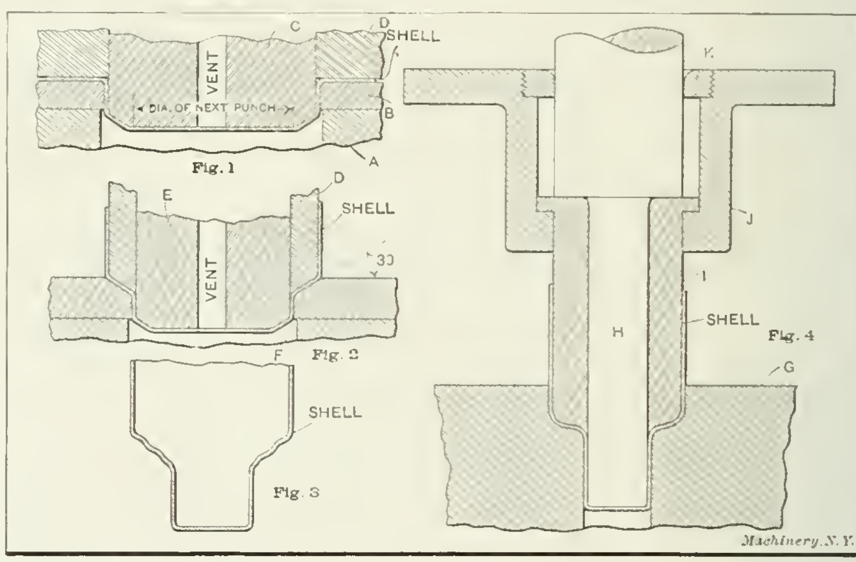


Fig. 1. First Drawing Die. Fig. 2. Re-drawing Die. Fig. 3. Shape of the Shell after reducing the Shoulder. Fig. 4. Punch and Die for Finish Drawing the Shell

drawing punches. The correct shape of the punch is shown in the illustration. In Fig. 2 the re-drawing die is shown. This die is of the same construction as that shown in Fig. 1, except that it is provided with a drawing angle of 30 degrees, which facilitates the drawing or "flowing" of the metal. The shell, in this case, is held by a blank holder *D*, which is actuated by the double-action of the press, and holds the blank with sufficient pressure to prevent it from buckling when being drawn out by the punch *E*. The dies for the successive re-drawing operations up to the point where the shoulder is reduced, are of similar construction to that shown in Fig. 2. The re-drawing dies for the reducing of the shoulder are also somewhat similar in design to that shown in Fig. 2, except that the shell is not forced through the die, but is returned by the knock-out bar of the press.

The punch and die for finish drawing and "ironing" out ridges in the shell is shown in Fig. 4. The die *G* is made of tool steel, as is also the punch *H* and the double-action blank holder *I*. The blank holder *I* is held in a bolster *J*, which, in turn, is fastened to the ram of the press. A collar *K* is screwed into the top of the bolster to stop the upward stroke of the blank holder until the shoulder on the punch comes in

contact with it. The idea of using a double-action press and a die along the lines shown in Fig. 4 is to throw the blow on the punch and crankshaft of the press, instead of on the toggles. This also insures the stripping of the shell from the punch, as the small end of the shell, which is brought down to size, is likely to stick in the die in this operation. Having a die of this construction also facilitates the stripping of the shell from the blank holder. The shape of the shell up to and beyond the shoulder is indicated in Fig. 3 where slight ridges are shown at the shoulder. These ridges are caused by the successive re-drawing operations.

The writer would call the reader's attention to the gradual decrease in the metal after each successive drawing operation. It is evident, of course, that the diameter of the shell must become less as it is reduced, so that the metal will not be subjected to excessive strain. The second drawing operation, that is, the first operation after the cup has been formed, reduces the shell from 9⅛ inches to 7½ inches or 1⅝ inch in diameter. For the following drawing operations, the reductions are as follows:

Third drawing operation reduces the shell from 7½ to 6⅛ inches or 1⅜ inch in diameter,

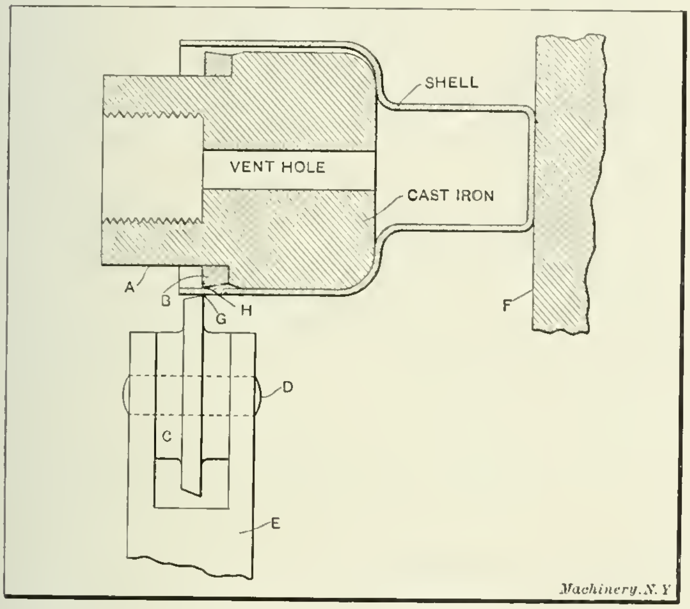


Fig. 5. Trimming the Shell to Length

Fourth drawing operation reduces the shell from 6⅛ inches to 5 inches or 1⅛ inch in diameter,

Fifth drawing operation reduces the shell from 5 inches to 4 inches or 1 inch in diameter.

These are the reductions in size of the upper part of the shell. The reductions in the re-drawing operations for the lower part of the shell are still less than those for the upper part, as follows:

For the first drawing of shoulder the shell is reduced from 4 to 3¼ inches or ¾ inch in diameter,

For the second drawing operation of shoulder, the shell is reduced from 3 1/4 to 2 9/16 inches, or 11/16 inch in diameter,

For the third drawing operation of shoulder, the shell is reduced from 2 9/16 to 2 1/2 inches, or 1/16 in diameter.

It is absolutely necessary that all the drawing punches have vent holes in them, so that the shell, when drawn, will not stick to the punch or die and work havoc with the press. Another point which should be carefully considered is the diameter of the blank. The blank should be made of such a size, that when the cup is finish drawn there will be from ⅜ to ½ inch to trim off. The reason for this is that the upper or open end of the shell becomes hard and crystallized owing to the excessive drawing, and extremely brittle. The crystallized part of the shell should be entirely removed so that, in flanging, the shell will not split or crack at the top edges. The writer would suggest that the shell, during the drawing operations, should pass through several annealing and pickling operations, so as to make it more ductile.

After the shell has been drawn to the correct length, it is ready to be trimmed. This is done before the flanging and is usually accomplished in a lathe of the roller-spindle variety. A method which could be used in trimming this shell is shown in Fig. 5. The shell is placed on a cast-iron chuck *A* which is screwed to the nose of the spindle. This cast-iron chuck is made slightly smaller in diameter than the inside of the shell. A hardened steel ring *B* is driven on the cast-iron chuck, and acts as a cutting edge. The shell is cut off by means of a hardened roller *C*, which is made circular in shape but has no cutting teeth. It is held on a pin *D* which is driven into a holder *E*. This holder is held in the toolpost of the

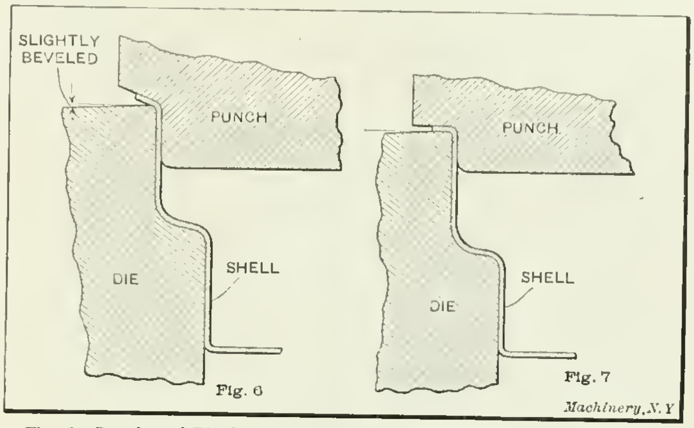


Fig. 6. Punch and Die for Starting the Flange Fig. 7. Punch and Die for Finishing the Flange

lathe. The shell is held on the chuck by means of a revolving backplate *F* which, in turn, is held in a holder fitted to the tailstock of the lathe. The edges *G* and *H* of the roller and hardened ring, respectively, are set so that they will slide freely past each other. The shank of the chuck is made considerably smaller than the shell, so that the part cut off can be easily removed.

The flanging of the top of the shell is the next operation. This can be done in two ways, one of which is shown in Figs. 6 and 7. This method requires two punches, both of which have hardened steel faces, but the same die can be used for both operations. The first punch, as shown in Fig. 6, starts the flange, and the second punch, as shown in Fig. 7,

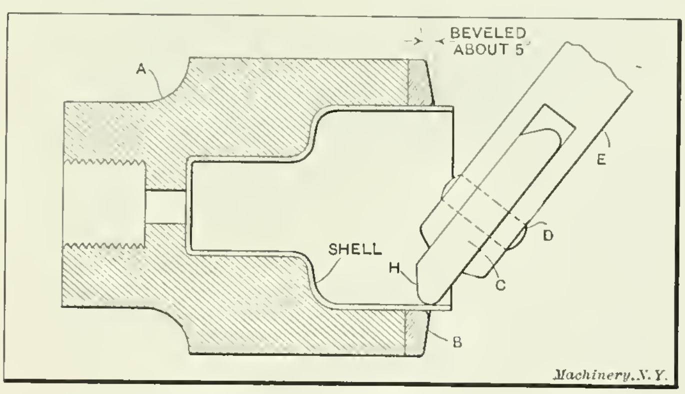


Fig. 8. Another Method of Flanging the Top of the Shell

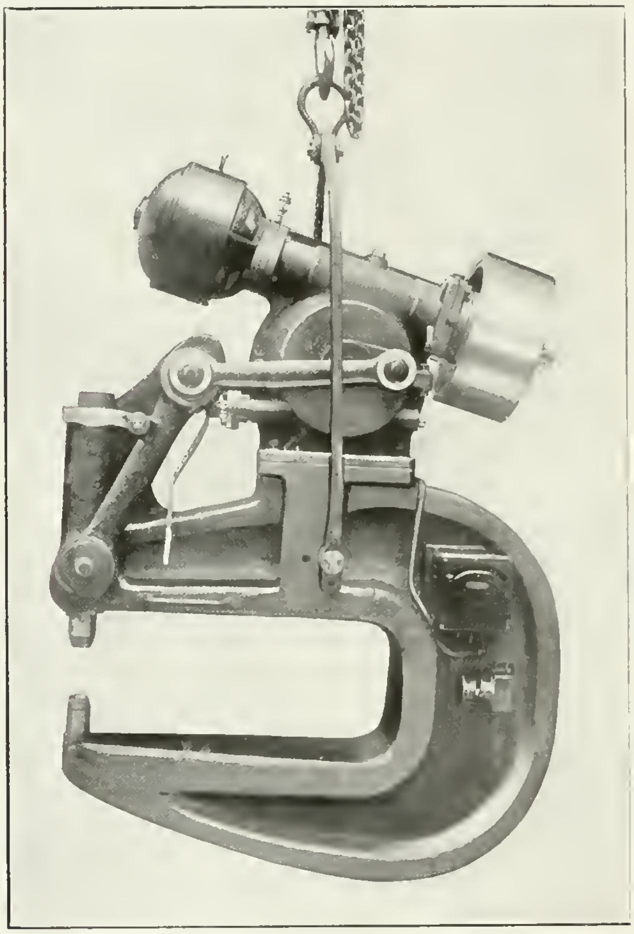
flattens it. The top face of the die is made of hardened steel, and is beveled slightly to allow for the spring in the material. The other method of forming the flange is shown in Fig. 8. This the writer considers better and more satisfactory than the one shown in Figs. 6 and 7. The flanging is accomplished in the lathe, the shell being held in a cast-iron chuck *A* which is screwed to the nose of the spindle. A tool-steel face *B* is fastened to the cast-iron chuck, over which the flange is bent by means of the hardened roller *C*. This roller is held on a pin *D* which is driven into a holder *E*, the latter being held in the toolpost of the lathe. The roller is applied in the manner shown in the illustration, and is brought from the inside out along the face. The face of the tool-steel ring *B* is beveled at about 5 degrees, to allow for the spring of the metal. Care should be taken to turn the flange over evenly and without buckling. The roller should be held at the correct angle to the work, to give the best results. When the flange is turned over, it is flattened down by the flat face *H* on the roller. If the suggestions given are carefully followed no difficulty should be encountered in making this shell.

GERMAN ELECTRIC RIVETING MACHINE

By FRANK C. PERKINS*

A German electric riveting machine, equipped with friction clutches as illustrated in the accompanying illustration, has been developed at Leipzig-Sellershausen. This machine for rivets of 1¼-inch diameter has a gap jaw of 40 inches, and is constructed for horizontal and vertical suspension. Another design has a novel form of electro-magnetic clutch for boiler riveting, while a third type has been designed with a friction clutch, to rivet all sorts of ironwork including rails and objects that do not require steam-tight rivets.

For locomotive and boiler work, use is made of an electric riveter having an electro-magnetic clutch so arranged that the



German Electric Riveting Machine

pressure stays on the rivet as long as desired. A machine of this construction for rivets of 1¼-inch diameter has a gap of jaw of 40 inches and is designed for universal suspension. A machine has also been built for rivets of 1-inch diameter with a jaw gap of 79 inches for horizontal and vertical suspension.

While it is true that an electric riveter in itself does not represent any particular novelty, it is maintained that all the other existing arrangements have the disadvantage of the motor running the risk of burning-up in consequence of the shock and great current variation. With these German electric riveting machines the motor is on the same shaft with the flywheel, the latter accumulating energy during the idle part of the operation; for this reason the motor is safeguarded and its burning-up is said to be absolutely impossible. It is also maintained that there is the additional advantage of an extremely low current consumption and loss of power.

As seen in the illustration, the machine consists of a steel casting having on its upper part the lever mechanism as on the pneumatic riveting machines. This lever is actuated by a connecting rod, which in turn is operated by an electric motor through a worm and worm gear. Movement of the lever and cup-shaped die is obtained by the engagement of a clutch-coupling. An accurately operating slide coupling is used, and is set in such a manner that it will throw out at the maximum pressure, and therefore unfailingly safeguards the machine and its parts from being damaged. A fuse protects the motor from excessive overload charge should the cup-shaped dies happen to be inaccurately set.

The cost of operation as well as the initial outlay, is extremely low for the reason that the central compressor station equipment necessary with pneumatic or hydraulic machines is not required. The capacity is said to be quite large as more than 200 rivets can be placed per hour provided that the workmen are able to follow the machine at this speed. This rate may be still further increased it is claimed, since a machine for rivets of 1-inch diameter makes 18 strokes a minute.

It is also claimed that in spite of this rapid production finished rivets of the best quality are obtained, and when the rivet is put into the hole properly the sheet and rivet become completely welded together as has been found when cutting through the rivet in a test piece.

The power required to operate is quite small. A machine forming heads on rivets of ¾-inch diameter requires a two-horsepower motor and for rivets of 1-inch diameter, one of 3.5 horsepower gives a working reserve of fully 50 per cent. The loss of power is also said to be extremely low. With a motor of the continuous current type, 220 volts pressure, it has been found that during the operation of the machine without load only from two to three amperes were used, while during the riveting process from eight to ten amperes were consumed. These results are undoubtedly of great interest as it is claimed they cannot be attained by either the pneumatic or hydraulic process. The low-power demands of the machine are said to be due to the fact that the motor mounted on the machine does not at the moment of riveting perform all of the work itself, but brings into service the flywheel, the momentum of the latter doing the work.

This German system of electric riveting is said to provide absolute safety in operation, for the safety coupling arranged within the flywheel throws out under excessive pressure and the blowing of the fuse breaks the circuit should the motor become heavily overloaded.

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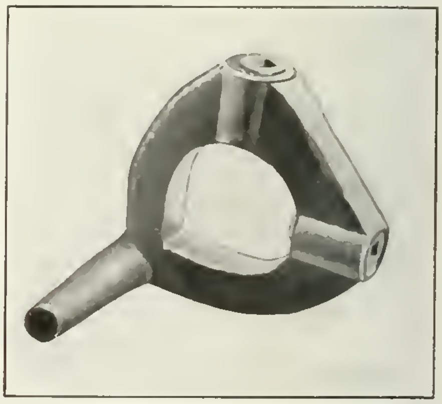
LATHE DOG WITH NON-PROTRUDING SET-SCREWS

The illustration shows a safety lathe dog used by the National Tube Co., Pittsburg, Pa., having two hollow set-screws instead of the usual pretruding square-head set-screws. The set-screws are made with square sockets and are larger in diameter than the square-head set-screws usually employed with the ordinary lathe dogs of corresponding capacity. The advantage of this form of dog, of course, is that, having no protruding set-screws, the workman is not likely to have his sleeve caught and arm mangled by the revolving screws when filing, polishing, etc. A disadvantage is that the large diameter of screws necessary to accommodate a wrench shank of the required strength makes it harder to tighten the screws snugly on the work than with the ordinary type.



Safety Lathe Dog used by National Tube Co.

This dog is part of the National Tube Co.'s interesting and instructive exhibit of safety devices and signs in the American Museum of Safety, 29 West 39th St., New York.

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We may declaim against "hot air" all we please, but just the same, way down in his heart, every man likes and appreciates a little flattery now and then, especially if it is given judiciously and artistically.—*The Wood-worker.*

TINNING CAST-IRON CROSSHEAD SLIPPERS

By FOREMAN TINNER

The process of thoroughly tinning cast iron is not understood by many persons to whom it should be familiar, and for the benefit of these, the writer will briefly outline the method generally employed for this work.

To tin a number of cast iron slippers at once, as required by M. H. W. in his query which appeared in the How and Why columns of the February number of MACHINERY, a small tin-dipping plant is necessary, as it is best to entirely immerse the slippers in the molten tin. The dipping plant should consist of the following: Acid tanks, tinning baths, water tanks and drying receptacles, etc. The tank for the acid and the cleaning liquid are generally rectangular boxes of a suitable size; and if it be desired to economize, an oil barrel sawn in halves will make two suitable tanks. It is sometimes considered advisable to have the acid tanks lined with lead; but this is by no means necessary, and the expense may well be saved. The tinning baths should be made of the best fire-box steel, not less than half an inch thick. To obtain a satisfactory coating of tin on the repaired cast-iron slippers, it is essential that all grease be thoroughly removed, which can be done by washing in a hot solution of caustic soda and water, and then rinsing in clean water. The old babbitt metal must also be removed; this can be done by immersing a number of the slippers in a molten metal bath. Care must be taken when immersing them, for if they are not perfectly dry, the metal "spits." To avoid this, the slippers should be first placed on a coke fire around the metal pot in order to dry.

New cast-iron slippers always have some sand (silica) adhering to them, which should be removed with hydrofluoric acid and water. The most suitable strength is 1 in 20. Sulphuric or muriatic acid is often used, but hydrofluoric acid is preferable, for it dissolves the sand, not merely dislodging it, and at the same time does not attack the iron as the other acids do. The pickle should be kept warm by means of a steam jet, for quicker results are thus obtained; a good temperature is about 150 degrees F. Caution must be exercised during the process to keep the surfaces in the bath from coming in contact with each other, as this would prevent the acid from doing its work. The slippers should be examined occasionally while in the pickle, and any sand or black spots should be removed by means of a stiff wire brush. Overpickling pits the castings, and care must be taken to avoid it. The length of time of pickling will depend upon the temperature and strength of the acid, and on the condition of the slipper casting surfaces.

After being thoroughly cleansed, the slippers should be immersed in a tank of clean water. If it is desired to keep the cleansed slippers for any length of time, they may be preserved from oxidation by being left under the water until they are ready for the tinning bath. When the tinning bath is ready (only the best block tin should be used), the slippers should be immersed in a boiling solution of caustic soda or potash, for about two minutes, then rinsed in water, and then in a bath consisting of a weak muriatic acid solution (1 in 40). The next step is to immerse them in muriate of zinc solution (zinc chloride). This is made by dissolving zinc in muriatic acid to the saturation point, and to every gallon of this solution, adding five pounds of salammoniac. Finally immerse in the first tinning bath at 500 degrees F. Great care should be taken, not to let the tin become red-hot, as undue heating would spoil the surface of the casting, giving it a "dry" appearance; at the same time it accelerates the formation of dross.

The bath should have a special flux on the surface, prepared by boiling muriate of zinc on top of the tin and adding thereto some salammoniac. The proper consistency of this flux is essential to good work. If it tends to become thick or hard, add more of both ingredients, and remove any hard part with a skimmer. The castings, as just mentioned, are immersed in this bath, the same care being taken as with the repaired slippers; they are afterwards taken out by means of suitable tongs.

The slippers next go to the second tinning bath. Care should be taken that none of the surface slag or flux is taken by the work into this bath. The bath should have a layer of tallow on the top, to the depth of half an inch, and when the slippers have been withdrawn from it, which may be at any convenient time after the tin is set, they may be thrown into a clean sawdust receptacle, which takes up the oil.

The operation of tinning is now complete, and if the proper method has been followed, and care exercised, the slippers will have a smooth coating, uniform in depth and color. It is a decided advantage to line the slippers with the babbitt metal immediately after they are tinned and cleansed, so as to avoid the time and expense of re-heating.

* * *

THE BABBITT MINE

By A. TRAVELER

"Yes," said Dornbirer, "I had some interesting and peculiar experiences out in the natural gas country, where I worked, you know, several years as a repair man, but the most profitable was the discovery of a babbitt mine.

"No, babbitt is not a natural metal, of course, and the mine was really a deposit formed as a result of careless shop management. Right here let me say that if all the leaks in the shops of this country made as rich and easily worked byproducts as did this one, the ground underneath some of our plants would be richer than the Comstock lode. You see, it was this way. Josh Brown was a natural promoter. He found out early in life that 'a sucker is born every minute,' and that his business genius was the faculty of getting the suckers. Well, Josh formed a 'syndicate' to manufacture wood pulp. It was afterward spelled 'skindicate' by those who got skinned, but that is getting ahead of my story. The syndicate looked around for a bunch of 'easy marks' and found them all right out in the natural gas region, where a lot of people had salted away easy money in bales. The town was to put up $100,000 for the privilege of having the wood pulp mill in its midst. Mind you, no guarantee was given as to how long the mill was to stay or how many men it was to employ.

"The mill was built and put into operation. It was hastily erected, poorly laid out and gave unlimited trouble almost from the start; but our chief trouble was with a ten-inch shaft direct-connected to the engine, running longitudinally through the mill to the grinders. This shaft soon got out of line and then the main bearing next to the crank was cut out. It was next to impossible to take out the bearing. The whole mill would have been dismantled, as it would have been necessary to raise the whole shaft up to get that box out. That fact gives you an idea how badly the mill was designed.

"Well, we had to rig up and babbitt that box in place the best way we could manage. The first time we tried it with 75 pounds of best babbitt that cost 25 cents a pound; but would you believe it, it didn't half fill that box, and another 75 pounds was poured into it before it was filled. You see, the shaft was out of line, and we didn't put it right, so it wasn't a week before the box was as badly cut as before, and another 150 pounds of babbitt went into it. It got to be a regular thing to babbitt that cussed box every Saturday night, and the purchasing agent bought babbitt by the ton. It surely did come high—25 cents a pound is $500 a ton, and that's going some, I tell you, when you use a ton every three months.

"We used to wonder what became of the babbitt, but so long as the bosses didn't care, we didn't worry, and things ran along from bad to worse until the stockholders got sick of the business and finally refused to put up any more cash to run a losing game.

"The mill shut down and stood idle a year. Meanwhile the prospects of making a wood pulp mill pay, so far from the source of timber supply, grew slimmer and slimmer. Finally it was decided to dismantle the mill and sell the machinery for what it would bring. I had found another job in the town, so I wasn't worrying about the failure of the mill; but

one day I was thinking of all the babbitt we had used in that main bearing box, and I had a good idea what became of it. You see, the mill had no basement. It was set on stone piers about 3 feet above the ground. The soil out there, you know, is nothing but sand in some places, and underneath that mill was a sandy streak—just nothing but loose white sand.

"I went to the contractor, a kind of Jew, and made an agreement to pay him $100 for all the junk left on the ground after he had cleaned up. He snapped me up quicker than a wink, and chuckled when I paid over the money. He seemed to kind o' think 'there wasn't going to be any core.' To tell the truth there wasn't much in sight that could be converted into ready cash when Mr. Contractor finally quit, but I didn't worry—for the simple reason that I had done some prospecting before I made the deal. I had jammed a crow-bar down in the sand underneath the place where we had poured so much babbitt into that box, and the bar struck something solid that was neither stone nor iron. See? Well, we shoveled about a foot of sand and uncovered a mass of babbitt ten feet across. I couldn't budge it with a long bar, and sent my partner off for a team, feeling pretty good I can tell you. When we got the team there we hitched on and you ought to have seen them pull. We dug all around it, but they couldn't drag it out. It took two of the best teams in town to pull that ragged block of metal out of that hole. I sold it to a junk man at 9 cents a pound, and you can figure up how much there was when I tell you that I cleared $1400 on the deal.

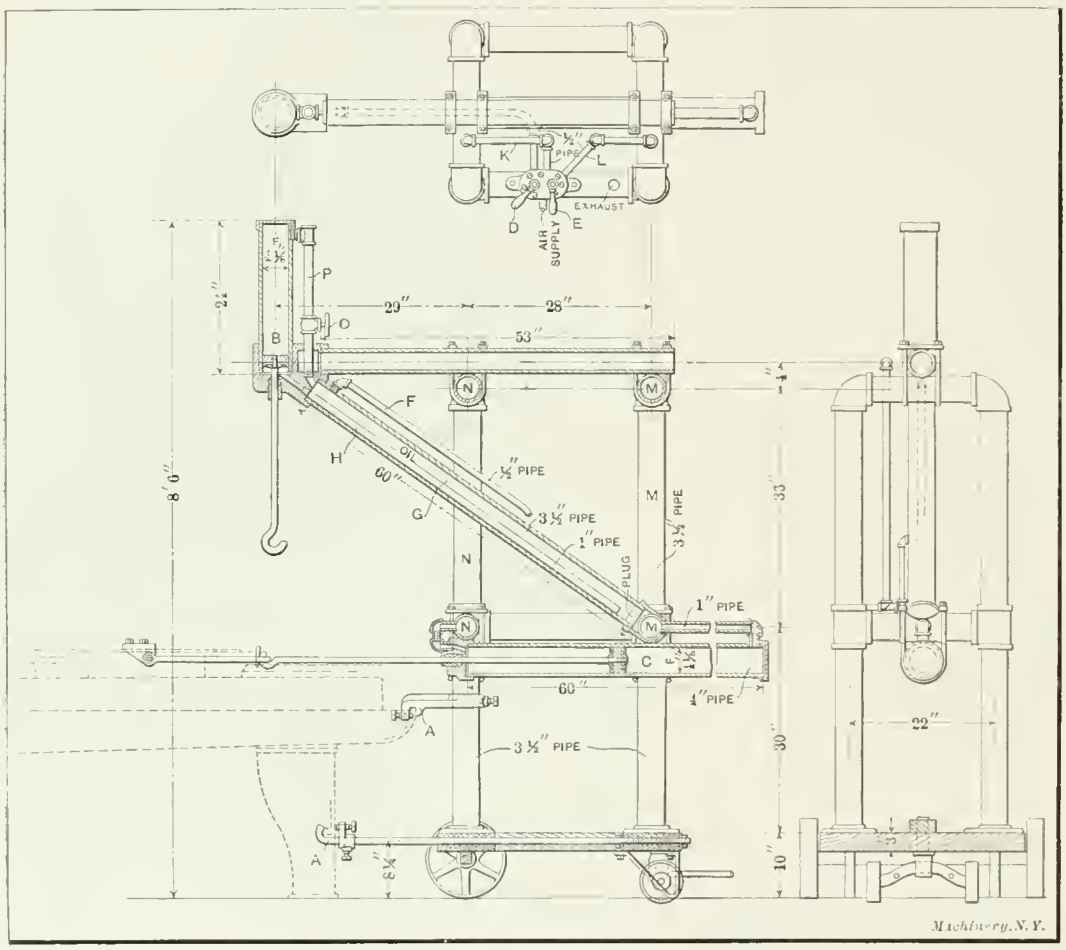
"You see, there was a blow-hole in the bottom of the cast-iron pedestal, and the biggest part of the babbitt that we had poured in ran out at that little hole down in the loose sand beneath. You don't believe it? Well, I don't blame you, but it's so."

* * *

Barring few exceptions, upright drilling machines show very little improvement in design or manufacture over those built twenty years ago. The same awkward lines prevail and the same methods of fitting. Soft patches, babbitted boxes in cored holes and other practices, good in their day but out of keeping with modern methods, still prevail.

PNEUMATIC-HYDRAULIC DEVICE FOR PULLING SLIDES WHEN SCRAPING

Several devices for mechanically pulling machine slides over the beds to which they are to be fitted by scraping, were described in an article entitled "Labor-saving Devices for Scraping Operations," published in the April, 1909, number of MACHINERY. The accompanying illustration shows a device for the same purpose which is in use in the erecting shop of the Jones & Lamson Machine Co., Springfield, Vt. The device is a combination hoist and pulling and pushing apparatus, operated by compressed air in combination with oil, the compressed air exerting a pressure upon the oil, which, in turn, exerts the required pressure upon the operating pistons. The apparatus is mounted on a truck, so that it can be conveniently moved to any part of the shop.



Pneumatic-Hydraulic Hoist and Machine Slide Pulling Device used in the Jones & Lamson Machine Co.'s Shop, Springfield, Vt.

When in use it is securely fastened to the bed of the machine on which the slide is to be scraped in, the clamps used for this purpose being shown at *A* in the engraving. The cylinder *B* is the hoisting cylinder, and cylinder *C* contains the piston which operates the slide as shown. The valve *D* controls the pressure in the hoisting cylinder, and the valve *E* the pressure in the pulling and pushing cylinder. When valve *D* is opened to admit the air, the latter enters through pipe *F* into the oil chamber *G*, from which the oil pressure is transmitted to the under side of the piston in cylinder *B* by means of pipe *H*. When the piston is to be lowered, the air is exhausted and the oil, returning to the reservoir *G* by means of the small pipe *H*, prevents a too sudden drop of the piston and its load.

When the slide pulling and pushing device is to be operated, the valve *E* admits the air pressure either to pipe *K* or pipe *L*, from which it is transmitted to the oil in the reservoir formed by the pipes marked *N* and *M*, respectively. When the pressure acts on the oil in the reservoir *N*, the piston is moved to the right, pulling the slide, and when the pressure acts on the oil in reservoir *M*, the piston moves to the left, the slide being pushed forward. It is evident that when the air is admitted on one side, it is exhausted on the other. The pipe *P* and the handwheel-operated valve *O* permit any oil that may leak by the piston in cylinder *B* to return to the oil reservoir *G*. At the upper end of pipe *P* there is a small vent-hole permitting the air above the piston to escape when the hoist is in operation.

* * *

The firm of Ernst Schiess, of Düsseldorf, Germany, has just completed what is believed to be the largest lathe in the world. It is intended for turning heavy steam turbine shafts and rotors, weighing up to 165 tons. The lathe will swing parts up to 16½ feet in diameter. The greatest distance between centers is 53 feet, and the total length of the lathe is nearly 80 feet. The lathe is motor driven, three motors being used, the main driving motor having a capacity of 80 H. P. The total weight of the lathe is 385 tons.

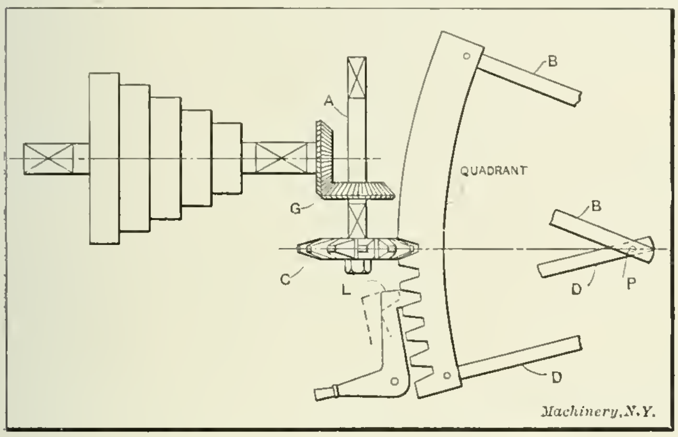
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

MILLING A REVERSE LEVER QUADRANT

A milling fixture used by H. T. Mills, toolroom foreman in the Fort Wayne shops of the Pennsylvania Railroad, is shown diagrammatically in the accompanying sketch. It allows the notches in reverse lever quadrants of any radius to be satisfactorily and quickly milled. While the indexing is not done with the precision of a dividing head, and would not be sufficiently accurate for most gear teeth, it answers admirably for its purpose.

An old plain miller, about the size of a present-day No. 1 is used, a bracket being bolted over the end of the spindle nose to carry a cutter arbor *A*, at right angles to the milling machine spindle. This arbor is driven from the spindle



Device for Milling a Reverse Lever Quadrant

through a pair of bevel gears *G*. A cutter *C* is carried outside of the bearings.

The quadrant to be milled is strapped to the top of the table. Guide rods *B* and *D* extend from the ends of the quadrant to a pivot point *P* on an outboard support at the center of curvature of the quadrant.

The first two or three notches are laid out on the quadrant by scale, and the slots are milled by feeding the table with the work up past the cutter. After this, the indexing for successive notches is obtained by a latch *L* which engages each one of the notches in turn after it has been milled. Thus whatever spacing was laid out for the first two or three notches is duplicated for all of the others.

Cincinnati, O. HENRY M. WOOD

SHAPE OF DRAWING EDGES IN SHEET-METAL DRAWING DIES

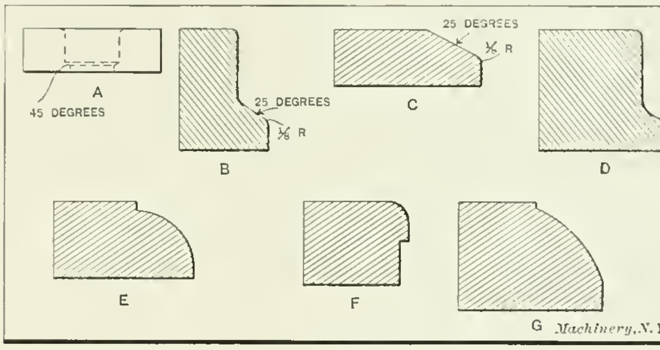
Many interesting articles on the drawing of sheet metal have been published in MACHINERY and other technical magazines, but nowhere has the writer run across definite instructions or rules as to the proper way of making the drawing edges on such dies. The drawing process for sheet metal, whether hot or cold, by which deep cylindrical or cup shaped articles are made from a flat sheet is very different from the ordinary bending of strips or operations of like nature, and embodies certain entirely different principles. There is present an interesting example of the "flow" of metals, and mechanics know that such flow takes place without weakening the metal, it merely growing harder or firmer, in the same way as it does when subjected to rolling or hammering.

Sheet-metal drawing consists in confining the blank which is to be drawn between two rigid surfaces, so that the metal cannot wrinkle when being pulled radially inward, which it has a tendency to do on account of the constantly decreasing circumference of its edge. When redrawing with inside blank-holders, the lower corners only are held firmly, the walls of the cups being supported, to prevent wrinkling or overlapping, from the inside. For some tin-work of large diameter, the writer, when reducing from the first "draw," has been obliged to hold the walls of the work between an inside and an outside surface to prevent wrinkles and irregularities.

While in the writer's experience the corners have been made of various angles, curves and radii to allow the metal to freely flow into the drawing die, no fixed rule has been followed, nor is he certain as to just what angle or radii drawing and redrawing dies should have to produce the best results. A tentative rule that has been of considerable help when using blank-holders, is to make the corner of the drawing die of a radius equal to six times the thickness of the metal. For redrawing with an inside blank-holder, the face of the die is made with an angle of from 25 to 30 degrees from the horizontal, and with about 1/8 inch radius to remove the sharp corner. Owing to the wide variation of the work and uncertain conditions, the possibility of formulating exact rules is doubtful. Notwithstanding this, it would be interesting to hear from readers of MACHINERY pertaining to their experience along this particular line.

The illustrations in the accompanying engraving are not submitted as examples of how drawing die edges should be made, but only to show how they have been made in the writer's experience. It is hoped that this will bring about a discussion of a subject that is steadily growing in importance, and elicit information from more experienced mechanics.

The figures as indicated are: *A*, an outline of a cartridge redrawing die having a drawing edge at an angle of 45 degrees; *B*, is a reducing die for a large cup; *C* a redrawing die to use with an inside blank holder; *D*, another type of redrawing die, the reducing part, or drawing edge being in the form of a reversed curve; *E*, a cupping die for thick stock to be used without blank-holder; *F*, a cupping die to operate with



Examples of the Shape of Drawing Edges for Sheet-metal Drawing Dies

blank-holder; and *G*, a die similar to that at *E*, the only difference being the long curve of the drawing edge, this die being used for extra-thick stock. The straight part of the reduced portion of the dies is made from a minimum of 1/16 inch to a maximum of 3/4 inch, but never more than the latter dimension, even for the very heaviest work, whether hot or cold.

Milwaukee, Wis. C. H. ROWE

A USEFUL MILLING MACHINE VISE

In factories manufacturing machines of sheet metal or machines using light uniform castings or forgings, the milling machine plays a very important part. The principal reason lies in the expeditious manner in which sheet-metal parts may be edge-milled with an additional cost for fixtures, of only one vise jaw and a suitable cutter. This is a comparatively small outlay as compared with that necessary for a shaving die to perform the same operation. Comparing the two processes, the speed of production is about the same, while the quality of work is somewhat in favor of milling.

The accompanying drawings clearly show the construction of a semi-automatic vise that was designed for use in a large adding machine factory, and which has proved through long use to be all that could be desired. While there have been many more or less automatic fixtures devised in the last few years, very few of them have proved as successful as this.

Fig. 1 shows its general construction, and the relative locations of the milling cutter at its extreme positions are indicated. The vise consists of a cast-iron body A, and has two machinery steel tongues B that fit into the slots of the milling machine table, to which it is conveniently bolted in the customary manner. In this main casting A, there is a sliding

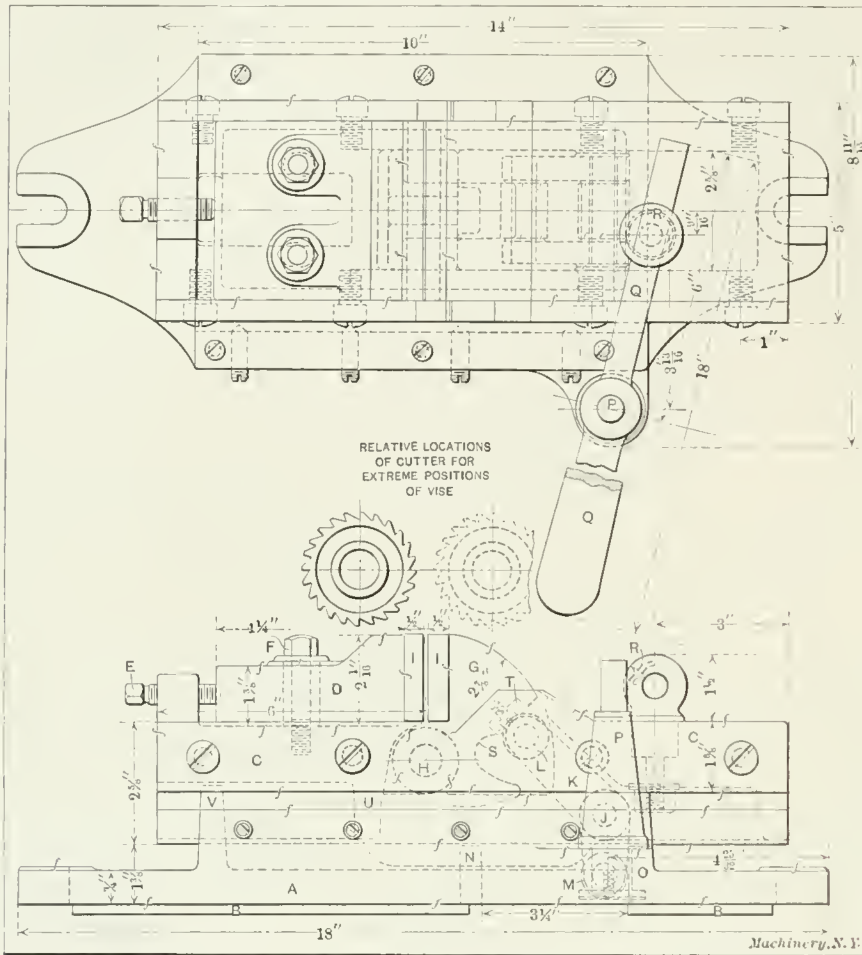


Fig. 1. Assembly View of Semi-automatic Milling Machine Vise for Milling Thin Pieces

piece C, which is the operative part of the vise. It slides in recessed grooves on either side of the main casting A.

On this casting C, are the two vise jaws. The jaw D is adjustable for the different sized articles to be machined, by means of the set-screw E, which bears up against the end of this casting, and in combination with bolt F, which clamps the jaw when located, holds it rigidly. The other jaw G is attached to the casting C by pin H on which it swings, as shall be explained later. This swinging jaw G is shown more in detail in Fig. 2. Both these jaws have faces I, of casehardened machinery steel, which clamp the article to be machined.

Pivoted at J there is a bell crank K, shown in detail in Fig. 3, on each end of which there are rollers L and M. The lower

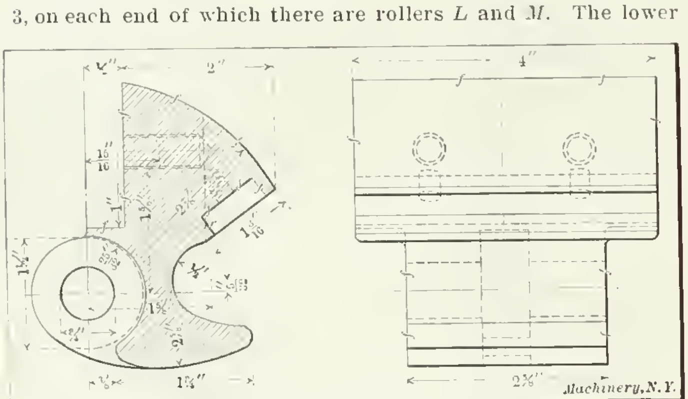


Fig. 2. Detail of Swinging Jaw of the Vise

portion of the bell crank passes into an opening in the bottom of the main casting A, at each end of which are shoulders N and O against which the roller M strikes.

Fixed in the main casting A there is a vertical post P, attached to which is a lever Q passing through a swivel bolt R in the sliding casting C. The lever Q, operating in either direction, moves the part C backward and forward, in the main casting A.

The operation is as follows: Suppose that the article to be milled is in the vise between the jaws D and G, the positions of the various parts being as shown. The milling cutter will be to the left, as shown in full, and a movement of the handle Q to the right moves the sliding part C to the left, forcing the article to be milled under the cutter. The relative position of the cutter will then be to the right, as shown dotted. When this sliding part C has moved a certain distance to the left the roller M strikes the face of the stop N and as the motion of C continues to the left, the bell crank K will swing in a counter-clockwise manner, the roller L dropping into the recess S from the inserted face T which has a taper of 3 degrees. The roller L dropping into this recess, permits the jaw G to drop by its own weight, swinging about center pin H. This releases the work.

In order that the motion of C may not be so great as to jam the parts, stop U on C comes in contact with stop V on the stationary casting A before it moves too far, preventing further motion. When the jaw G has thus swung down, the work falls with it, dropping below the cutting line, lying back at an angle so that when the lever Q is again moved to the left, the article being milled will not strike the cutter.

When the sliding part C has moved the major portion of its distance to the right, roller M strikes the face of stop O. At this point the cutter being to the left of the jaws, the finished work may be removed and a fresh piece inserted on the sloping face of jaw G, when the motion of the lever Q may be continued to the left, which moves C to its extreme position on the right, forcing roller M against the face of O, which lifts the bell crank K so that roller L leaves the recess S and moves up along face T, clamping the article to be

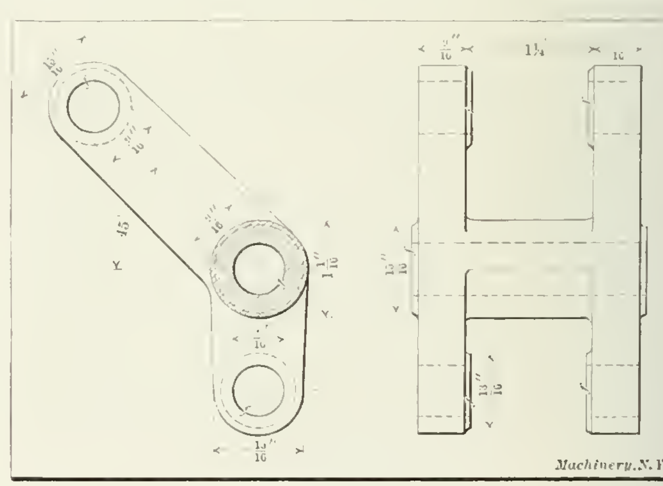


Fig. 3. Detail of Bell-crank which operates the Swinging Jaw of the Vise

milled in the vise, when the operation may be repeated as before.

While from the explanation, the operation may seem rather lengthy, consideration will show that the movements are very rapid and only require a motion of the lever Q in either direction to perform all the work necessary for the operation of the vise, so that, as will be seen, the action is really semi-automatic.

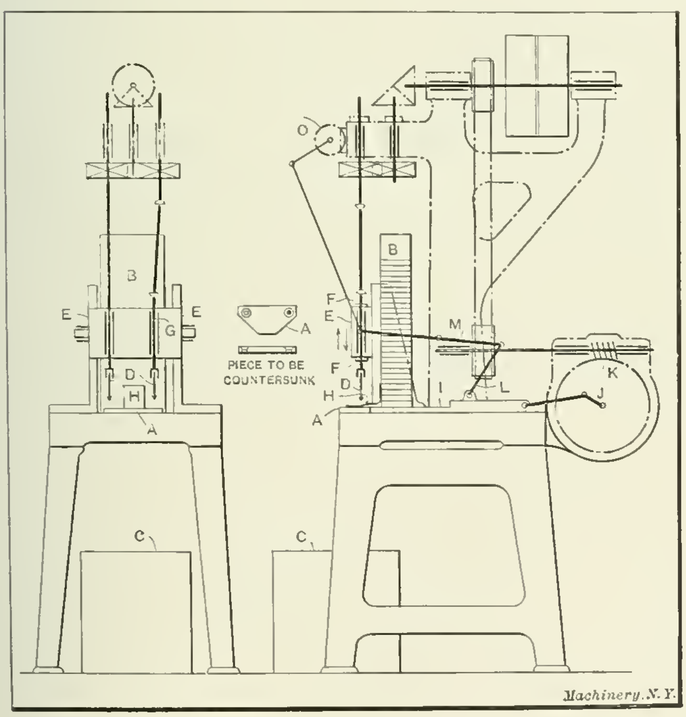
St. Louis

AUTOMATIC COUNTERSINKING MACHINE

Some time ago the writer had the opportunity of seeing a machine similar to the one here illustrated, and realizing that the principles upon which it was designed might be of interest in the future, he made sketches of it in his note-book. The engraving cannot be considered as a scale drawing, for the original was only a diagrammatic sketch, intended merely to illustrate the operation.

The purpose of the machine was to countersink simultaneously both holes of the piece *A*, shown in the detail view. The pieces, after being placed in a chute *B*, were automatically fed into the mechanism, reamed, and finally discharged into the box *C*. Previous to these operations, however, the holes were punched in another machine. The accompanying illustration is practically self-explanatory of the method of operation. Spindles *D* driven from above, are journaled in a sliding head *E*, and are vertically secured in this head by the collars *F*. In order that the machine can be used for countersinking holes the distance apart of which varies, one of these heads *G* has a cross-wise adjustment. To make this practicable, this shaft is driven by universal joints.

The piece being countersunk is held in position by the spring clamp *H*. The plunger *I*, passing under the chute *B*, feeds the pieces *A* forward, one at a time, and at the same time ejects the reamed piece into the box *C*. This plunger or slide *I* is actuated by the crank *J*, to which it is connected by a connecting-rod. The crank *J*, in turn, is driven through a worm gear and worm *K*, the latter being on a shaft driven by a belt on the main drive shaft. The plunger *I* also actuates the feed through the levers *L* and *M*, the latter of which is pivoted



Automatic Countersinking Machine and Piece operated on

near its center. As *J* revolves, it successively forces the countersinks into the work, and introduces the new piece, at the same time ejecting the finished article.

The number of pieces produced are counted by the number-counter *O*, connected, as shown, to the sliding head *E*. It will be seen that the only labor required is to see that the feed chute is kept supplied, and that the box for the finished pieces is emptied from time to time. Everything else is automatically cared for.

E. KWARTZ

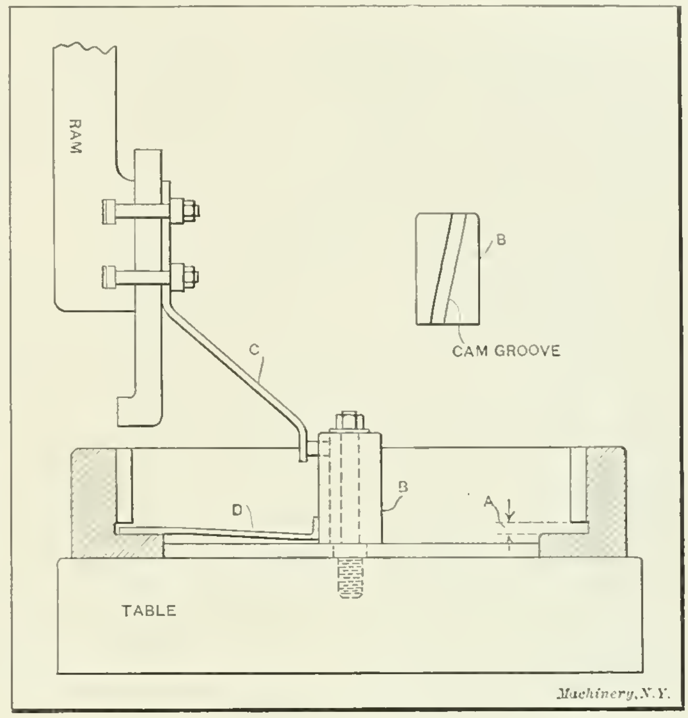
Chicago, Ill.

A HELPFUL HINT FOR THE SHOP

The cutting of the teeth of a large internal gear is not an unusual or difficult job for the slotter, yet when there is only ⅜-inch clearance between the end of the cut and the gear wall, it makes a rather tiresome day for the operator to stand constantly by his machine ready to clean out the chips from the groove at every stroke and thereby keep the tool from jamming.

A job of this nature comes in frequently in large lots so that the device shown in the accompanying figure was made, the results from which have been very satisfactory. While the chips are not all cleaned off the flange, they are pushed back sufficiently so that at least one complete tooth can be cut without attention. The clearance is shown at *A*.

The device which is a very simple one consists essentially of



Method of Cleaning an Internal Gear of Chips while the Teeth are being slotted

a cast-iron bushing *B* in which there is a cam groove. This is oscillated on a stud fitted into the slotter table, by means of a flat piece of stock *C*, bent to suit, which projects from the slotter ram, and on the end of which there is a cam roll. The motion of the ram transmits, by means of the cam groove, an oscillating motion to the sleeve, and the arm *D*, secured to the latter, sways back and forth at each stroke under the tooth being cut, thereby keeping the space free from chips.

Plainfield, N. J. H. TERHUNE

TOOL GUIDE ATTACHMENT FOR THE PLANER

Fig. 1 shows a casting which usually necessitated two settings on the planer to finish the surfaces *A* and *B*. This was

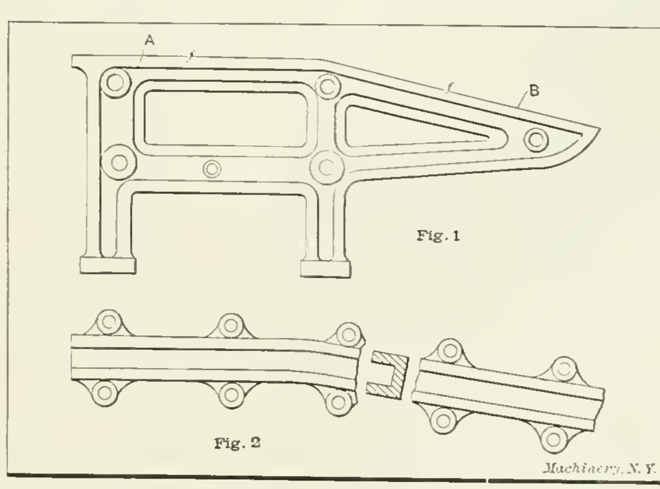


Fig. 1. Casting to be planed. Fig. 2. Templet used for Guiding the Tool

a difficult job, to say the least, as it required accurate setting to bring the two faces in the desired relation to each other. To facilitate this, the device shown in Fig. 3 was adopted

This consists mainly of a tool-holder *A*, held in the planer head, and carrying a sliding member *B* of square section, in which is held a cutting tool *C*. A boss *D* is attached to one end of the bar *B*, in which is held a spindle carrying a roll *E*. The tool is guided by a templet *F*, which is clamped to the table of the planer. A detailed view of this guide is shown in Fig. 2.

In operation, the work, Fig. 1, is set up on parallels, so that the roll *E* does not touch the bottom of the groove in the

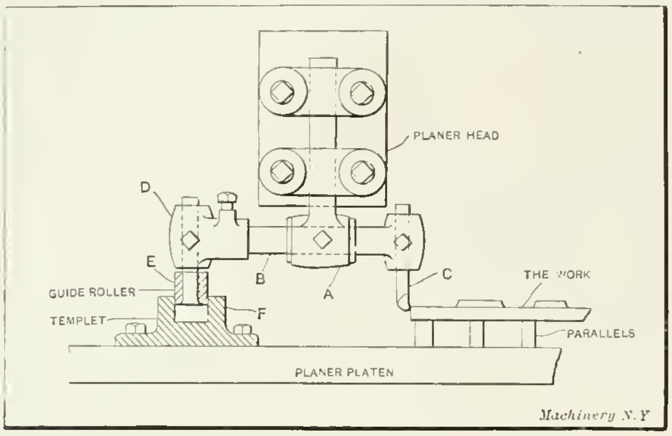


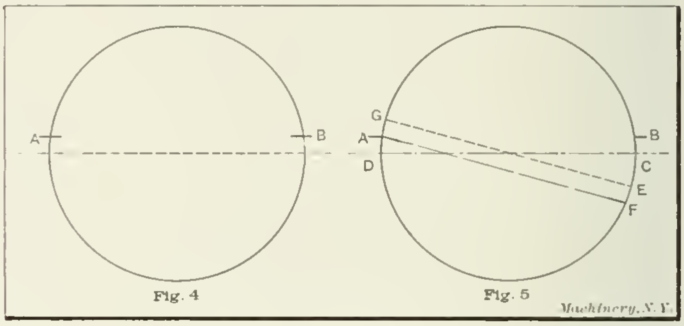
Fig. 3. Tool-guide Device set up on the Planer

guide; of course, the whole job should be set as close to the planer head as possible to prevent chattering. The guide *E* is set to correspond with the casting, Fig. 1, when the face *B* is parallel with the stroke of the planer. This prevents the tool from "digging in" when planing the surface *A*, as the tool is drawn *from* the work. This arrangement, of course, is only suitable for light cuts, but nevertheless, it is a good deal quicker than setting up for planing each face of the casting separately. CHIPS

SCRIBING A CENTER LINE ON CYLINDRICAL WORK

An accurate and useful method of locating an exact center line on a lathe faceplate or any job in a lathe, such as a gun, breech-blocks, jigs, dies, etc., is explained in the following. The surface of the work should first be prepared so that a fine line scribed with a sharp surface gage point will show up well. If the metal is steel or cast iron, blue vitriol can be used to advantage. By dissolving a crystal of blue vitriol, the size of a walnut, in a cupful of water with a few drops of sulphuric acid, a mixture will be obtained that, when applied to a finished surface on cast iron, wrought iron or steel, will produce a thin coating of copper so that scribed lines can easily be seen. The tools necessary are a surface gage and a piece of metal having one true surface for the gage to slide upon. This piece should be long enough to reach across the shears of the lathe, and it should rest firmly without any rocking movement.

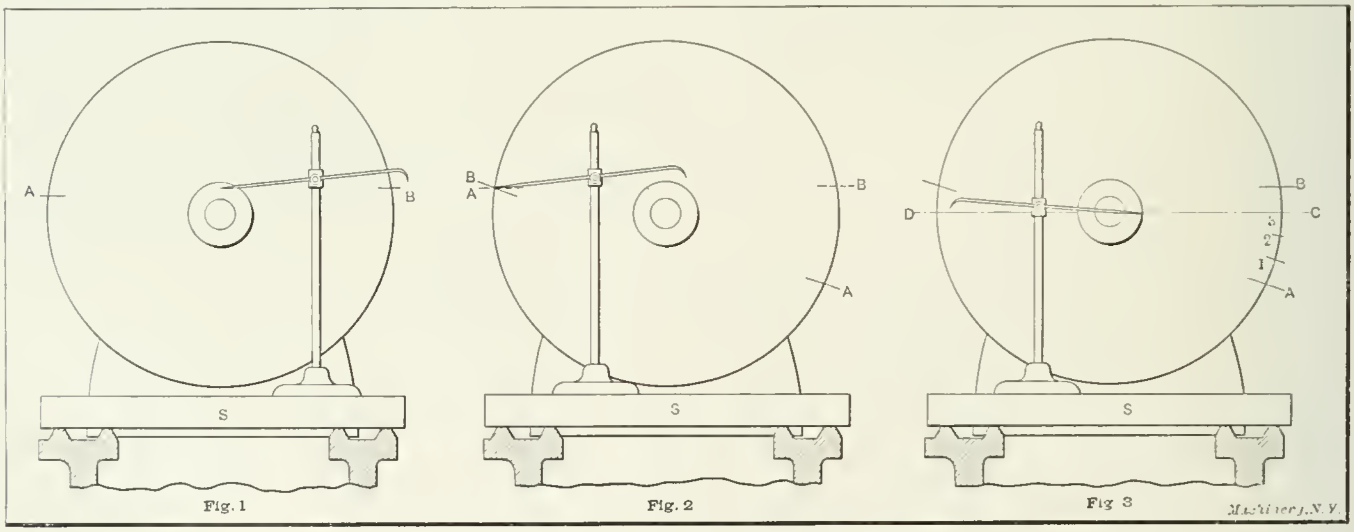
After the bar *S* is placed on the shears of the lathe, as illustrated in Fig. 1, with the true surface uppermost, place the surface gage on it with the pointer set as nearly central with the work as possible, and scribe light lines *A* and *B*; then with the gage pointer on the left side, turn the faceplate or chuck by hand until the line *B* moves around far enough to coincide with the pointer, as shown in Fig. 2. The lines *A* and *B* will then occupy the positions shown by the full lines, the dotted lines showing their original positions. The location of these lines above the center has been exaggerated in order to more clearly illustrate this method. The surface gage is now moved to the right side and another short line is scribed where *B* was originally. The gage pointer should, of course, remain undisturbed throughout the operation. The space *A-B* is next divided into four equal parts, as illustrated in Fig. 3, and the third division, counting from *A*, will be on the center line, which can then be scribed with the surface gage as shown. In most cases it will be necessary to divide *A-B* into four parts by guess, owing to the small space between these points.



Figs. 4 and 5. Illustrations accompanying Geometrical Proof

The work can be proved by starting on another part of the circle, and, without moving the surface gage pointer, repeating the whole operation. If this work is carefully performed, accurate results can be obtained, providing the surface operated on is finished nicely and a fine gage point is used.

The geometrical proof of the method, which may interest some, is as follows: In Fig. 4 let the circle represent the faceplate of the lathe. The lines *A* and *B*, are the trial lines and the center line is shown dotted; Fig. 5 represents the faceplate turned so that line *B* is at *A*. *C-F* which is the distance wanted, is a curved line, but, in practice, it will be so short that the curvature need not be considered. By construction, in Fig. 5, space $A\text{-}D = A\text{-}G = F\text{-}E = B\text{-}C$, and $C\text{-}E = D\text{-}G$, for they subtend equal angles at the center of the circle. Then $C\text{-}E = 2\ A\text{-}G$ or $F\text{-}E + B\text{-}C$. Therefore $C\text{-}F = \frac{3}{4}$ of $B\text{-}F$, which proves that a line scribed with a surface gage at height *D* in the manner described will be a center line.



Figs. 1, 2 and 3. Various Steps in Locating Center Line

Schenectady, N. Y. JAMES H. CARVER

A CIRCULAR RACK FIXTURE

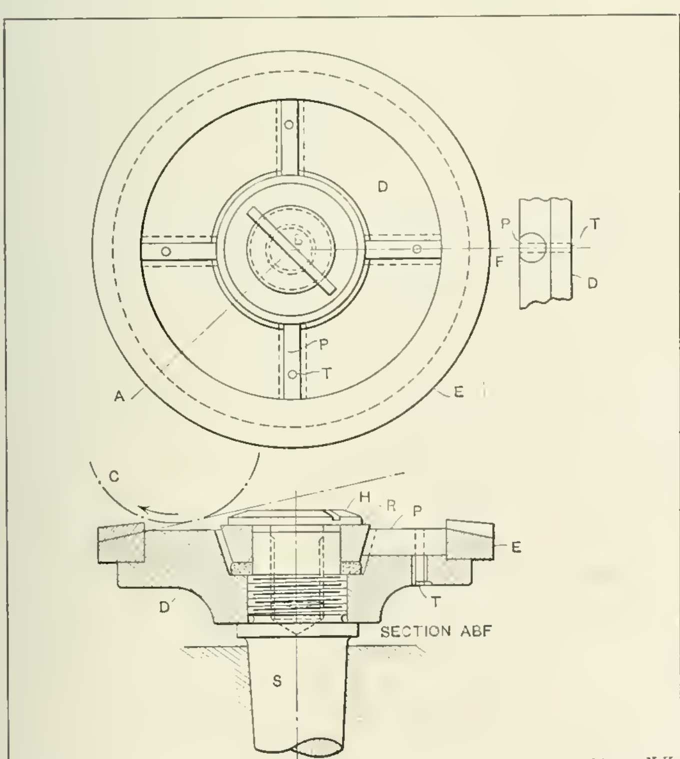
A simple and satisfactory device for holding small circular racks when cutting their teeth is shown in the accompanying illustration. The cutter in the indexing position shown by the dot and dash arc *C* turns as indicated by the arrow and feeds to the left.

The fixture consists of the tapered spindle *S*, the disk *D*, the holding screw *H*, the conical ring *R* and four extension pins *P*. Its action is as follows: The rack *E* is placed in the position shown, but should not fit tightly. By turning the screw *H* the ring *R* is pulled down, spreading the pins *P* which press radially outward against the rack and hold it in position. To remove the rack, the cutter is run to the right out of the way, when by unscrewing *H* the compressed rubber cushion under the ring *R* will raise the latter, releasing the extension pins. The taper of ring *R* should be from 20 to 30 degrees so as not to become friction-bound when screwed down. The small pins *T* prevent the extension pins from turning, but allow them a slight lateral play.

The construction and operation of the fixture will be evident from the drawing, and is such that it may readily be adapted to other proportions. When there is sufficient room, the screw *H* should have a hexagon head in addition to a wide flange; but a washer should never be used under a cap-screw as a substitute, as this would be apt to cock the ring *R*, causing it to bind. When convenient, it is well to replace the screw *H* by a flat-headed bolt, extending through the fixture and machine spindle, and having a hand nut on the lower end.

The following points are worthy of note and will aid one to make the fixture accurately: First, turn and face the taper ring *R* carefully on a straight mandrel. Next, make the tapered spindle *S* and fit its upper end to the ring *R*. Do not bore the screw hole but preserve the centers. Chuck, bore and rough out the disk (top side first), making the taper recess one-eighth inch larger than the ring *R* and leaving depth enough for the rubber spring. One-sixteenth inch should be left on the upper face to facilitate drilling the round extension pin holes. Then rough out the screw hole.

Next, lay out, drill and ream the holes for these pins and



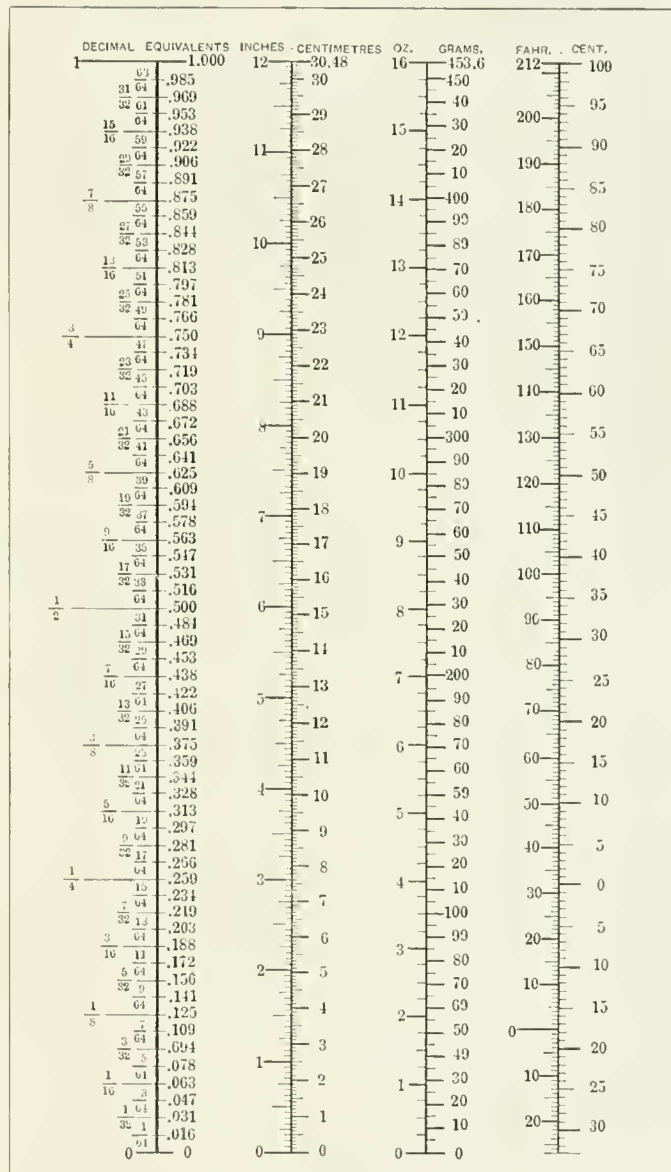
A Circular Rack Fixture

fit them so that they project far enough into the center cavity to finish properly. Fit the dowel pins *T*, but do not enlarge their holes in the disk until later. Now re-chuck the disk with its top face toward the chuck, and bore, thread and face it to fit the spindle thread tightly. Mount the disk, pins, etc., on the spindle centers and finish the upper side of the disk; *i. e.* turn the rack seat and outer ends of the pins *P*, face the disk and bore the inner ends of the pins to fit the ring *R* so that it will project beyond the end of the spindle *S* to allow for adjustment. Remove the spindle and extension pins from the disk and enlarge the holes in the disk for the dowels *T*, as shown in the lower view. Bore and thread the screw hole in the end of the spindle, using a steadyrest, and make the screw to fit. Assemble the fixture and if necessary key the disk to the spindle *S*.

South Bethlehem, Pa. H. A. S. Howarth

CONVERSION CHART FOR LENGTHS, WEIGHTS AND TEMPERATURES

The accompanying chart for converting common and decimal fractions, English and metric lengths, English and metric



A Conversion Chart for Lengths, Weights and Temperatures

weights and Fahrenheit and Centigrade thermometer scales was compiled by me for office use. We have found it very convenient and I suggest that the readers of Machinery would also find it convenient, especially if made on a larger scale for office use. The original is 10 by 18 inches.

West Lynn, Mass. K. Tornberg

AN INSIDE MICROMETER GAGE FOR LARGE WORK

Micrometer gages, such as are here illustrated, have been used by the writer on large work for several years and have proved so satisfactory that a description of them would probably be appreciated.

Fig. 1 shows the construction of the micrometer. Essentially it consists of an extension to the typical inside micrometer shown at *A*, the latter having its stem threaded as shown at *B*, with a flat top thread of a pitch of about 40 per inch. This is the only change in the instrument itself. The projections *C* are those found on some makes of inside micrometers.

This inside micrometer is attached to a piece of tubing, as shown, by means of the taper chuck and nut which are detailed in Fig. 2. In both figures, *D* is the inner member of the chuck and *E*, the outer. Nut *F* which screws onto the end of *D*, forces the taper members together, expanding *E* in the tube, and compressing *D* on the micrometer, clamping the whole securely. The inner member *D* is tapped to correspond with the thread of the inside micrometer. A similar arrangement is made at the other end of this piece of tube, where a chuck similar to the one just described is used, only in place of the inner member's being tapped, it is bored smooth, a piece of smaller tube or rod inserted, the end being turned down in the case of the rod, or having a piece sweated in, in the case of the tube, the whole appearing as at the right end of the instrument.

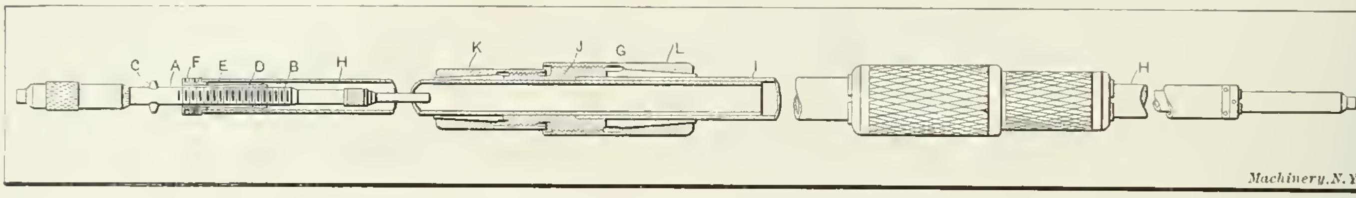


Fig. 1. Sectional View of Inside Micrometer for Large Work

For large work, a piece of heavier tubing, as shown at *I*, Fig. 1, is used for the center part, making the instrument stiffer. Chucks, one of which is shown in section at *G*, join end tubes *H* to the center tube *I*. These chucks are of the common split form. The tightening of knurled nuts *K* and *L* clamps the tubes firmly together.

The portion *B* of the original inside micrometer is threaded in order that exact adjustment may be made by turning the micrometer so that measurements may be taken from zero.

When the larger center portion is used, precautions should be taken that the smaller tube conforms fairly closely with the bore of the larger in order that the creeping tendency, due to unavoidable bending of the instrument might be obviated. As an extra precaution it might be stated that any knocks, even though slight, should be avoided in a gage of this size, whether of the solid or adjustable type. It is always necessary to support such a gage at the same points and in the same way at the measuring machine and while taking a measurement, as otherwise differences in "sag" will slightly alter the length of the gage.

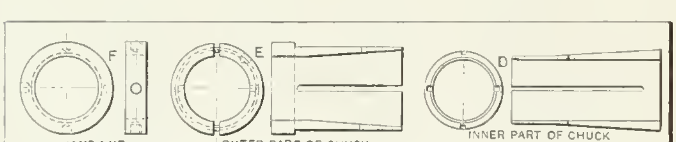


Fig. 2. Details of the Small Clamping Chuck of the Micrometer shown in Fig. 1

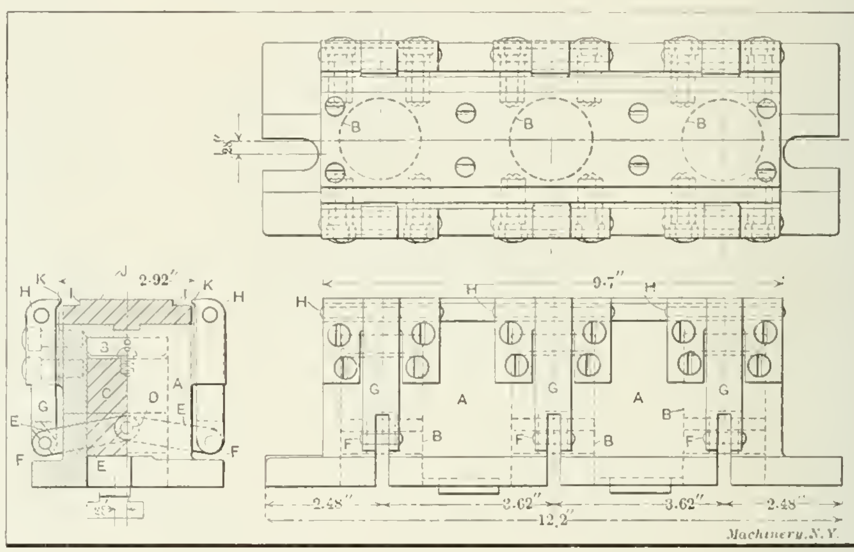
As a final word of warning it might be stated that such gages are not to be considered as standard, for no inside micrometer above two feet in length can be considered as such, but should be compared at frequent intervals with the shop standard. Therefore, when the work is large and exacting, it is advisable to calibrate the gage before taking the size of the work and finally checking back on the standard after the measurement has been taken. WM. S. ROWELL

Morton Park, Ill.

A PNEUMATIC MILLING FIXTURE WITH QUICK RELEASE

A handy milling fixture as used by one of the largest typewriter firms in the country, is shown in the accompanying assembly drawing.

The base casting *A*, which is bolted to the machine table (offset as indicated by the groove strip), is bored to form three air cylinders, as at *B*. The leather packed plungers *C* connect at *D* to the toggle joint arms *E*, which, in turn, connect through pins *F* to the clamping arms *G*, the latter being pivoted at *H*. Work to be operated on, is placed in the recesses *I* of the milling fixture table *J*, and, on the application of air pressure in the cylinder, motion is transmitted from the plunger, through the intermediate arms, securely clamping the work with jaw points *K* of the clamping arms.



Pneumatic Milling Machine Fixture with Quick Release

The jaws will hold the work thus as long as air pressure is applied, but on its release, they spring back, due to the peculiar construction of the air valve, which, on the air pressure being released, automatically passes air to a pipe running lengthwise of the fixture, in one of the table slots, connecting to the bottom of the plunger, raising it, and thereby releasing the work.

In practice, this fixture has proved very satisfactory, giving excellent service, and with a few modifications, it might readily be adapted to a large range of work.

DESIGNER

REDUCTION OF EXPRESS RATES

Many of MACHINERY's readers, who are large shippers of goods by express from and to New England points, are not aware of the substantial reduction of express rates recently made.

For about one year Mr. Henderson, of the National Claim Bureau, 170 Broadway, New York City, and myself have been fighting the Adams Express Co. in a suit before the Interstate Commerce Commission, No. 3183, endeavoring to secure lower express rates to and from New England, and by decision recently handed down by that Commission, the Commission has ordered a reduction of 25 per cent on rates to and from New York and Brockton, Whitman, Rockland, Taunton, North Attleboro, Mass., and Pawtucket, R. I.

This rate took effect February 6, 1911. It applies to what

is known as the "Boat and Rail Line," but is rail to Fall River and thence by boat to New York. The rate was formerly $1 per hundred either by rail or water, and now it is 75 cents per hundred; small packages accordingly. To secure this rate it is important that you mark all packages via "boat and rail," otherwise the Adams Express Co. will charge you $1 per hundred. The service is equally as good as all rail, and in some respects better.

This decision is the first break in the express monopoly, and it is of great importance. It would be well to notify all customers to mark goods between the aforesaid points via "boat and rail." RICHARD J. DONOVAN

170 Broadway, New York.

DISABLED DRILL SHANKS AND SOCKETS

In the January, 1911, issue of MACHINERY Mr. Cook describes a method of repairing the tang slots in drill sockets, stating that the advertised remedies for drill troubles refer to damaged tangs only, and overlook or ignore the trouble that arises when the tang slot (or tang seat as some might call it) in the socket is worn out. The writer suspects that some of the manufacturers may take issue with Mr. Cook on

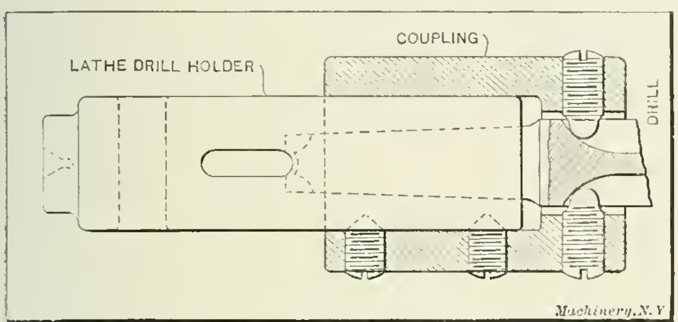
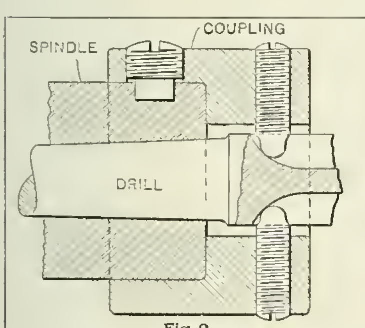


Fig. 1. Drill Coupling which may be used when both Tang and Slot are worn out

this question, as there are sockets on the market which dispense with both the drill tang and the slot with which it engages.

However, if it is not desired to purchase any of the new sockets, one of the home-made drivers or couplings illustrated in Fig. 1 of the accompanying drawings may be made at small expense. This coupling makes it possible to use the old drills and sockets when both tang and slot are worn out.

As shown, the coupling is secured to a lathe drill-holder by



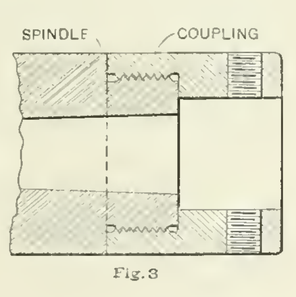


Fig. 2. Coupling applied to Drill Spindle with Short Projecting Edge

Fig. 3. Coupling applied to Drill Spindle which does not project

two V-pointed set-screws, the drill being gripped in the flutes by two round-pointed screws. Obviously the device will answer equally well for a common drill socket. As the old socket is likely to be damaged more or less by hammer marks, it should have a light cut taken over the part where the coupling is to be attached. The coupling should be bored for a tight fit on the socket, but the hole for the drill should be of sufficient size to freely admit the largest drill that the socket will carry. The writer has successfully used this device for ordinary work, but has not tested it in very heavy drilling.

A coupling made on this principle can be used on a drill spindle when the tang slot is worn out. Fig. 2 shows such a coupling, as designed for a certain drill-press which the writer has in mind. In this particular machine the end of the spindle which carries the drill projects only 1⅛ inch below its bearing in the arm when the spindle is raised to its highest position. In such a case one good sized screw might be used as indicated in the sketch, or two screws may be placed "quartering," as some would prefer.

If the construction of the machine is such that the spindle in its highest position does not project at all below the arm, tho coupling cannot be larger in diameter than the spindle. In such a case the construction shown in Fig. 3 will answer. Here the coupling is screwed on the spindle, the latter being turned smaller and threaded on the end. Some manufacturers make their drilling machines with thread already on the spindle. A coupling like one of those last described might be kept permanently on the drill spindle, and it might have in addition to the two round-pointed screws, two of some other shape to drive sockets. If the coupling prevented the shank of a drill chuck from entering the full depth in the spindle, a longer shank could be made; and this shank could have an enlarged collar with two grooves or "countersinks" to receive the points of the set-screws which drive the drills.

By way of apology for the old-style drill sockets and drill shanks, it may be said that much of the trouble that has been complained of is due to ignorance and carelessness. When the key is missing, the careless workman uses a hammer to pound the socket out of the spindle and the drill out of the socket. This damages both drill and socket to such an extent that the drill will not go into the socket the full depth, and the tang works at a disadvantage. The drill runs "out of true" also. If now while drilling a defective casting the drill hangs in a "blow hole," the framework of a light machine may "give" sufficiently to cause the socket to lift and "ride" the drill tang. It requires but a few repetitions of such abuse to ruin both the tang and its slot in the socket. The drill should fit the socket so well that it would be driven partly by friction, and the key should be chained to the machine within convenient reach of the workman. Under these conditions the common twist drill will "stand up" fairly well for average work; but it may as well be admitted that the tang is too weak for the heaviest forced drilling and roughest usage. W. S. LEONARD

Atlanta, Ga.

RESTORING OVER-EXPOSED BLUEPRINTS

In the "How and Why" columns of the February number of MACHINERY a method was given for restoring over-exposed blueprints. While the method was all right, the writer would suggest another one which is simple, and can be easily accomplished. This method is accomplished by taking the over-exposed print from the washing tank and while still wet laying it face upward on the table, then placing an unexposed dry piece of blueprint paper of the same size over the wet one, and rubbing it with a piece of cloth or with the hands. This brings the two surfaces into intimate contact, and when separated it will be found that the over-exposed print is perfectly clear and of a rich blue color. The color obtained by this method is better than that obtained by the ordinary exposure and development. There is one objection to this method, which is that a piece of blueprint paper is wasted for each print made. S. M. RANSOME

Cleveland, Ohio.

"PUNCHES AND DIES FOR MAKING A SPRING CLIP"—A CORRECTION

On pages 434-436 of the February number of MACHINERY, engineering edition, was published a description f a set of dies that I designed while working for the Elliott-Fisher Co. I would like to correct the statement that these tools were "in the nature of an experiment." The tools were designed to do the work and there was no experimenting about them whatever. J. CERMAK

Lima, Ohio.

WHAT ARE MACHINE TOOLS?

Machine tools are that *class* of machines which, when considered as a *group*, can reproduce themselves.

Meriden, Conn. WALTER L. CHENEY

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

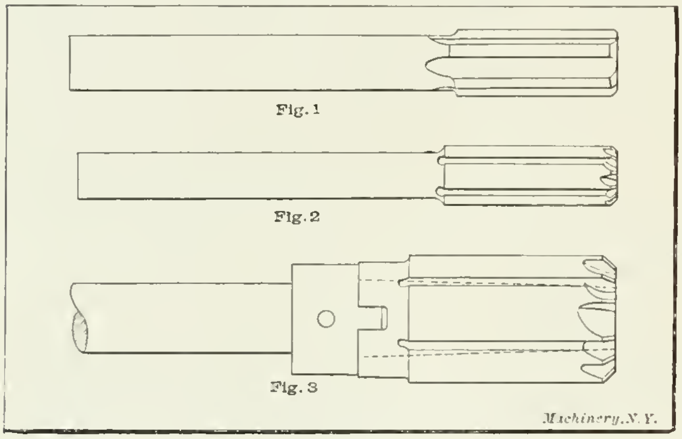
FRICTION DISKS FOR CUTTING SOFT-STEEL SHEETS

G. F. Co.—We have to cut some No. 26 gage, soft-steel sheets with a rotary disk, which is $7\frac{5}{8}$ inches in diameter by $\frac{1}{8}$ inch thick, and has a 5-inch hole. The disk is to cut the material by friction only. We have tried tool steel, but find it is too brittle and that the disk chips off. We would appreciate any information on this subject.

USE OF FLUTED REAMERS IN JIGS

R. G. B.—A difference of opinion exists as to the possibility of finish reaming machine parts with a fluted reamer, through a hardened steel bushing, without excessive wear on the reamer. Some manufacturers claim that it is not a manufacturing proposition, while others claim that this method is their regular practice. I am interested in the subject, and would appreciate your assistance in procuring the opinion of your readers.

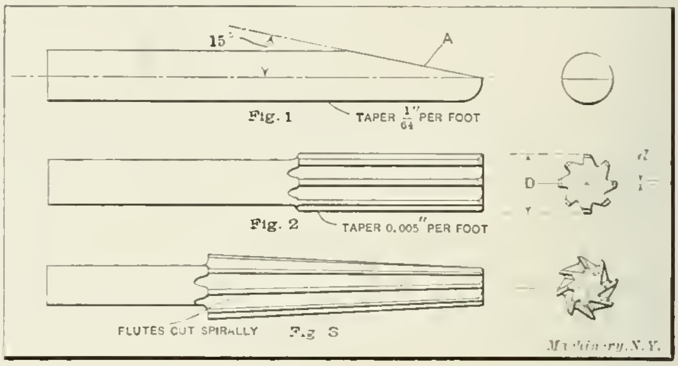
A.—The ordinary fluted reamer shown in Fig. 1 is not the best type to use for machining operations, especially where the reamer is to pass through a hardened bushing. No doubt this reamer is used, however, for this class of work, but it is not the preferable form. The rose reamer shown in Fig. 2 is better, and is especially recommended for this class of work. This reamer is fluted on the periphery as shown, but is not backed off, the cutting edges being on the end of the reamer only. The body of the reamer is made tapering towards the back an amount equal to about 0.010 inch per foot. It is obvious that by using a reamer such as shown in Fig. 2, very little, if any, wear will take place on the periphery of the reamer, as it has no cutting edges. Shell rose reamers are used for work over one inch in diameter, and are commonly made as shown in Fig. 3. These reamers are cut on the same principle as the rose reamer shown in Fig. 2, having cutting edges on the front end of the reamer only. The flutes in the body of the reamer are for the purpose of conveying oil to the cutting edges, and also to facilitate the removal of the chips.



REAMERS FOR CUTTING BRASS

R. H.—What is the correct way to make straight or taper reamers for cutting brass? Should the cutting edges of the teeth be on the center, back of it or ahead of the center?

A.—The type of reamer to be used for cutting brass is determined to a considerable extent by the diameter of the reamer and the machine in which the reaming is to be accomplished. For screw machine work the reamer shown in Fig. 1 gives good results, when the diameter of the hole is not greater than $\frac{3}{8}$ inch. This reamer is made from a piece of drill rod, hardened, and is tapered slightly toward the back an amount varying from 0.005 to 1/64 inch per foot. It is resharpened by grinding on the face *A*. When the hole to be reamed is greater than $\frac{3}{8}$ inch, a reamer of the form shown in Fig. 2 should be used. This reamer is fluted its entire length similar to an ordinary hand reamer and the teeth are backed off. It is preferable, when cutting brass, to locate the cutting edges ahead of the center so that a negative rake will be presented to the work, which produces a scraping cut. The teeth should also be of an uneven number or else staggered to obtain good results. The distance *d* that the cutting edge is ahead of the center should equal $\frac{D}{20}$, where D is the diameter of the reamer. For taper reamers where the taper does not exceed $1\frac{1}{4}$ inch per foot the flutes should be cut spirally as



shown in Fig. 3. A left-hand spiral of about one turn in 36 inches is generally used. The cutting edges should also be set ahead of the center the same distance as the reamers shown in Fig. 2. Where the taper is greater than $1\frac{1}{2}$ inch per foot the flutes can be cut straight, but should be serrated so that the chips will be broken up. The serrating is accomplished by gearing the lathe in a similar manner as for cutting a thread. The grooves which are about 1/16 inch deep by 3/32 inch wide are cut with a round-nose tool. About three turns to the inch is generally used for serrating a reamer.

MAKING TOOLS FOR DRILLING, TAPPING AND MILLING COPPER

E.—How should the tools for drilling, tapping and milling copper be made, and what lubricants should be used in the machining processes?

A.—In drilling copper, the angle of the cutting edge and the character of the drill used is determined by the depth of the hole to be drilled. For drilling through thin sheet copper, or for shallow holes, an ordinary twist drill can be used, but this should be ground with a negative rake, and the lips ground in so that the lip of the drill will not have as much clearance as would be necessary for drilling steel or iron. For deep holes, a straight-fluted drill is commonly used. This drill should be lubricated with either soap and water or beeswax, the latter giving excellent results.

It is sometimes recommended, and is generally found to give good results, to cut spiral flutes on taps to be used for copper, and also to have an odd number of flutes. The spiral should be right-hand for a right hand thread and with a lead of about one turn in 12 inches. Beeswax is recommended also as a lubricant for tapping. For cutting the grooves in the tap, a cutter should be used which will not make the cutting surface radial, but which will set it off at an angle of about 15 degrees from the center, thus producing a negative rake.

For milling copper, the teeth of the cutter should not be spaced close together for general conditions, but, of course, there are some cases, for example, the slitting of narrow stock, in which it would be necessary to have them closer together than it would be when cutting thick stock. About $\frac{1}{8}$-inch pitch is generally used for slitting saws. The face of the teeth, instead of being radial, as is the usual practice for cutting steel, should be laid off at a tangent to a $\frac{7}{8}$- or 1-inch circle, depending on the diameter of the cutter. For milling cutters for surfacing-work, it is best to cut the teeth spirally, a spiral of one turn in seven inches being about right.

There are various cutting compounds used for cutting copper, but either soap and water or beeswax will be found to be the most efficient. Beeswax gives a very smooth finish and has no other objections except that it gums up the machine. It is also said that milk is a good lubricant when cutting copper; tallow will give about the same results as beeswax.

"INS AND OUTS OF GEAR HOBBING"—A REJOINDER

By E. J. LEES*

In his article in the January issue of MACHINERY, "Ins and Outs of Gear Hobbing," Mr. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., has attacked the gear-cutting system commonly known as hobbing, and made some comparisons with gears produced by the Fellows gear shaper, much to the advantage of the latter; therefore we ask Mr. Flanders to answer this one question: Does the sharpening of the cutter used on the Fellows machine change the circular pitch of the cutter? We should very much like a direct answer to this one question. We are not asking about the correct involute or anything else, simply does the process of grinding the Fellows cutter to maintain the cutting edge change the circular pitch of the cutter or not?

Mr. Flanders states that the machine used for his experiments was in his judgment the best designed and most satisfactory machine of all the hobbing machines, and then proceeds to call attention to such vital errors in design as overhang in cutter, restricted bearings for shafts and the use of differentials. The absence of all these points are the particular and some of the principal advantages advanced for the machine we manufacture, to recommend it to the purchasing public. We emphasize the fact that there is no overhang in our cutter (hob), that there are larger and stiffer bearings in our machine than in any other gear cutter made, that we do not use a differential or "jack-in-the-box" and that we have no shafts of length with torsional stress, our longest exposed shaft from bearing to bearing being eight inches. We discussed all this with Mr. Flanders at MACHINERY's last outing in October last, and gave him a circular describing our machine.

We realize that any innovation in any field must expect to encounter every kind of opposition, but is it not a fact that if the gear hobbing process were otherwise than the success it is, our competitors would treat it with silent contempt? We claim that the correct machine and the correct hob will produce correct involute gears of any number of teeth within the range of the common acceptance of the term. We claim that the gears produced are the same no matter how much the cutter is ground for sharpening. We admit that the helical gear is quieter than the spur, but most emphatically assert that it is more correctly cut on a hobbing machine than in any other manner, and deny, as implied by Mr. Flanders, that the hobbing process "puts one over" on the user, simply on account of the fact that the helical gear being so much better than the spur takes care of the faults of the hobbing process. In regard to the explanation of centering the hob, the experiments as given only indicated distortion in the hob used. Otherwise all teeth in a hob, which are supposed to be and should be duplicates, would produce the same results. Here again lack of care is shown in selecting the hob.

Mr. Flanders further asserts that a hob should be helically fluted at right angles to the lead. This we assert is entirely wrong. In the hob which we manufacture the flute, though straight, is still at right angles to the angle of the lead. In a radial spirally-fluted hob the teeth at one end are hooked while at the other end they are stubbed as related to the generating plane.

What has often been mistaken for flats by the average user is caused by the distortion in the hob which prevents correct generation and allows some tooth or teeth to cut where they should generate or, to use a homely expression, one or more of the teeth being out of true, when coming into the generating plane "side swipe" the work and leave a flat surface. Theoretically, there is no question about there being flats on any generated gear, and this applies to bevel as well as spur gears, but *theoretically* it is impossible to mill a flat surface with a cylindrical cutter.

* * *

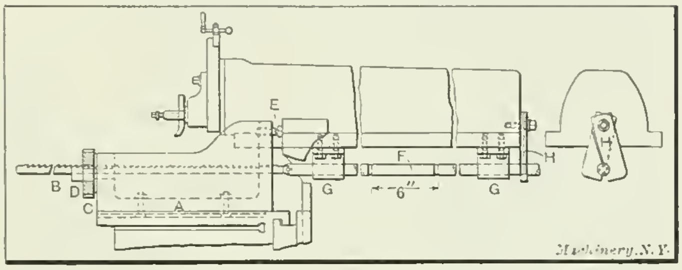
The foreman with the faculty of putting the right man in the right place has the master key to success in handling men.

*President Lees-Bradner Co., Cleveland, Ohio.

BROACHING ON THE SHAPER

Smith & Mills Co., Cincinnati, Ohio, builder of shapers, has made a number of interesting shaper appliances for use in its own shop, to perform operations that ordinarily are done on a gear-cutter, broaching machine, etc. The illustration shows a simple rig, which converts the shaper into a fairly effective draw-cut broaching machine, used for cutting keyways in gears and pulleys.

An open box casting *A*, having a hole bored through the front wall for the slotted mandrel *D* on which the gear *C* is mounted for keyseating, is bolted to the knee. The cutter blade *B*, about four feet long, one inch wide, and of the thickness required by the width of keyways to be cut, is drawn through the gear by successive strokes of the ram. The ram motion is transmitted to the cutter by the notched bar *F* and



Broaching Attachment on Smith & Mills Shaper

the latch *H*. The notches on the bar are 6 inches apart and the stroke of the ram is adjusted to a movement slightly more than six inches, or twelve inches if the cut is not very wide and deep. To pull the cutter four feet on the short stroke which is used for the larger keyways, eight strokes are required, and half as many, of course, when using the twelve-inch stroke.

The thrust on the casting *A* is taken directly by the column through two screws, one of which is shown at *E*. The guides *G*, bolted to the under side of the ram to support the bar *F*, do not interfere with the regular uses of the shaper, and are permanently fastened in place. The latch *H* is simply two pieces of flat steel reduced to half-thickness where they overlap, and pivoted on the top screw on which they freely swing. When the ram moves forward, the leaves swing apart and drop into one of the notches of the bar on the return stroke, when they act the same as a pawl.

This rig on a 21-inch shaper with the stroke reduced to six inches has ample power for any ordinary keyseating required in the making of the Smith & Mills shapers. The keyseats in two steel gears are cut at once.

* * *

DESIGNING A SHAFT

"I have made some careful calculations," said the Chief Draftsman to the "Big Boss," "and I find that if we use a $2\frac{1}{4}$-inch shaft for the main driving shaft in the head of that machine I spoke to you about yesterday, we will have a mighty small factor of safety, but I don't see how we can use a bigger shaft without rearranging the whole design, because there is room for no more and we've got to have some clearance besides."

"Oh, well," said the "Big Boss," "I think that difficulty can be easily overcome. You have a small factor of safety in the shaft already, the way the thing is designed, and as you know, a hollow shaft is stronger than a solid shaft—that being one of the fundamental principles of the strength of materials. Now, the way to fix this matter is to drill a small hole through the shaft and we will have obtained a factor of safety which will undoubtedly give us all that is desired. I am glad you spoke to me about this as, otherwise, you might not have thought of this easy way out of the difficulty and might have gone to considerable trouble redesigning the machine so as to be able to put in a shaft of a larger diameter. It is a mighty good thing, Mr. Smith, to go back once in a while to the text-books and take note of the fundamental principles. I have found that it has helped me over lots of difficulties, for while I am a practical man, I pride myself on having acquired just enough theory so that I can combine the two to advantage."

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

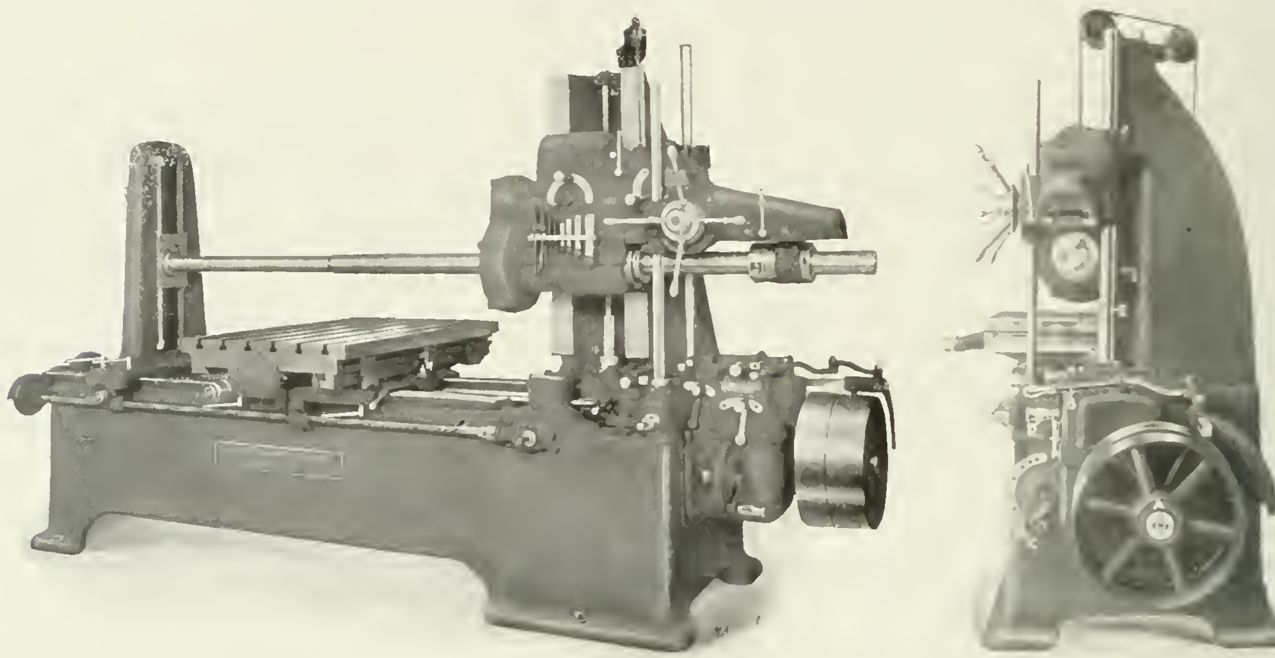
Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

THE UNIVERSAL HORIZONTAL BORING MACHINE

The Universal Boring Machine Co., Hudson, Mass., is now manufacturing the No. 3 size of horizontal boring machine, illustrated in Figs. 1 and 2. The size of this machine expressed in figures is 3 by 30 by 30 inches, the figures indicating the diameter of the boring-bar, its horizontal travel, and vertical feed. The engravings Figs. 1 and 2 illustrate the front and end views of the machine, respectively. As will be noted, this machine is of the constant-speed drive type and it is adapted for either belt or motor drive. The construction is very rigid, the upright which supports the spindle head being of the box form, and the bed and saddle being so constructed as to give a maximum support to the table. In this connection it should also be noted that the saddle has large bearing surfaces on the bed. The location of the operating levers and the handwheel for the rapid adjustment of the boring-bar, and the facilities for changing speeds and feeds, are also noteworthy features.

The Spindle Drive

As the machine is of the single-pulley drive type, the drive may be direct from the main line, the tight-and-loose pulleys being carried on the machine itself. The driving pulley is 18 inches in diameter, 3½ inches wide, and runs at 250 revolutions per minute, which gives a powerful and efficient drive. A conveniently-located shifter-handle, at *B* (Fig. 2), shifts the driving belt. The loose pulley is of single-piece construction and an oil reservoir for supplying its bearing is cast solid around the hub at *A*. The bearing proper has a groove cut in it in which is laid a wick, the ends of which dip into the reservoir below. The drive to the spindle is transmitted from the speed gear-box through the vertical shaft *E* to the head proper. The exterior and interior details of the head are shown in Figs. 3, 4, and 5. The construction of the spindle head is radically different from the No. 2½ machine, (which was described in the department of New Machinery and Tools, September, 1909), the head casting being one single piece, with oil pockets cored out in the casting itself for holding lubricant for the bearings.



Figs. 1 and 2. Front and End Views of No. 3 Horizontal Boring Machine, built by the Universal Boring Machine Co.

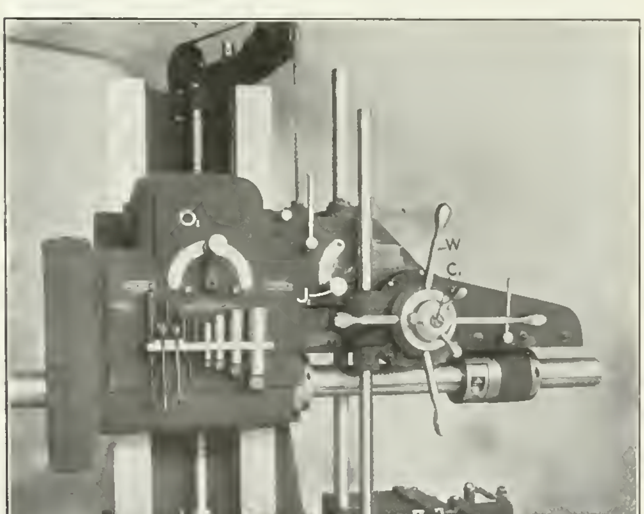


Fig. 3. Detail View of Spindle Head, showing Operating Handles

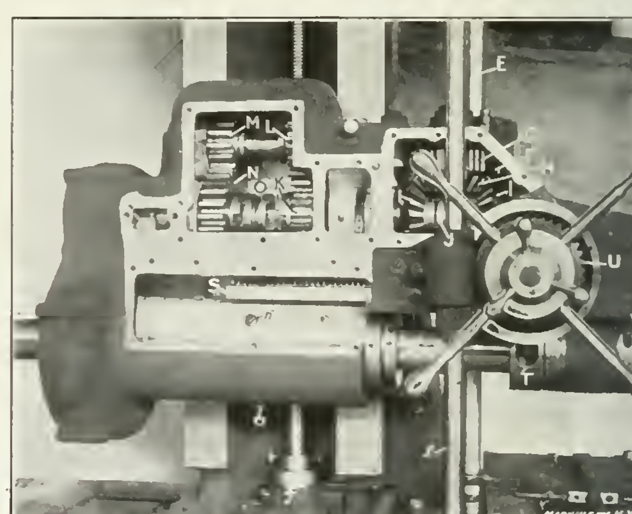


Fig. 4. Spindle Head with Plates removed to expose Mechanism

In Fig. 3 are shown the various operating handles. The handle J_1 reverses the spindle's direction of rotation by operating the jaw clutch J, shown in Fig. 4, and the handle O_1 operates the clutch O, changing the machine from a direct-geared drive to a back-geared drive. As will be seen in Figs. 4 and 5, the power is transmitted from the speed gear-box through the shaft E to the spur gear F, then through G to the bevel gear H. The bevel gears H, I and I_1, together with the clutch J, make up the reversing mechanism. From the reversing mechanism the power is transmitted direct to the driving gear Q, when the clutch O is engaged with K; or around through the gears L and M, when the clutch is engaged with N.

The driving gear is located at a point nearest the work, as shown in Fig. 5, Q being the driving gear and P the driving pinion. This arrangement greatly reduces the torsional strain on the spindle and stiffens it, thus eliminating the chatter usually present when taking heavy milling cuts on machines having the drive at a long distance from the work. The driving gear has a long hub which forms the spindle bearing, and to the spindle are fastened two keys, V and V_1, which drive the boring-bar. The hub of the driving gear forms a faceplate to which a face milling cutter may be fastened, there being four drilled and tapped holes for this purpose. This gives a direct and powerful drive.

The design of the head casting permits the rack S (Fig. 4) to travel the full length of the head, so that the hand-wheel for the quick movement of the boring-bar, can be placed on the head well in towards the face of the spindle, allowing the operator to see the cutters and make adjustments at the same time. A travel of 30 inches at one setting of the adjustable collar T is obtained. The automatic bar feed is received from the feed gear-box through shaft f, which carries a worm meshing with the worm-gear U. On the same shaft with this worm-gear, there is a spur pinion which drives the rack. Referring to Fig. 3, C_1 is a positive clutch which secures handwheel W to the worm-gear.

Automatic Lubrication of the Spindle Head

The details of the automatic lubrication of the spindle head, are well shown in Fig. 5. As this illustration indicates, the head is completely self-oiling. The spindle proper is surrounded by an oil reservoir, the gears run in a bath of oil, and the oil reservoirs for the various bearings are cored out of the casting. The locations of the various oil reservoirs are indicated by the letters, i, j, l, k, m, and n. This system of oiling consists of a wicking laid in a slot milled out of the bearing, the ends of the wicking dipping down into the reservoir below. The large reservoir for the lubrication of the main spindle bearings, is filled at n and drained at o. (See Fig. 4.)

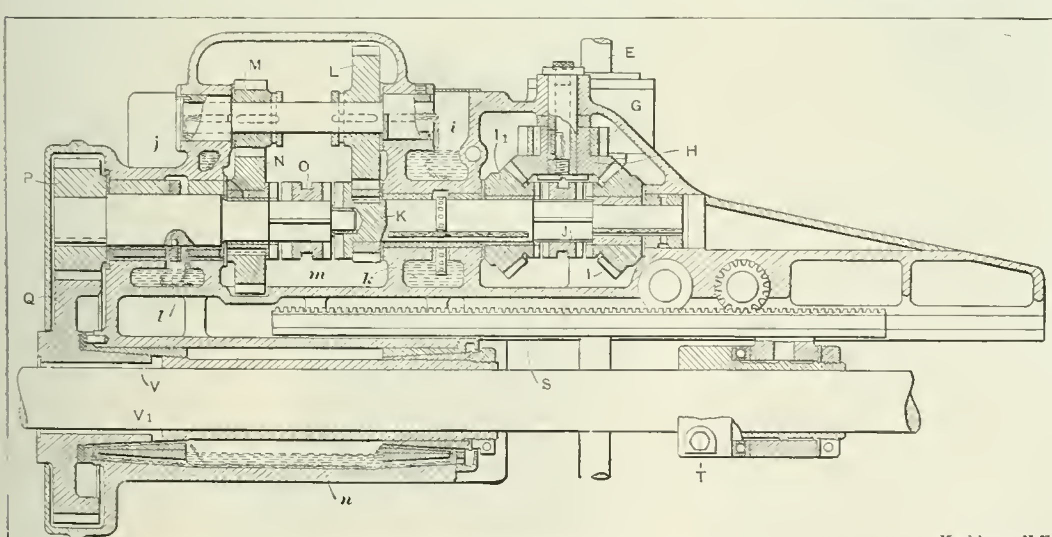


Fig. 5. Sectional View of the Spindle Head

Automatic Feed to the Table

The method of transmitting the automatic feed to the table is shown in Fig. 6. As will be noted, the table has been removed from the saddle, so as to show the details of the feed. The power is transmitted from the feed gear-box through the shaft X which has mounted on it a 45-degree spiral gear meshing with the 45-degree spiral gear Y, and a jaw clutch. The spiral gear runs free on shaft X, and the jaw clutch is keyed with a sliding spline. The spiral gear Y carries the nut for operating the table feed, and when the lever at the right of the saddle is pulled out, as shown, the jaw clutch engages corresponding teeth in the hub of the spiral gear beneath the saddle, thus engaging the feed. The stop Z is for throwing out the cross feed automatically. The saddle is traversed by power or hand longitudinally along the bed of the machine. A hand crank feed with micrometer adjustment is furnished for the operation of the table longitudinally and transversely.

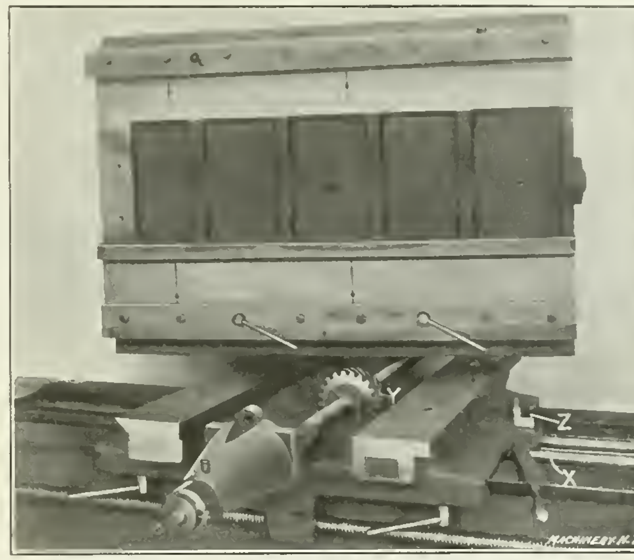


Fig. 6. Table removed from Saddle to show Feed Transmission

Speed and Feed Changes

The gear-box is strong and compact, and contains the feed and speed change gears, which are made of steel. These gears run in a bath of oil which insures sufficient lubrication and quiet operation. Eight speed changes are secured from the gear-box by means of levers C and D, Fig. 2, and these are doubled at the head by the back-gear lever, giving a range of from 15 to 200 revolutions per minute. There are nine feed changes in either direction for the head, one lever reversing or stopping all feeds. The feeds range from 3/4 inch to 5 1/2 inches per minute, without reference to the speed of the spindle. Fewer changes of speed are required where this system of feed drive is used, as it provides finer feeds for small cutters at high rotative speeds, and coarser feeds for larger cutters at low rotative speeds than can be obtained when the feed is driven from the spindle.

Miscellaneous Features

An automatic vertical milling feed as well as an automatic quick-raising and lowering feed, are provided for the head, in addition to the automatic feed in either direction for the boring-bar and the cross and longitudinal feeds for the work table.

The outer support bearing for the boring-bars, is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing is accomplished by means of a

screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two move simultaneously. Provision has been made for realigning the bearings in case of wear.

This machine has been built with a special view to accuracy and permanence of alignment, and it is particularly adapted to the machining of jigs, crank-cases, cylinders, and similar work requiring accurate boring, milling and drilling operations. The weight of the No. 3 machine is about 10,000 pounds.

DUDGEON HYDRAULIC RAIL BENDER AND PUNCH

Two interesting hydraulic tools that are the product of Richard Dudgeon, Broome and Columbia Sts., New York City, are shown in the accompanying halftones. One of these tools, illustrated in Figs. 1 and 2, is a hydraulic rail bender. This rail bender is provided with double pumps so that both pumps can be used when the work is light, or until the strain becomes excessive, when a quarter-turn of the valve handle will throw out the upper pump and permit the lower one only to operate, which gives the ram a reduced speed and a corresponding increase in power. In this way, a considerable saving in both time and labor is effected.

The ram is fitted with a rack and pinion movement which permits it to be run out rapidly against the rail without the labor of pumping, so that the first stroke of the lever is made against pressure, the suction caused by the movement of the plunger filling the cylinder. When the ram is to be returned into the cylinder, the valve handle used in changing the pump from duplex to single, is given an additional quarter-turn, which opens the valves, so that the return of the ram forces the fluid back into the reservoir. The pumping mechanism, shown in the sectional view, Fig. 2, operates on the same principle as that used on the Dudgeon universal jack, which was described in the department of New Machinery and Tools for March, 1910.

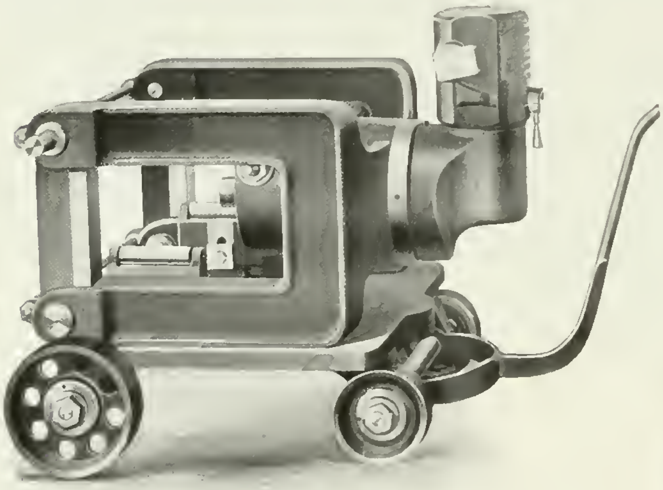


Fig. 1. Dudgeon Hydraulic Rail Bender

Inasmuch as the hydraulic rail bender and the hydraulic punch have always been special tools that used much higher pressures than the hydraulic jack, a man accustomed to the repair of jacks would doubtless have difficulty in repairing these special appliances, as the packings, valves, and joints intended for a pressure of 8000 or 10,000 pounds to the square inch, do not require the same kind of treatment as similar parts subjected to pressures of 15,000 or 17,000 pounds per square inch. These figures represent about the difference in pressure between the hydraulic jack and the rail bender and other forms of tools of the same type. In this new design of rail bender, the pressure is uniformly 6000 pounds to the square inch, which is the same as that used in the universal hydraulic jack. In fact, the rail bender is an adaptation of the universal jack, as before stated, and it is made, where possible, of jack parts; therefore, a railroad having a stock of jack repair parts can use them on the rail benders, and men accustomed to repairing hydraulic jacks can operate and repair this type of rail bender equally well.

To facilitate repair work, the valves, pistons, and pumps have been made as simple as possible. The valves can all be removed by unscrewing one bonnet, and unscrewing a plate permits of taking out the piston. If injury to the pump itself requires its removal, this may be effected by unscrewing a nut and threaded ring. Owing to the difficulty of machining the interior of the cylinder when formed integrally with the frame, it has also been made removable, the unscrewing of a threaded collar permitting it to be taken out for machining, when necessary.

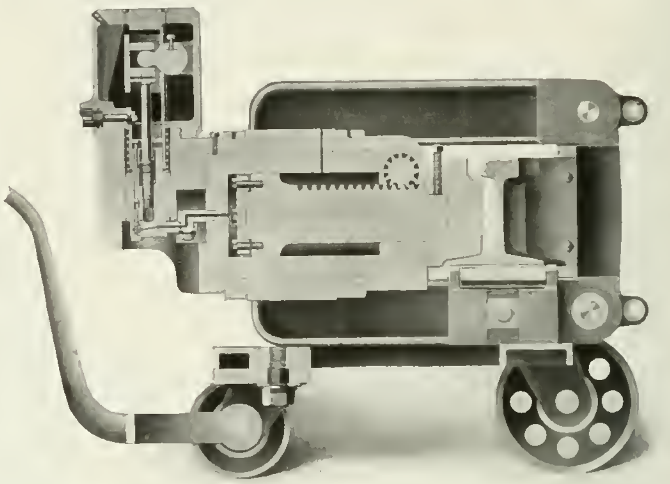


Fig. 2. Sectional View of the Rail Bender

In Fig. 3 is shown a portable hydraulic punch. This punch also has the rack-and-pinion adjustment for the ram, the double pump giving two speeds, and other features common to the rail bender. It is built in two sizes, the smaller of which has a capacity for I-beams ranging from 6 to 12 inches, and the larger for I-beams from 6 to 24 inches. The punch and die are, of course, removable to permit the use of different sizes.

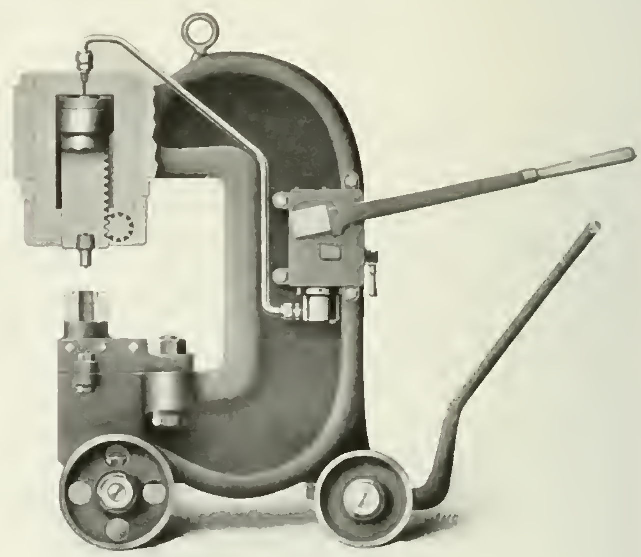


Fig. 3. Dudgeon Hydraulic Punch

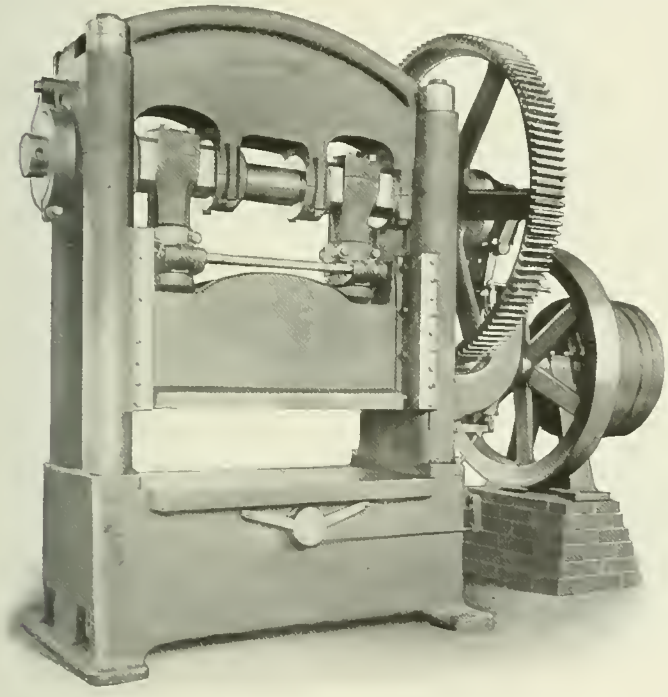
MAX AMS MACHINE CO.'S DOUBLE-CRANK PRESS

The accompanying illustration shows the construction of a line of heavy double-crank presses that is now being built by the Max Ams Machine Co., Mt. Vernon, N. Y. These presses are especially designed for heavy stamping operations, such

as blanking and forming automobile parts, stair risers, ceilings, metal shingles, etc. The parts of the machine have been so proportioned as to gain the best results with the least weight possible. The frame is of the built-up type and is reinforced by four steel rods which take the entire working strain. The slide is well gibbed and it has a parallel adjusting mechanism for raising and lowering. The shaft is large in diameter, to avoid springing, and has large adjustable bearings. The gears are cut from the solid and the driving pinion is made from steel. The clutch is of the sliding block type which is particularly adapted for heavy duty. The striking surfaces are lined with hardened steel faces, and in order to eliminate wear on these faces, the sliding block is pushed away from the wheel sufficiently to give a clearance space.

The press illustrated has a safety device which is especially recommended by the builders. This device has two operating levers, both of which must be grasped by the workman when starting the press. With this arrangement it is impossible for the operator to place his hands between the punch and die while the press is in action. If two men are required to handle the work, four safety levers can be provided. These levers are arranged so that they may be disconnected if necessary.

The principal dimensions are as follows: Width between the uprights, 60 inches; stroke of the slide, 3 inches; distance between the bed and slide when the latter is down and the adjustment up, 10 inches; dimensions of flywheel, 60 by 6½ inches; weight of flywheel, 1700 pounds; diameter and width



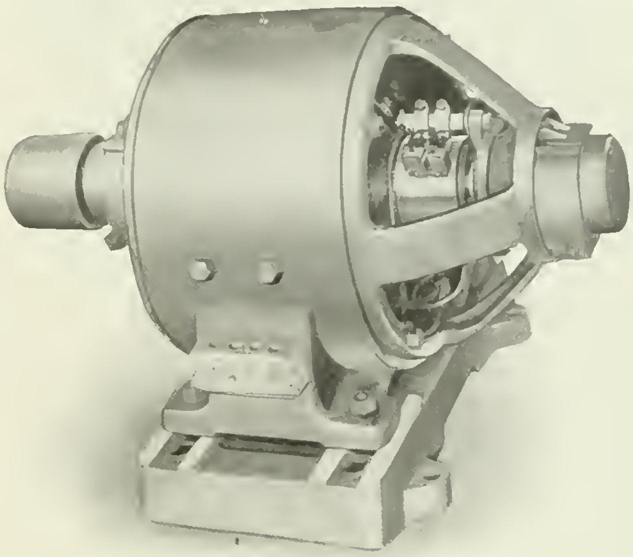
Ams Double-crank Prese for Heavy Stamping Operations

of driving pulley, 36 by 8 inches; ratio of gearing, 1 to 9 1/3; and approximate weight, 40,000 pounds.

GENERAL ELECTRIC COMMUTATING-POLE MOTOR

The severe service required of electric motors in many industrial power applications, and the consequent necessity for reliability and efficient operation, requires the use of machines possessing good commutation, overload and heating characteristics, combined with mechanical ruggedness. The type CVC commutating-pole motor brought out by the General Electric Co., Schenectady, N. Y., has been specifically designed to meet such requirements.

Sparking under the brush of a non-commutating-pole direct-current machine is almost wholly due to the absence of a magnetic field, automatic in action and of sufficient intensity to reverse the armature coils, successively short-circuited as corresponding segments pass under the brushes. The commutating poles of CVC motors are connected in series with one another, and also with the armature; their magnetizing power is, therefore, in proportion to the armature current, and consequently, may be employed to compensate for armature reaction, allowing sparkless commutation over wide ranges of load and under adverse conditions of operation. In addition, commutating-pole motors allow a wider range of speed control by field, than is permitted with motors of non-commutating-pole design. The freedom from sparking reduces the heating of the commutator and brushes, minimizes atten-



General Electric Commutating-pole Motor

tion and repairs, and greatly increases the life of these parts.

Internal ventilation is secured by a simple and durable form of fan mounted on the armature shaft within the pulley end bearing head. This fan, while consuming a negligible amount of energy, insures cool operation under severe conditions of temperature and load. The main field coils are wound on strong horn fiber spools, amply insulated with pressboard, mica, varnished cambric, etc., to insure freedom from breakdown under possible excessive potential strains. The windings are rendered moisture-proof by thorough impregnation with a special insulating compound. Before final assembly, the coils are armor-wound with a single layer of enamel-covered wire, which serves the double purpose of protecting the active windings from mechanical injury and assisting to a higher degree of heat radiation.

The commutating poles are wound with rectangular copper wire, the coils being assembled on horn fiber spools, which thoroughly insulate the coils from the pole pieces. Special pains have been taken to so design the commutator that complete immunity will exist from loose or "high" bars. The commutator bars are insulated from one another and from the commutator shell by selected sheet mica, micrometer gaged to a uniform thickness, and of proper hardness to wear down evenly with the copper. The outer corners of the segments are rounded to prevent chipping of the mica, and the inner edges are notched out to prevent short-circuiting between the bars. There are small grooves in both the flat sides of the copper segments which serve, when the commutator is hydraulically pressed in its assembly ring, to firmly anchor the mica insulating segments, thus avoiding the possibility of "high" mica.

As the bearing heads are interchangeable, the relation of the terminal block to the commutator and pulley end heads, may be shifted by removing the heads, turning the armature end for end, and finally replacing the heads to correspond with the reversed armature position. It is thus possible to have the terminal block accessible under varying conditions of installation.

The bearing linings are large, and thorough lubrication is insured by the use of heavy oil rings of generous cross section. All bearing brackets and frames are drilled and tapped

symmetrically so that the motors may be readily arranged for side-wall or ceiling suspension by turning the bearing heads 90 or 180 degrees, respectively, with relation to the frame.

DAVIS 26-INCH TURRET LATHE

The accompanying halftone, Fig. 1, shows an improved design of turret machine for boring, forming, and turning, that has been brought out by The W. P. Davis Machine Co., Rochester, N. Y. The driving mechanism of this machine has been rearranged, a gear box similar in construction to those used on engine lathes has been added, thus giving a wide range of feeds for turning and thread cutting without the use of change gears, and a number of other changes have been embodied in the new design.

The machine has a geared friction head and triple back-gears so arranged that the triple gear can be meshed directly with the faceplate, if desired. The spindle is made of a special grade of steel, and it has a heavy 18-inch, four-jaw independent chuck. The boxes have ample oiling facilities and are made of the best quality babbitt metal, which is compressed before being bored. The cone has four steps which, in connection with a two-speed countershaft and the back-gears, gives a wide range of speeds. The addition of a change gear box permits changes for turning or threading to be quickly obtained. There are thirty-two changes possible, enabling threads from 2 to 32 per inch to be cut. The position of the feed control levers are plainly shown by an index plate that is simply arranged. Special or fractional threads can also be cut by changing the end gears.

The method of transmitting the feeding movement from the spindle to the gear box is shown in the detailed view, Fig. 2. Shaft *A*, which is driven from the spindle through spur gears as shown, drives shaft *B* which transmits the movement to shaft *G* and the gear box. This box contains a cone of eight gears giving a similar number of feed changes by shifting a tumbler gear, and this number is doubled by engaging key *E* with one of the two gear combinations shown. By reversing the gears between *B* and *G*, a total of thirty-two feed variations is secured. It should be explained that three of the eight cone gears were omitted on the drawing to show more clearly the reversing mechanism. If it is desired to reverse the feed either when turning or thread cutting, this may be done by operating the foot treadle shown at the front of the machine. This treadle controls the location of a clutch that is interposed between the bevel gears *C* and *D*. When this clutch is shifted to the right, into engagement with gear *C*, the drive to shaft *B* is direct, but when the clutch is thrown to the left into engagement with gear *D*, motion is transmitted from *C* to *D* through idler gear *F*, thus giving a reverse movement.

The turret has automatic stops for each of its six positions, that are located on the bed and are adjustable at any point desired within the length of the bed. Each of the turret faces measures 6 by 8½ inches and is provided with a 2½-inch hole having a keyseat and key to prevent boring-bars from rotating. There are also four small holes for attaching forming tools. A locking device is provided for holding the various faces in alignment with the spindle, and the turret has an open center so that a mandrel can be passed through it. The saddle on which the turret is mounted has a bearing of 30 inches on the bed, and a travel of 40 inches. In addition to the sixteen instantaneous and reversible feed changes, the turret has a hand feed operated by the pilot wheel shown. The carriage also has hand and power feeds with automatic stops for the longitudinal feeding movement. A four-sided turret type of toolpost is mounted on the cross-slide and is supplied with a power cross-feed. This toolpost can, of course, be revolved so that four different tools can be used without changing. The carriage and also the turret saddle are driven by the lead-screw, so that either of them may be used for thread cutting.

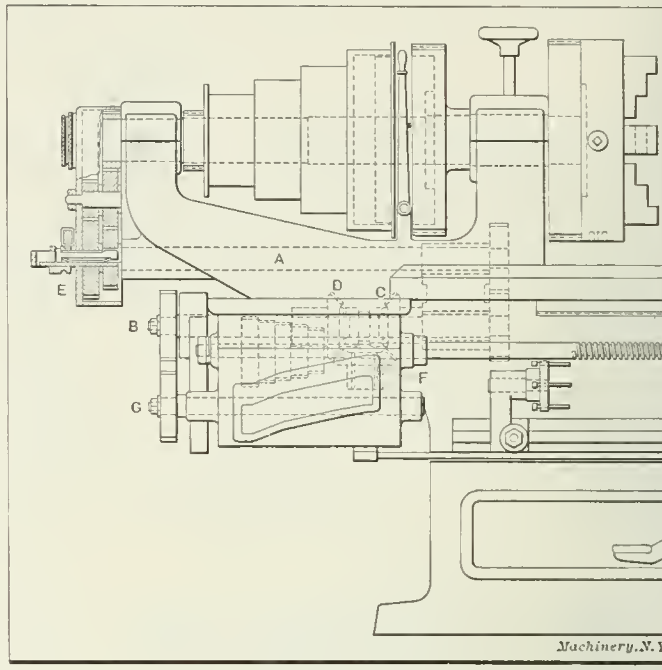


Fig. 2. Detail showing the Feeding and Reversing Mechanism

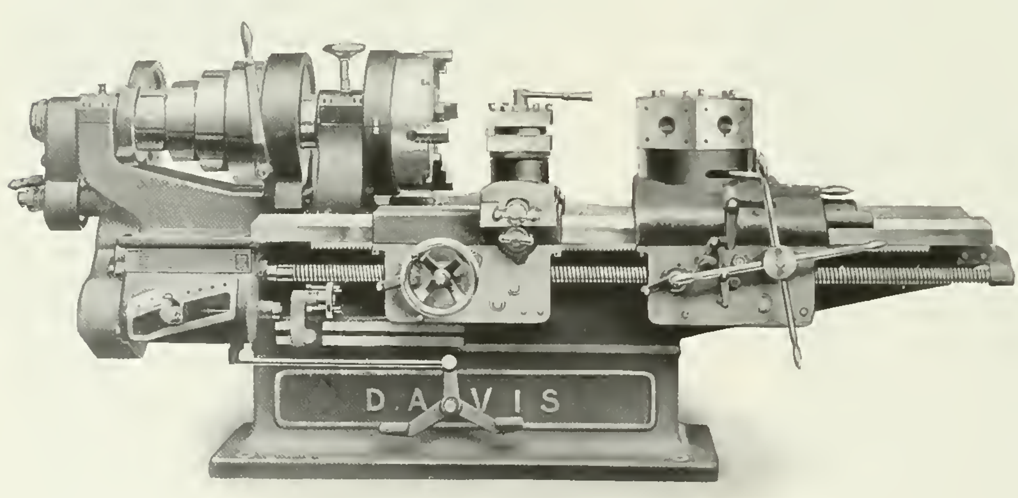


Fig. 1. Davis 26-inch Turret Boring, Forming and Turning Lathe

Some of the general dimensions of this machine are as follows: Diameter of hole through the spindle, 3⅛ inches; size of front spindle bearing, 4⅞ by 7 inches; size of back bearing, 4¼ by 5¼ inches; swing over the carriage, 18 inches; swing over the ways, 26 inches; maximum opening between face of chuck and turret, 50¼ inches; width of the driving belt, 4 inches; net weight, 7000 pounds. The countershaft for this machine has two dust-proof friction pulleys which are self-oiling. The hangers are also self-oiling. The machine can be furnished, if desired, with an oil pan and pump for lubricant.

MOTOR CONTROLLING APPARATUS

The Electric Controller & Mfg. Co., of Cleveland, Ohio, has developed a magnetic switch for controlling the acceleration of electric motors, that is inexpensive and free from complication. As this switch will automatically close its contacts when the motor current falls below a predetermined value, it is a combined magnetic switch and current-limiting relay. The switch has an operating coil which is connected in series with the motor to be started, this coil being composed of a

few turns of heavy wire of fireproof insulation. If the motor current exceeds a predetermined value, the switch will lock out and will not close until the current has been reduced by the speeding up of the motor. A train of these switches, cutting out starting resistance step by step, provides a method of motor acceleration which is absolutely automatic and protective, and it accomplishes this with apparatus so simple that the expense will not prohibit its application to any electric motor.

The front and side views of this magnetic switch (which is known as the type A) are shown in Fig. 1. The operating coil is enclosed and protected by a cylindrical iron shell mounted on a slate panel. At the top are two copper laminated brushes which, when the switch operates, are short circuited, thereby cutting out a section of resistance. At the bottom of the coil shell a movable plug is provided for adjusting the amount to which the current must fall before the switch operates; screwing in this plug will increase the lock-out value, and, of course, screwing it out will reduce the value of the lock-out current.

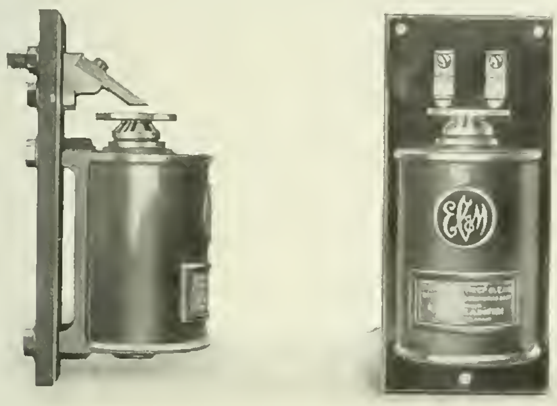


Fig. 1. Magnetic Switch which is used in the Automatic Motor Starters developed by the Electric Controller & Mfg. Co.

Fig. 2 shows the operating characteristics of this switch. In this illustration, the vertical distances represent current flowing through the operating coil, and the horizontal distances, positions of the adjusting plug. The shaded area indicates the operating limits of the switch. For example, if the plug is at position *a*, the switch will lock out at any current above 200 amperes but will definitely close as soon as the current falls to 200 amperes. Similarly, with the plug at position *b*, the switch will lock out at any current value above 300 amperes, but will operate when the current falls to 300

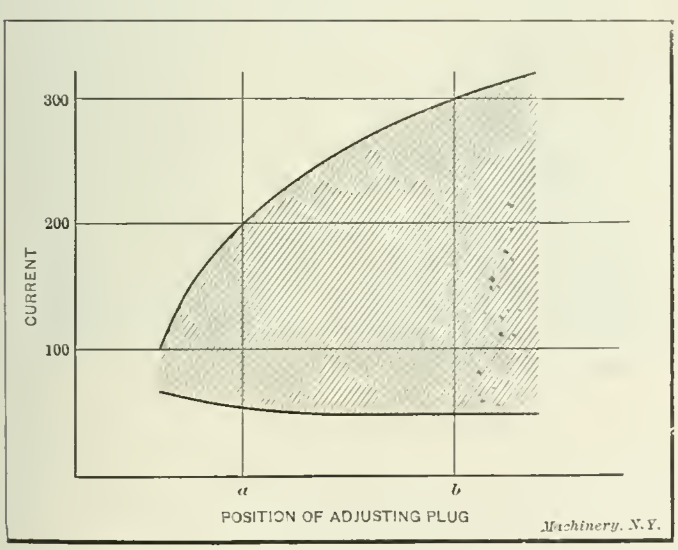


Fig. 2. Diagram illustrating Operating Characteristics of the Magnetic Switch

amperes. The bottom of the shaded area indicates the minimum current at which the switch is operative although, after the switch has once closed, it will remain closed until the current has dropped to practically zero.

A complete line of motor starters embodying the use of this switch, which are known as the E. C. & M. automatic motor starters, has been developed. These have been standardized for 110, 220 and 550 volts (direct current) and cover a wide range of horsepowers. In order to make them as universally applicable as possible, the starters have been laid out in six different forms and, in addition, with various numbers of the accelerating switches. The simplest form consists of a train of type A switches, suitably mounted in connection with resistance, a front view of such a starter being shown in Fig. 3.

Fig. 3. Simple Form of Automatic Motor Starter

This starter is intended to be used in connection with a knife switch, exterior to it. If it is desired to incorporate the knife switch in the starting panel, this is done as illustrated in Fig. 4. Where push-button or automatic control is desired, a shunt wound magnetically-operated switch is also incorporated; this is also preferable for large motors. The starter, including the magnetic switch, can also be equipped with an overload, giving complete circuit-breaker features and either of these modifications can be furnished with or without knife switches. A complete line of accessories has also been developed such, for instance, as would be required for automatic pressure regulation, maintenance of water level in water tanks, etc.

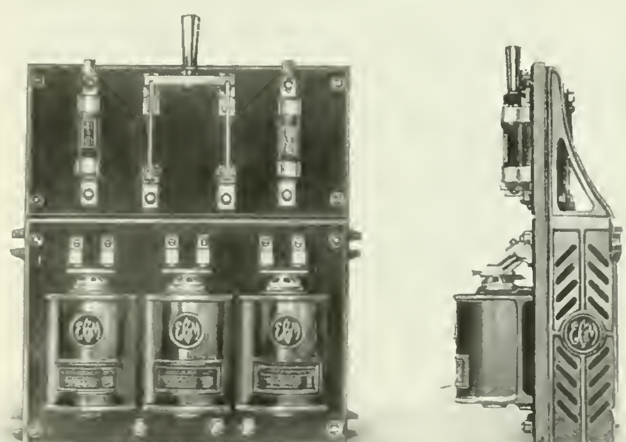


Fig. 4. Panel containing Magnetic Switches and Knife Switch

The number of accelerating points which any particular starter will develop, is one more than the number of accelerating switches used. For small motors where the load to be accelerated is light, one or two type A switches will be ample; on the other hand, for large motors, and particularly motors which have to accelerate heavy inertia loads, five or six type A switches should be selected. This starter in its simplest form provides no-voltage protection, for if the voltage fails, all of the switches at once drop out, inserting all of the starting resistance in series with the motor; upon the return of voltage, the motor is automatically accelerated in the normal method. To start or stop the motor, it is merely necessary to close or open the knife switch. The acceleration is entirely automatic and will be accomplished in the shortest, safe time. If the load is light, the switches will close rapidly and bring the motor up to full speed in a short period

of time, and if the load is heavy, the switches will close much more slowly and the time required to bring the motor to full speed will be considerably lengthened.

This type of switch also finds a large application in controller work, and the company is prepared to furnish it in connection with either reversing or non-reversing controllers for motors of practically any horsepower and of the common voltages.

NO. 5 ROCKFORD MILLING MACHINE

The Rockford Milling Machine Co., Rockford, Ill., is now manufacturing the design of milling machine illustrated in Fig. 1. This particular view shows the machine equipped with a vertical milling attachment, while Fig. 2 shows the application of a slotting attachment. Both of these attachments are driven by a sleeve or quill, which is connected with the main spindle through spur gearing. This quill is inserted

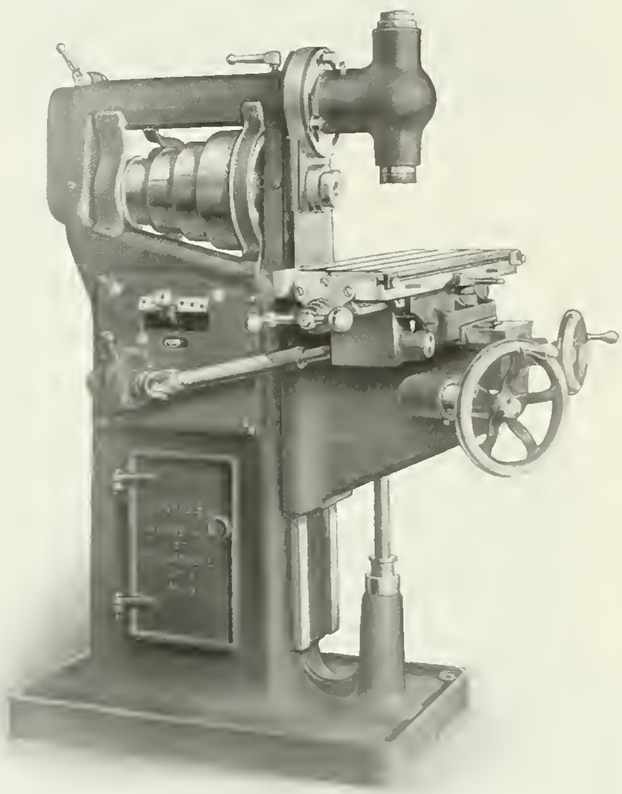


Fig. 1. Rockford Milling Machine with Vertical Milling Attachment

from the back, and it is clamped in place by the same screw which tightens the overhanging arm. When the machine is to be used for regular milling operations, the driving quill may be quickly removed and replaced by the overhanging arm. As the engravings show, these attachments have large bases which are bolted to the column, and the elongated bolt holes provide means for angular adjustment, the angle being indicated by suitable graduations.

This machine has a four-step cone and double back-gears, giving sixteen changes of spindle speed. There are fourteen feed changes ranging from 0.005 inch to 0.210 inch per revolution of the spindle. These changes are effected by handles located on the left side of the column, as shown, one of which gives seven variations through a tumbler gear mechanism, which number is doubled by the interposition of back-gears. The maximum longitudinal feed for the table is 24 inches; the transverse travel is 7½ inches; and the vertical movement below the center, 19 inches.

The principal dimeusions of this machine are as follows: Working surface of table, 32 by 9 inches; over-all dimensions of table, 38 by 9 inches; dimensions of the vise jaws, 1½ by 6 inches; maximum opening of jaws, 3¼ inches; diameter of overhanging arm, 3½ inches; distance from center of spindle to overhanging arm, 5¼ inches; width of driving belt, 2½ inches; length of front spindle bearing, 4 inches; diameter of hole through spindle, ⅞ inch; taper of hole in spindle, B. & S. No. 10; net weight of machine and attachments, 1760 pounds. The equipment includes a two-speed countershaft, the necessary wrenches, a vise, and a flanged support for the overhanging arm. In the design of this machine, the aim of

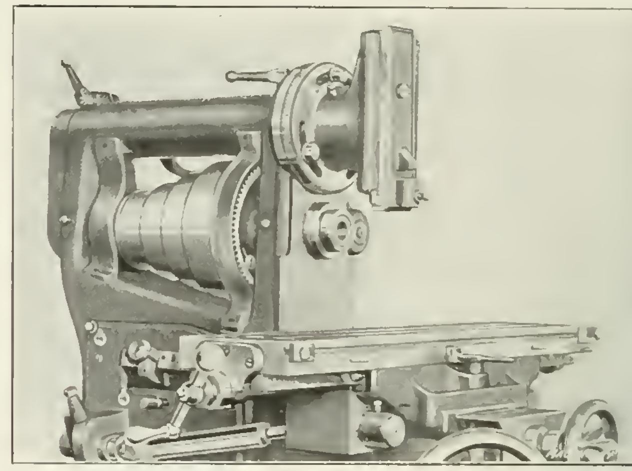
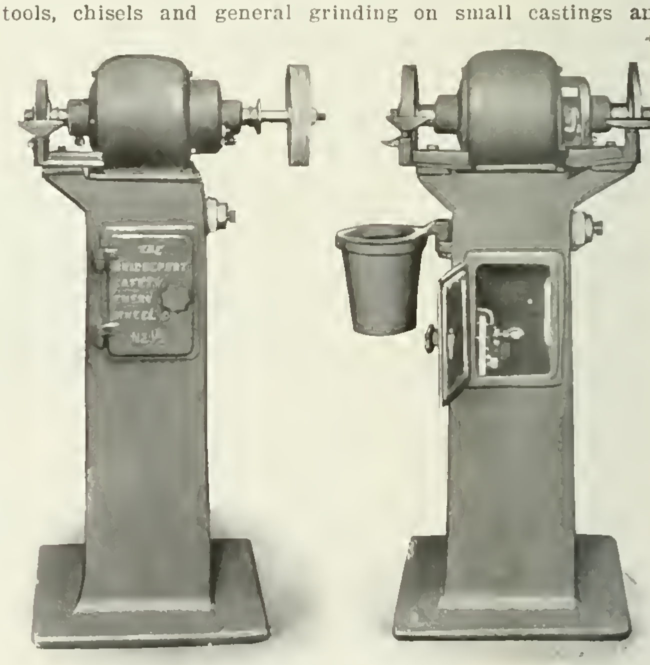


Fig. 2. Slotting Attachment applied to Milling Machine

the builders has been to produce a high-class tool, combining strength with mechanical advantages.

BRIDGEPORT MOTOR-DRIVEN GRINDER

A design of electrically-driven grinder that is now being built by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., is shown herewith. This machine can be arranged with a grinding wheel on each end, or, if desired, one or both of these wheels can be removed and replaced by extra heads that screw on the spindle for holding cotton buffs, felt wheels, wire brushes for cleaning and various other attachments that might be made to screw on in the same manner as the cotton buffs. This machine, as arranged, is for dry grinding, and it is adapted to a variety of work such as drills, lathe and planer tools, chisels and general grinding on small castings and



Bridgeport No. 1 2 Motor-driven Grinder

wrought-iron parts. If there is any probability of drawing the temper of tools when grinding, a water pot can be arranged on the side of the base as shown in the view to the right. The motor is stopped by a snap switch attached to the side of the column, and the starting rheostat is within the column and is reached by opening the door, as shown to the right. These machines are provided with direct-current motors for different voltages or motors of the alternating type as may be desired. The distance between the grinding wheels is 17 inches, the height from the floor to the center of the spindle is 40 inches, and the weight, 350 pounds. The grinder can be provided with an attachment for grinding twist drills if desired.

BATH IMPROVED DUPLEX INTERNAL GRINDERS

A number of improved features have recently been incorporated in the internal grinding machines built by the Bath Grinder Co., Fitchburg, Mass. A No. 2½ size of duplex internal grinder is shown in Fig. 1. This machine has a single spindle-head which carries two grinding spindles that are driven by one belt. These spindles project on each side of the head and operate simultaneously on the work held in the

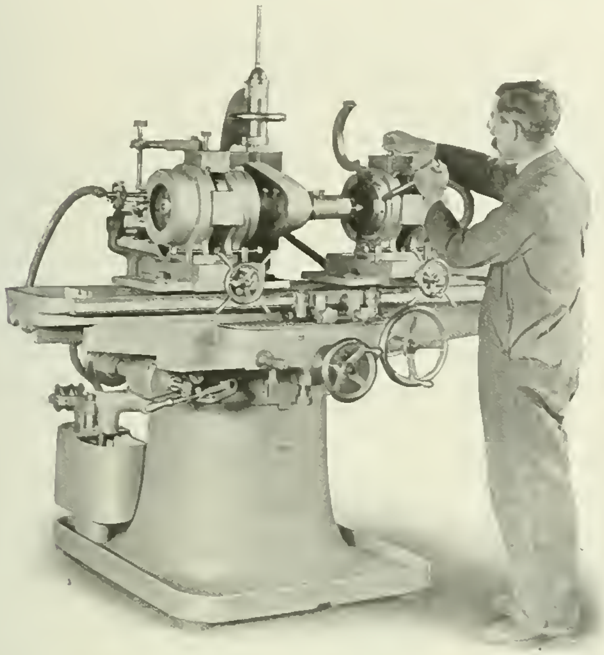


Fig. 1. No. 2 1-2 Duplex Internal Grinder, built by the Bath Grinder Co.

headstocks shown. Both headstocks are mounted on cross-slides that are adjusted transversely by the small pilot hand-wheels shown. Dials on these cross screws indicate the size of the holes on similar parts, by the coincidence of two zero marks, which prevents mistakes. The method of tightening a collet or other work-holding fixture, is illustrated in connection with the right-hand headstock. One half the cover

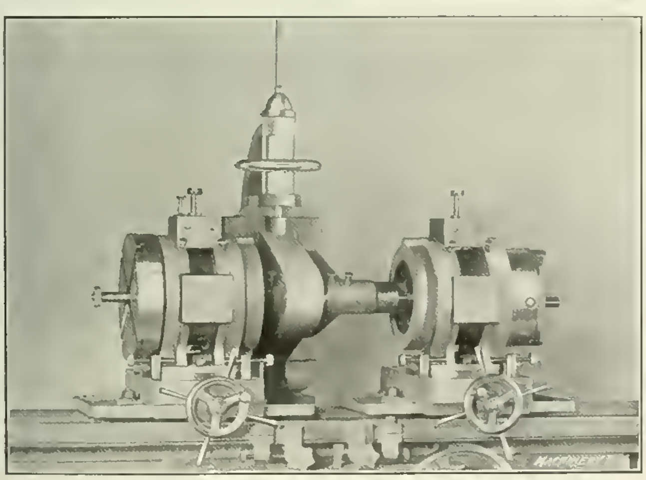


Fig. 2. Headstocks on No. 2 1/2 Grinder, with Faceplate and Universal Chuck

flange (which forms a part of the water shield) is swung upward, as shown, and while the end collar is tightened, the work-head is prevented from rotating by a spring-pin which is temporarily engaged with a hole in its periphery.

Fig. 2 shows the No. 2½ machine with a faceplate mounted on one headstock and a universal chuck on the other, with the grinding spindles entering from the back end, and in Fig. 3 the headstock is seen reversed, to enable grinding from the front end of the hole instead of the back end.

Fig. 4 is a partial view of the No. 5 duplex grinder and illustrates an improved design of headstock for internal work. This headstock is of the swiveling type, which enables straight or taper holes to be ground, and it is provided with water shields or guards for wet grinding. The water pipe is connected directly to the cover, as shown more clearly in the detail view, Fig. 6, connection being made by a flexible hose. When the cover is swung open for truing the wheel or for the insertion or removal of work, the water is shut off by the movement, so that no time is wasted.

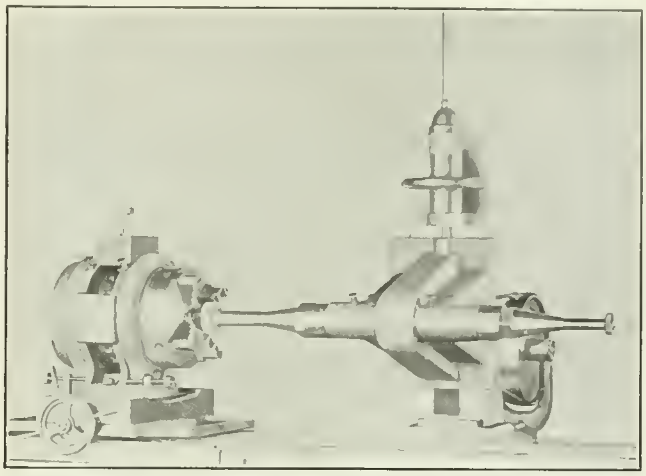


Fig. 3. Headstock Reversed for Grinding from Front End of Hole

A detailed description covering the general construction of the No. 5 duplex grinder, appeared in the department of New Machinery and Tools, October, 1909. A number of improvements have recently been embodied in this machine, among

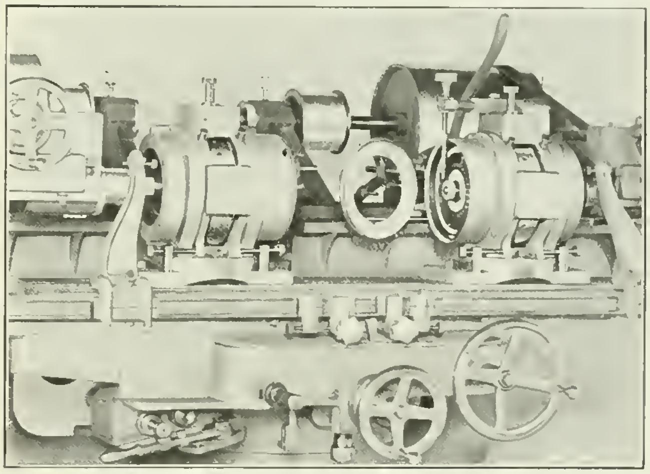


Fig. 4. Detail View of No. 5 Duplex Grinder

which may be mentioned the long reciprocating slide which has been widened and provided with large channels for the cooling water. Another noteworthy improvement is the design of reverse dog for the slide. The end of the dog which

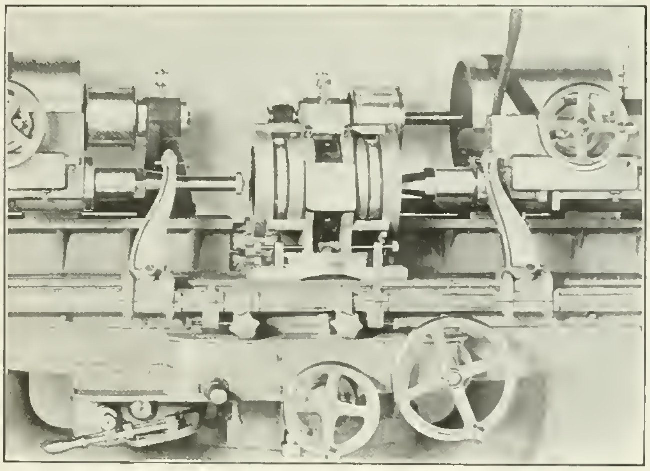


Fig. 5. Special Headstock for Holding Pneumatic Hammers, Long Bushings, etc.

comes in contact with the reversing lever, has three cam-like fingers of unequal lengths, one being long, one medium, and one short. When the dog is turned by the star handwheel so that the long finger strikes the reversing lever (as shown in

the illustration), the wheel is kept in the hole being ground, whereas the finger of medium length allows it to pass half way out of the hole, and the short one lets it entirely out. The advantage of this arrangement is that the stroke of the grinder can be set to keep the wheel at work continuously, that is, in the hole all the time, but whenever it is desired to lengthen the stroke slightly, this may be done by simply turning the dog to bring the short finger into contact with the reversing lever.

Fig. 5 is another detailed view showing the No. 5 machine

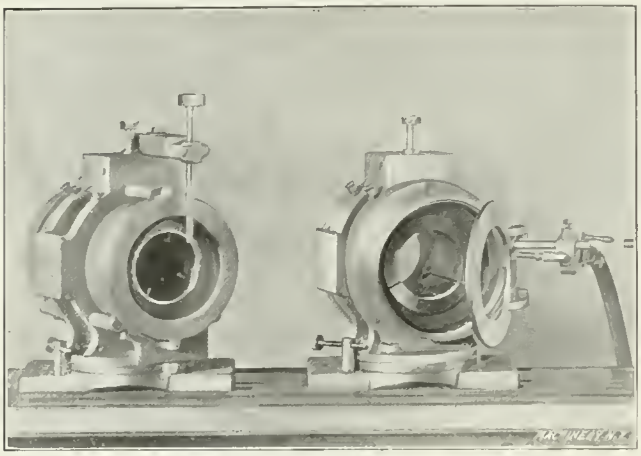


Fig. 6. Improved Headstock with Water Shields

equipped with a special headstock that is furnished for grinding pneumatic hammers, long bushings, etc. With this type of headstock, a coarse grinding wheel may be used for roughing the hole and a fine one for finishing, or two end bearings may be ground simultaneously.

The grinding spindles used on these machines have a large body of metal at the back end which absorbs the vibration of the nigh-speed grinding spindle, and also the heat generated

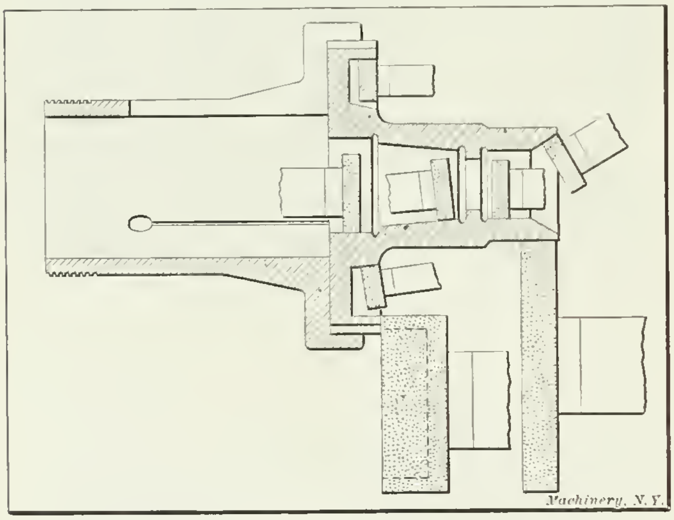


Fig. 7. Internal and External Grinding on a Gear

at the small end of the spindle, thus permitting higher speeds. The bearings are made from Tobin bronze, and the grinding spindles are hardened, ground and lapped. There are no oil holes in the body of the spindles, lubricant being admitted from the back end, which makes a dust-proof construction and allows the machine to be oiled without changing its position.

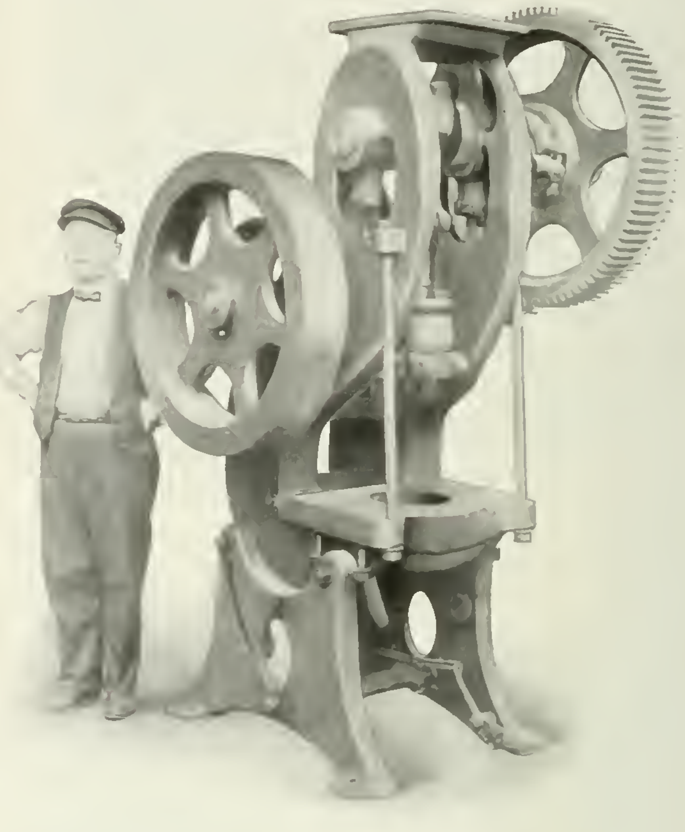
An interesting application of the duplex type of grinder to the finishing of a gear that is part of the dividing mechanism of a gear-hobbing machine, is illustrated in Fig. 7. As the engraving shows, the work is ground internally, from the back and from the front at the same time, and externally on the periphery and side.

FERRACUTE ELECTRICALLY-DRIVEN PRESS

The increasing use of electric power for driving machinery, naturally necessitates changes in the design of the driven machines to provide for the proper application of the power.

The Ferracute Machine Co., of Bridgeton, N. J., has just built a form of press that is particularly adapted for an electric motor drive. A prominent feature of this press is the enlargement of the upper part of the frame so as to provide a base or shelf on which to bolt the motor. This feature is apparent in the accompanying illustration, which shows a DG4 press with a somewhat heavier flywheel than usual, occasioned by the requirement that the press should run at a comparatively slow speed.

The flywheel may be bolted direct to the motor, or, as in this case, a silent chain wheel may be interposed between the flywheel and the frame of the press, the power being applied through the medium of a chain belt. While the press may be inclined, in ordinary cases the upright position is preferable. This way of attaching a motor, economizes space and obviates



Ferracute Press designed for Motor Drive

possible injury to the motor or operator, thereby giving it a distinct advantage over the usual method of placing the motor on a projecting shelf or on the floor.

The press shown has a stroke of 8 inches with 3 inches adjustment; a 35-inch flywheel with a 6-inch face, weighing 750 pounds; a total height of 91 inches, and a total weight of about 5100 pounds. The pressure exerted by the ram is about 50 tons.

WESTINGHOUSE ALTERNATING-CURRENT MOTOR

The alternating-current slip-ring induction motor is especially adapted to severe, varying speed, reversing service, because of its simplicity of structure and the absence of complicated parts. The Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has recently placed on the market a new induction motor (known as the MW type) that is built especially for operating cranes, elevators, hoists, turntables, etc. This motor is illustrated in Fig. 1, and Fig. 2 shows the design of rotor.

The construction is exceptionally strong in order to withstand the heavy stresses of the service referred to; the starting torque and overload capacity are high; and the motor is capable of developing a maximum power for given dimensions. In operation it is practically noiseless, which is essential for elevator service. The construction of the frame, brackets, bearings, and shaft is the same as that of the Westinghouse type MS motor, which has been used successfully in heavy

steel mill duty. The frame is a cylindrical casting with large supporting feet and numerous openings for ventilation. The stator coils are heavily insulated, form wound, and are laid in open slots. The brackets are so designed that they give rigid support to the bearings, and they are machine split in all except the three smallest sizes.

The rotor is of comparatively small diameter so that it has a low flywheel effect and is easy to brake. It is perfectly balanced, and the windings are securely fastened in place.

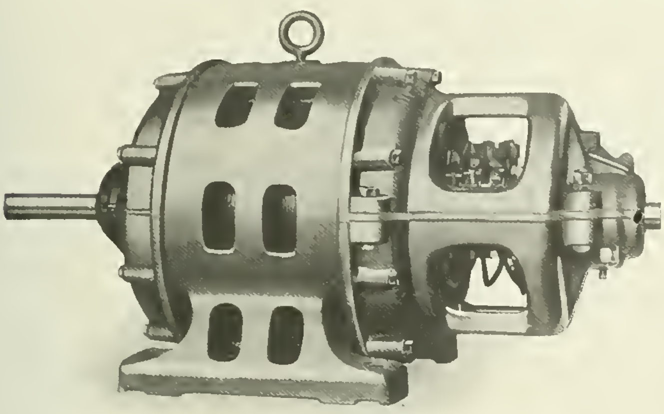


Fig. 1. Westinghouse Induction Motor for Elevator, Crane and Similar Service

These features make the rotor especially adapted for frequent starting, stopping, and reversing. The collector rings are inside the front bearing housing. The shaft is made of axle steel and is very heavy. The bearings are large babbitt-lined iron shells.

Convenience of repair has been an important consideration in the design of these motors. Removal of the upper half of either bracket gives access to the bearings and the interior of the motor without disturbing brushes or connections. The shaft can be removed and replaced without disturbing the

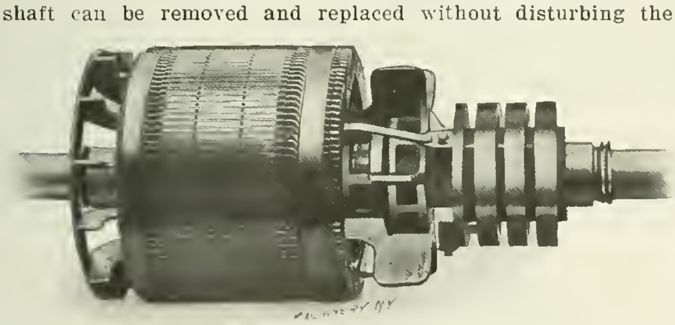


Fig. 2. Rotor of the Westinghouse Induction Motor

rotor windings. The bearings can be readily relined; and the construction of the coils and the manner in which they are laid in the slots, permit ready renewals. All parts are standard, and many of them, such as brackets, bearings, oil rings, brushes, brush-holders, etc., are interchangeable for several frame sizes.

This type of motor is made in a number of capacities ranging from 5 to 300 horsepower and in several speeds.

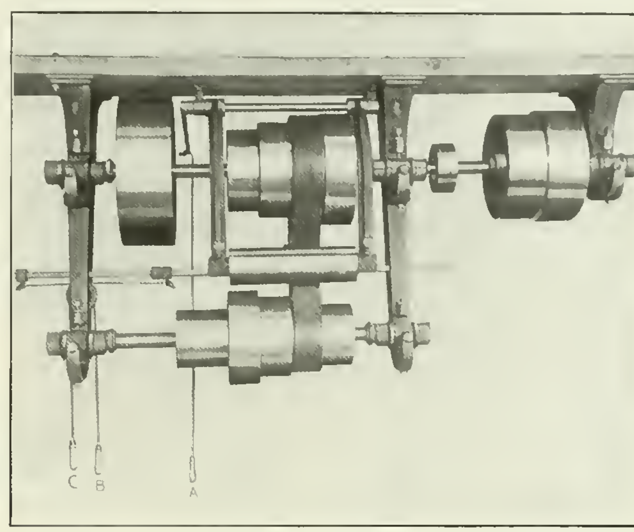
GRAY VARIABLE-SPEED PLANER COUNTERSHAFT

A simple design of variable-speed, ceiling countershaft for application to planer drives, has been brought out by the G. A. Gray Co., Cincinnati, Ohio. This countershaft gives four different cutting speeds with a constant high return speed, and the speed changes are easily made.

The drive consists primarily of two inversely-placed cones (see accompanying engraving), one of which is mounted on a constant-speed shaft which also carries the return pulley, and the other on the variable-speed shaft which carries the pulley for the cutting stroke. The constant-speed shaft, which is the upper one in the illustration, is driven from the lineshaft through a pair of tight-and-loose pulleys, and the variable-speed shaft is driven from the constant-speed shaft by an endless belt, as shown.

The speed changes are made by pulling cord *A* which raises a swinging idler and slackens the belt; the latter is then shifted by pulling either cord *B* or *C*, depending on whether the speed is to be increased or diminished. The swinging idler, by its own weight, keeps the endless belt under the required driving tension and also increases the arc of contact between the belt and cone pulleys. This belt has sufficient width to easily transmit the full power required by the planer. The momentum of the two cones supplements that of the heavy flywheel pulley, and reduces the strain on the lineshaft at the moment of reversal.

The tight-and-loose pulleys are of different diameters so that there is practically no strain on the lineshaft belt when it is running on the small or loose pulley. The pulley shafts run in large ring-oiling, universally-adjustable bearings. The small pulley located to the right of the upper cone (on the constant-speed shaft), drives the power elevating mechanism. The idler for keeping the belt under sufficient tension is keyed



Planer Countershaft giving Four Cutting Speeds and a Constant High Return Speed

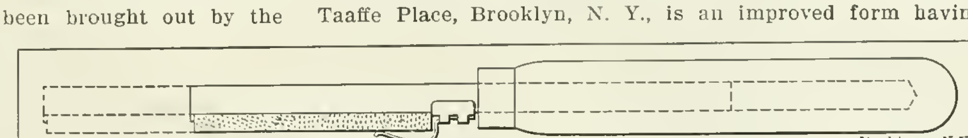
to its shaft which runs in babbitted bearings, lubricated by sight-feed oilers.

From the foregoing it will be seen that there is only one belt leading from the lineshaft to the countershaft, and no complication of shifting levers to puzzle the operator and get in his way. There are no sleeves, gears, frictions or long-hubbed pulleys running loose on their shafts and likely to stick and cut; no positive clutches or sliding gears to be bruised or broken, and no pulling of belts by hand in order to get jaw clutches or sliding gears in the correct relative position for shifting.

This countershaft is simple in construction, noiseless in operation, and speeds can be changed quickly without shutting off the power or even stopping the planer.

BADGE TELESCOPIC OILSTONE HOLDER

An oilstone holder is shown in the accompanying line engraving which is particularly adapted for the use of toolmakers and diemakers for stoning fine tools, punches, dies, etc. This holder, which is manufactured by F. J. Badge, 286 Taaffe Place, Brooklyn, N. Y., is an improved form having



Telescopic Oilstone Holder

a bar or stone-holder which telescopes into the handle. This bar can be extended, as indicated by the dotted lines, far enough to hold an oilstone 4½ inches long, or it can be pressed into the handle until only sufficient length is exposed to hold

a 2-inch stone. This adjustment enables stones of various lengths to be held close to the handle where they may be used more effectively. The bar is of V-section, and round, triangular, square, or rectangular stones can be held. An abutment on the end of the bar prevents the stone from moving endwise, and it is held by a clip or spring.

FEEDING MECHANISM FOR ROCKFORD SHAPERS

The shapers built by the Rockford Machine Tool Co., Rockford, Ill., have been equipped with a new power feeding mechanism for the head. This mechanism is free from complication and is, therefore, serviceable and not liable to get out of order. It feeds the tool either up or down and operates with the head set at any angle.

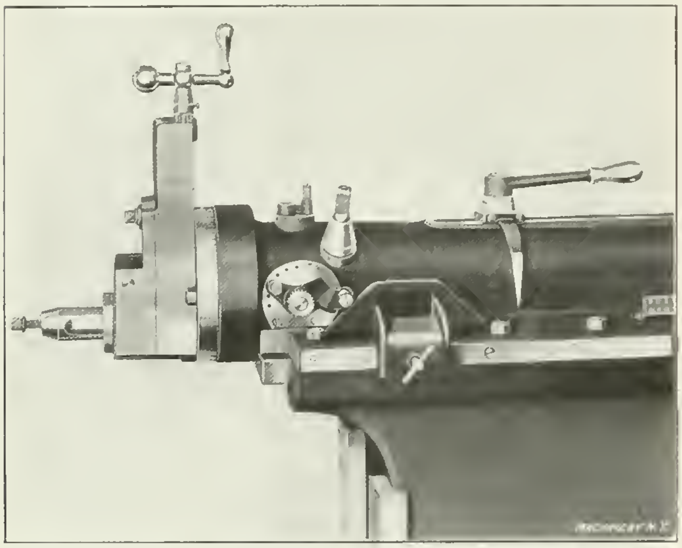


Fig. 1. Rockford Shaper with Power Vertical Feed

Fig. 1 shows the application of this feed to a Rockford shaper, and Fig. 2 illustrates its operation. A block *B*, having angular ends, is clamped to the column and can be readily adjusted to suit the position of the ram, or moved out of the way when not in use. This block is so located that the pawl-arm *A* carrying a roller, is lifted by the angular end of block *B* during the latter part of the ram's return stroke. This movement of the pawl-arm is transmitted to cross-shaft *C* which connects with the vertical feed shaft through bevel gears and an intermediate shaft *D*.

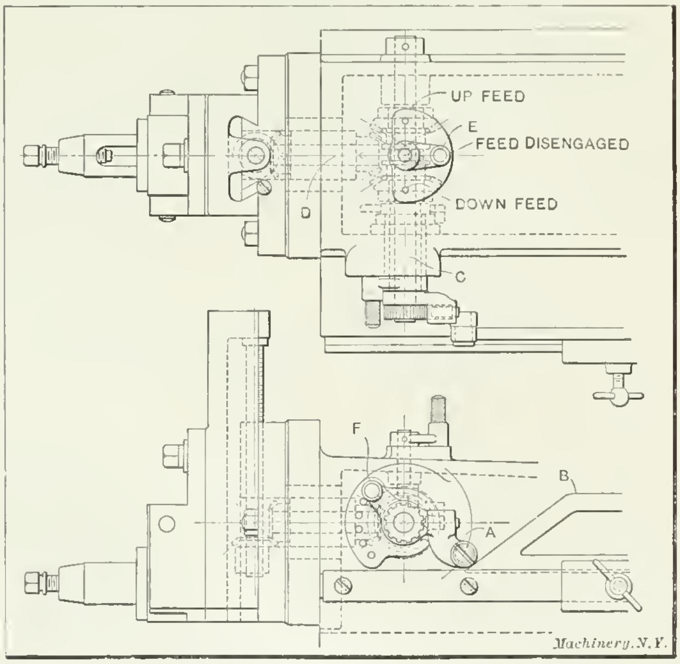


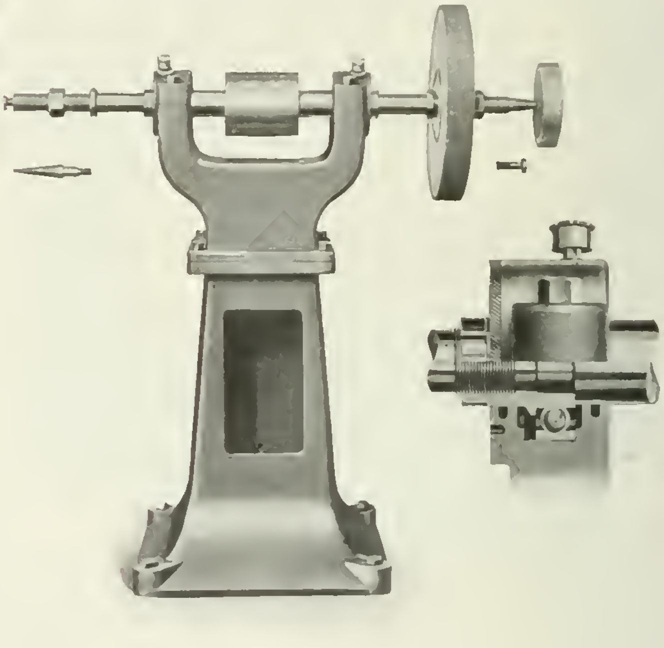
Fig. 2. Elevation and Plan of Vertical Feed Mechanism for Rockford Shaper

The direction of the feed is reversed by means of lever *E* which controls the position of the sliding bevel gears shown in the plan view. This lever also has a neutral position for disengaging the feed. The lever *F* on the side of the ram is for regulating the amount of feed. The position of this lever is changed by engaging a spring-pin in its end with the holes shown, and, as it is shifted downward, there is a corresponding change in the position of pawl-arm *A* in a reverse direction, which results in diminishing its rotary movement and consequently the feed. This simple arrangement gives six changes of feed varying from 0.008 to 0.048 inch.

Ordinarily the sliding block *B* should be located far enough back to prevent the pawl roller from passing beyond it at the end of the stroke. If necessary, however, the feeds can be doubled by using both ends of the block for feeding, the block being placed far enough forward to bring both ends into engagement with the pawl.

POLISHING MACHINE

The polishing machine illustrated herewith is manufactured by the Central Autogenous Welding Co., 73 Union St., Worcester, Mass. The spindle of this machine is mounted in annular ball bearings of the radial type, that have ample space for lubrication and a design of housing that prevents entrance of any abrasive from the wheels. The capacity of these bearings for taking thrust is 25 per cent of their radial load capacity, so that whether the edge or side of the wheel is being used, it always runs true and in the same plane.



Polishing Machine built by the Central Autogenous Welding Co.

The bearings are packed with grease to protect them, and compression grease cups are provided to keep them full constantly. A slight over-flow of this grease out of the housing, effectively prevents any abrasive from getting into the bearing, as it is carried away by the grease. The construction of one of these spindle bearings is shown by the detailed view to the right.

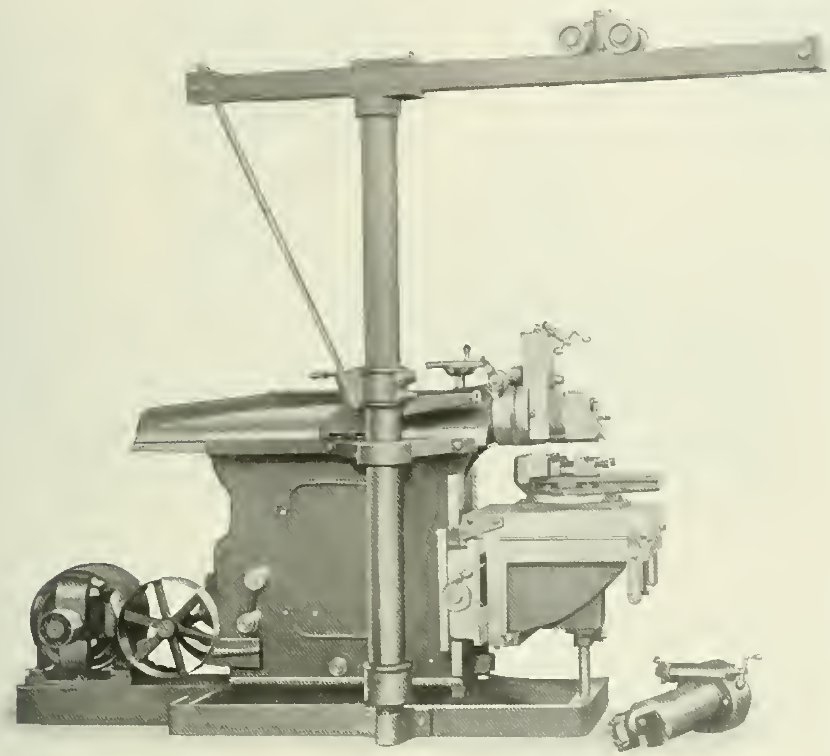
This machine can be driven either from an overhead countershaft or from one located below the floor, there being an opening for passing the belt down through the pedestal. The design illustrated is known as the No. 4 "heavy duty" polisher, and some of the principal dimensions are as follows: Length of spindle, 39¼ inches; diameter of spindle in bearings, 1¾ inch; diameter between the flanges, 1½ inch; size of spindle pulley, 5½ inches wide by 5 inches in diameter; height from floor to center of spindle, 37 inches; and complete weight, about 550 pounds.

CINCINNATI 32-INCH BACK-GEARED CRANK SHAPER

The heavy-duty back-geared crank shaper shown in the accompanying view, is a machine especially fitted for railroad

work. As much of the shaper work in a locomotive repair shop is heavy, a revolving jib crane, having a capacity of 1500 pounds, has been attached to the machine as shown. On account of the height of this crane (9 feet) the illustration does not give a correct impression as to the size of the shaper, which weighs 9370 pounds.

The head of this shaper is designed to operate on the pull-cut principle, and it has a concaving or circular planing attachment with a power feed. There is also an extended circular feeding head, (shown in the illustration just in front of the machine) that has both hand and power feeds. The knee is of special design having a tilting top which has a working surface of 30 by 24 inches. The vise shown has two clamping



Cincinnati 32-inch Railroad and Manufacturing Shaper

screws and will hold either straight or tapering pieces. The vise jaw plates are of annealed tool steel, and the swiveling base is graduated for angular adjustment.

An opening through the column just beneath the ram, provides room for keyseating long shafts or similar work. The ram has a long and wide bearing in the column, and the rail is deep, ribbed horizontally, and strongly gibbed to the column. The length of the stroke is adjusted from the working side of the machine, and its position is changed by means of a handwheel seen just back of the ram. These changes can be made while the machine is in motion or at rest. The cross traverse screw has a graduated collar reading to 0.001 of an inch, and a variable automatic feed which may be adjusted from nothing to the full feed while the machine is running.

The shafts used in this shaper are of high-carbon steel and all are accurately ground. All gears and T-slots are cut from the solid; and all flat sliding surfaces, as well as the surfaces between the apron and table, are hand scraped to surface plates. The pinions used are of cast steel and the miter gears are cut from the solid stock. This machine is the product of the Cincinnati Shaper Co., Elam St., and Garrard Ave., Cincinnati, Ohio.

REMINGTON BENCH LATHE AND ATTACHMENTS

The precision bench lathe and attachments shown in Figs. 1 to 3, are the product of the Remington Tool & Machine Co., Boston, Mass. The improvements in the lathe and its equipment include a combination screw-feed and lever-feed tailstock; a belt tension device; independent stops on the turret slide; a graduated swiveling toolpost on the forming slide; and a lever- and screw-feed for the milling attachment.

The combination tailstock is shown applied to the lathe in Fig. 1. The horizontal movement of the tailstock spindle is 3 inches, and the eccentric end of the binding bolt is adjustable for wear. Fig. 1 also illustrates the means for varying the belt tension. The legs of the bed rest on shoes, which are provided with adjusting screws, so that a lateral movement of 2 inches is obtained. With this adjustment, a continuous lapped-joint belt may be used, as the tension between the countershaft and machine can be varied as required. The stretching of new belts often results in wasting considerable time, which can be eliminated by having a convenient means of adjustment. The turret attachment, which is shown in Fig. 2, has six holes and there is an independent stop for each of the six tools. The forming slide has a swiveling toolpost graduated in degrees, so that straight forming cutters may be used for turning to any angle. The milling attachment shown in Fig. 3, has a lever for hand milling operations and a ball crank handle for screw feed.

The headstock has a three-step cone designed for a 1¼-inch driving belt. The large end flange has sixty accurately-spaced holes which are engaged by a tension-pin for indexing. The spindle is of the two-angle type. It takes ⅝-inch stock through the self-centering spring collet chucks, and ¾-inch material when a universal chuck is used. The end adjustment of the spindle is made by advancing a fiber collar that comes in contact with a shoulder on the front of the spindle. This feature enables holes ½ inch in diameter to be drilled continuously, without any sticking or hugging of the spindle in the bearings. The bearings are made of tool steel and are hardened, ground and lapped.

The tip-over T- or hand-rest is so arranged that the upright portion can be temporarily removed for gaining easier access to the work, without losing the original setting of the rest. The sleeve of this rest is reversed, thus bringing the binder handle at the base where it does not interfere with the

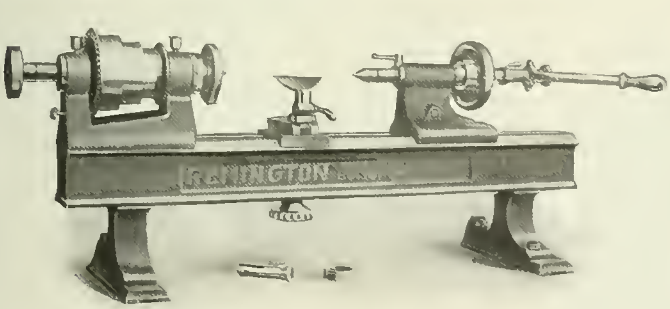


Fig. 1. Remington Precision Bench Lathe, with Lever- and Screw-feed Tailstock

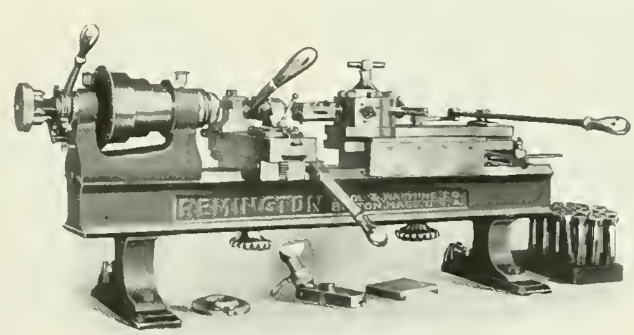


Fig. 2. Bench Lathe arranged with Turret and Forming and Cutting-off Slide

tools or hand. The eccentric locking ring used for holding the T-rest in position, does not interfere with the working tools.

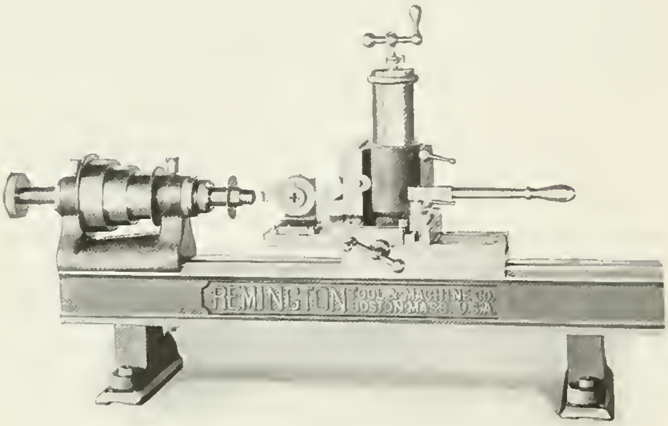


Fig. 3. The Lever- and Screw-feed Milling Attachment

This lathe has a swing of 8¾ inches over the ways, and a 36-inch bed, giving a maximum distance between the centers of 18 inches.

NEWTON COLD-SAW CUTTING-OFF MACHINE

A 32-inch cold saw cutting-off machine that is a modification of the standard design built by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., is shown in Figs. 1 and 2. This machine is designed for sawing the webs of crankshafts, and it embodies a number of features that have been incorporated to increase production partly by reducing the idle time of the machine.

The saw blades are extra heavy and the drive sufficiently powerful to operate two saws simultaneously to their maximum efficiency. The machine is fitted with a geared feed-box giving nine changes with nine gears, and a power quick return. There is also provided a positive safety and adjustable automatic release for the fast traverse and feeds. The gear box is one of the company's standard designs, and the different combinations of gearing are brought into mesh by three sleeves, one of which is stationary, while the two outer ones slide on their shafts. The feed-screw has a bearing at

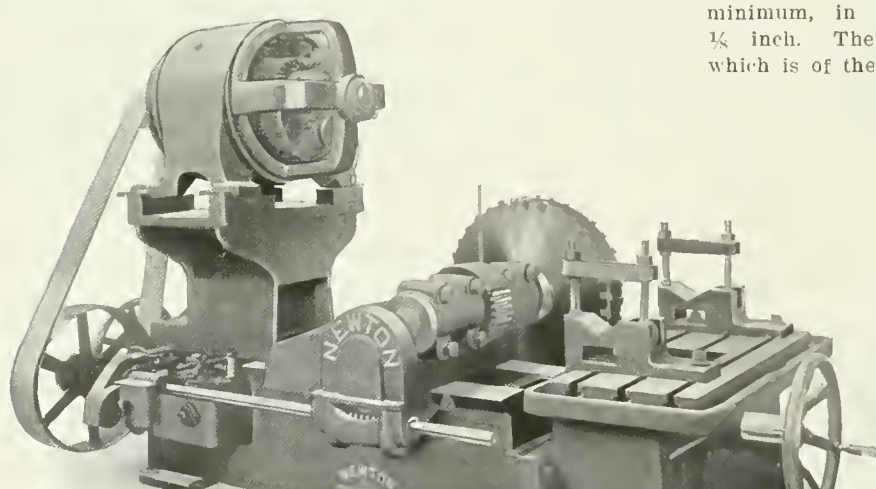


Fig. 1. Newton 32-inch Crankshaft Cold Saw Cutting-off Machine

both ends so that it is always maintained in tension, and it may be operated by handwheels located at both the front and rear of the machine for this purpose. The lever for engaging the fast traverse is operated from the front.

The machine is driven by a twenty-horsepower General Electric, 220-volt motor, having a speed range of from 500 to 1500 revolutions per minute. The drive is through a double 6-inch belt, and the motor is elevated, as shown, in order to give a greater bearing of the belt on the pulleys.

The spindle of the machine revolves in bronze-bushed, capped bearings and it is supported at each end. The spindle and the driving spur gear mounted on it (between the two bearings) are both of nickel steel. The teeth of the pinion that engages with the spindle gear, are cut from the solid shaft on which the solid bronze worm-wheel is fitted. This

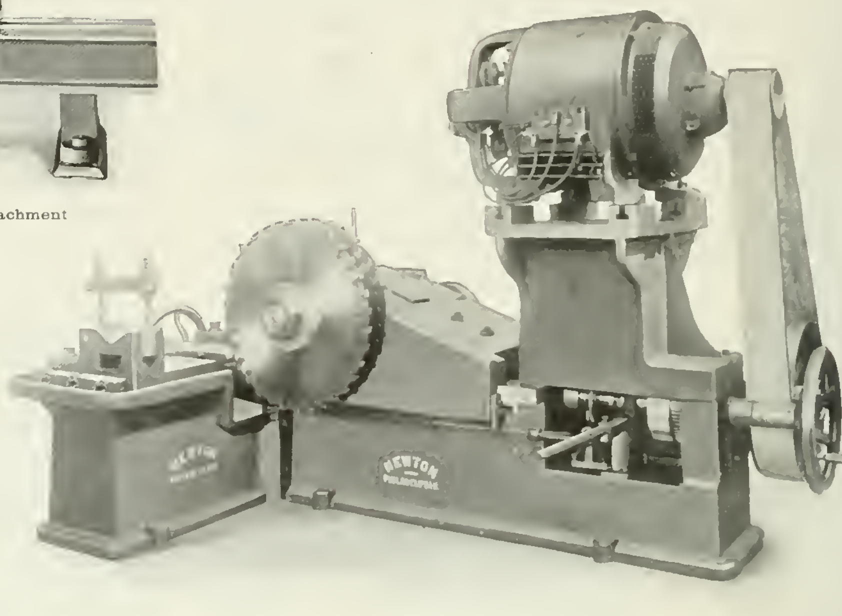
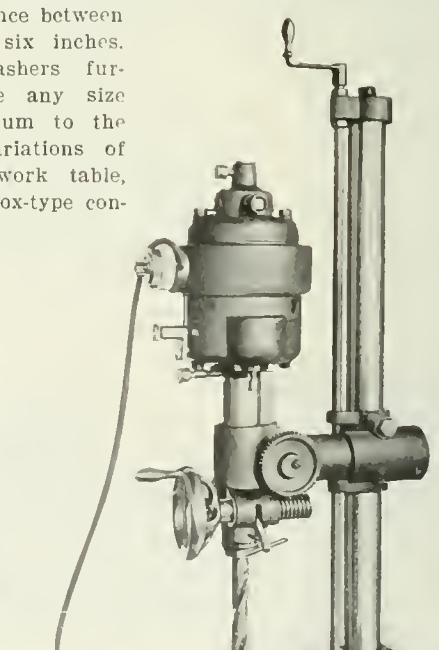


Fig. 2. Another View of the Newton Cutting-off Machine

worm-wheel has proportionately large bearings on the shaft, and teeth of steep lead. The driving worm is of hardened steel and has roller thrust-bearings. The worm gearing is encased to give continuous lubrication.

The spindle is extended to permit operating the blades at a maximum distance between their centers of six inches. The spacing washers furnished will give any size from the maximum to the minimum, in variations of ⅛ inch. The work table, which is of the box-type con-



Electrically-driven Radial Drill, manufactured by the Lamb Electric Co.

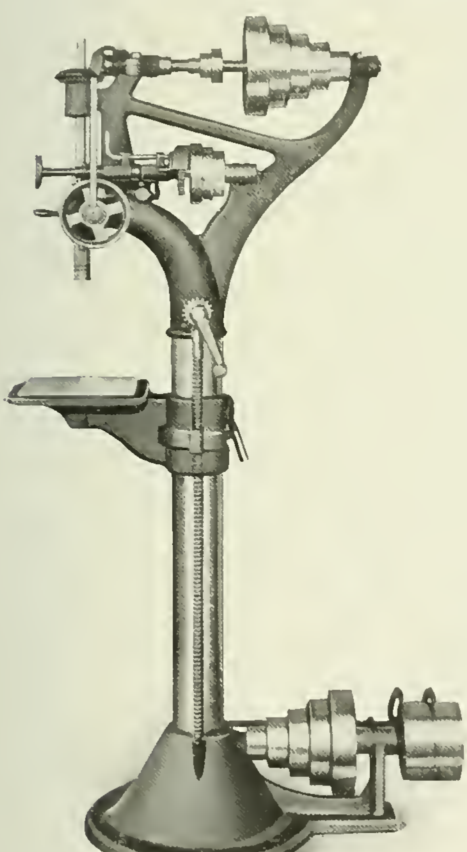
struction, has an oil pan cast integral with it for carrying off the lubricant. The work is held in V-blocks which are shown mounted on the table in Fig. 1, and are included in the equipment.

LAMB PORTABLE ELECTRICALLY-DRIVEN RADIAL DRILL

The portable electrically-driven radial drilling machine illustrated herewith has a maximum capacity for holes up to 1 inch in diameter and the drill spindle can be adjusted to any position. The current for the motor may be obtained from a lamp socket, if a power circuit is not available, and the motors are wound for either direct or alternating currents. The machine can be arranged for either a single speed of 135 revolutions per minute, or for two speeds of 135 and 230 revolutions per minute, respectively. The speed changes may be quickly obtained by simply shifting a knob. The spindle is fitted with a No. 3 Morse taper and it has a movement of 5 inches. The arm holding the spindle can be adjusted to any angle, as the motor is integral with the spindle sleeve. The column is made of steel tubing and the standard length is 3 feet; it can, however, be made longer at a slight additional cost if desired. This drill weighs 130 pounds and it is strongly constructed. The Lamb Electric Co., 20 Huron St., Grand Rapids, Mich., is the manufacturer.

ROCKFORD 14-INCH SENSITIVE DRILL

The Rockford Drilling Machine Co., Rockford, Ill., is now manufacturing the design of upright drilling machine shown in the engraving. The feeding mechanism of this drill is so arranged that it can be handled conveniently and quickly, which is a particularly desirable feature on a machine of the sensitive type.



Fourteen-inch Drill built by Rockford Drilling Machine Co.

The feed is driven by a belt operating on the cone pulleys shown. These cones give three feed changes, and the lower one is placed as low as possible to give a long feed belt, thereby increasing the frictional pull. The feeding movement is transmitted from the lower cone to the worm gearing through a steel pinion and gear, which are covered by suitable guards as shown. The feed frame is in one piece and swings on a long hinge pin which is held by a lug cast solid with the main frame of the machine. The same lever is used for starting and stopping the feed, which is controlled by pressing the lever in an upward or downward direction.

The machine has an automatic stop which is located on the opposite side and, therefore, does not show in the illustration. This stop is so arranged that the full travel of the spindle sleeve is available. A lever on the right-hand side of the machine, that is held by a suitable spring, is used in place of the former hand lever feed. This lever is adjustable as to length and can, therefore, be placed in the most advantageous position for feeding.

The small handwheel shown at the end of the shaft carrying the worm, is very convenient for facing operations. This wheel is attached to the worm shaft, and when used for feeding, the spur pinion for operating the feed is disengaged by a push lever located just above the worm shaft.

UNIVERSAL CHIP GUARD

Every machinist who has had experience on machine work realizes the need of protection for the eyes against the hot chips which fly with considerable force from the cutting point of the tool and are a source of constant danger. The Universal Stamping Co., 47 Poultney St., Buffalo, N. Y., has placed

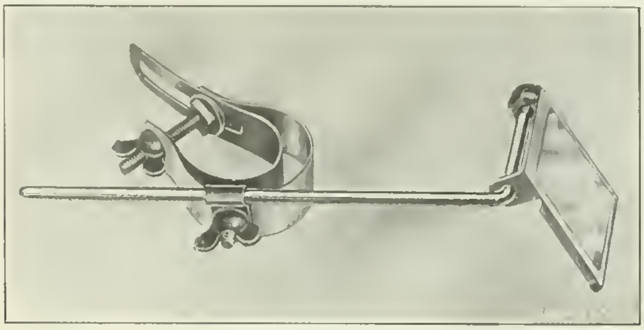


Fig. 1. Chip Guard for Protecting the Eyes, manufactured by the Universal Stamping Co.

on the market a chip guard that is designed to afford this protection without interfering with the operation of the machine. A view of this guard is shown in Fig. 1, and Fig. 2 illustrates the method of applying it to a lathe. The guard proper is made of glass, so that the tool point and work are always visible. This glass is mounted in a steel frame that is attached to a rod held by a clamp on the toolpost. The guard can be set at any angle and the rod may also be moved in any direction, thus giving a universal adjustment. As the rod is

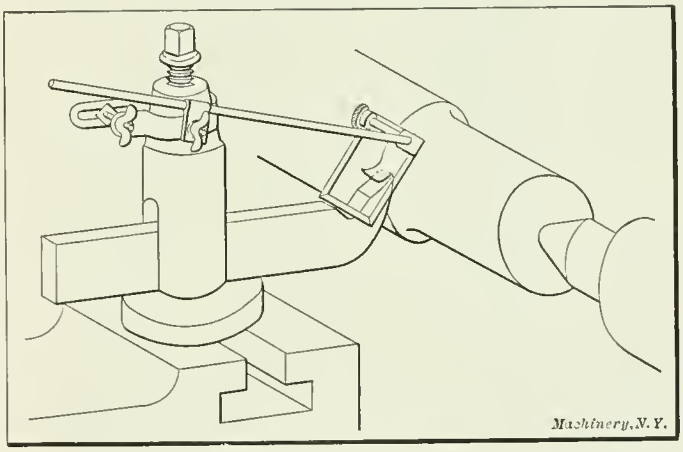


Fig. 2. Chip Guard applied to a Lathe

attached to the toolpost clamp by a swiveling connection, the guard can be quickly moved out of the way, when necessary, by swinging it upward or sideways. The clamp is so made that it can be adjusted for toolposts of different diameters. This guard is not intended for machines taking long and heavy cuts, but for that class of work which requires frequent calipering and constant attention. It is manufactured in two different sizes, known as Nos. 1 and 2. The smaller size is for toolposts up to 1¾ inch in diameter, and the larger for toolposts up to 2¼ inches in diameter. The price of this guard postpaid is 75 cents.

NEW MACHINERY AND TOOLS NOTES

Toolpost: O. K. Tool-Holder Co., Shelton, Conn. Toolpost adapted for heavy work and constructed so that the tool can be adjusted to any desired height. The construction is very compact and the parts are made of packhardened forged steel.

Lubricators: J. L. Osgood Lubricator Co., Buffalo, N. Y. Forced-feed valveless lubricators, especially adapted to machine tools, gasoline or steam engines, etc. The oil tank has two compartments, one for lubricating and the other for cutting oil, in the case of a machine tool. It contains the circulating pump which is driven by a chain belt.

Keyseater: Lapointe Machine Tool Co., Hudson, Mass. Motor-driven vertical keyseater having a two horsepower motor, and provision for automatically clearing the cutter on the return stroke, thus avoiding any drag on the work. The keyway depth is regulated by an index plate and locked finger which is positive in its action, and the feed is automatic.

Pipe Cutting Tool: Taylor-Wilson Mfg. Co., McKees Rocks, Pa. Tool for cutting pipe in the lathe, having a cutting blade and a steel disk located above it which nicks the pipe and also prevents the tool from entering too rapidly. The disk is adjustable for different diameters. This tool is designed to cut pipe or tubing ranging from 3/8 to 12 inches in diameter.

Fifteen-inch Lathe: Carroll-Jamieson Machine Tool Co., Batavia, Ohio. Double back-geared lathe with quick-change mechanism giving thirty changes for turning or screw cutting. All feeds are friction controlled, and the changes are effected by the manipulation of a knob and one handle. The double back-gears are in the ratio of 8 to 1 and 3 to 1. All gears are guarded.

Erecting Stand: Standard Motor Car Co., Scranton, Pa. Adjustable stand designed to facilitate the erection of machinery. This stand is adjustable for varying widths, and it is particularly adapted for work on automobile engines. The table for holding the part being erected, is tilting and reversible to bring the work in the most advantageous position, and when set it may be locked.

Punching and Riveting Press: Ferracute Machine Co., Bridgeton, N. J. Line of presses for punching holes and forcing rivets. The press is controlled by a foot treadle and clutch. The stroke is ordinarily 1½ inch, but it may be shortened or increased to a maximum of 2½ inches. The smallest machine of this line weighs 2300 pounds and is capable of exerting a pressure of approximately 15 tons.

Thread Gage: Wood & Spencer Co., Cleveland, Ohio. Snap thread gage designed for the rapid and accurate inspection of automobile parts. When using the gage it is unnecessary to screw the work into it, thus eliminating wear. Two different styles of gages are made, one having an adjustable blade and the other being non-adjustable. Both types are made in various sizes ranging from ¼ inch to 12 inches.

Speed Box: American Tool Works Co., Cincinnati, Ohio. Geared speed box for application to 4-, 5-, 6- and 7-foot plain and universal triple-geared radial drills. This box is of the cone and tumbler construction and provides eight changes of speed. These changes may be effected without shock, as the gears are kept rotating while changes are being made, by an auxiliary drive which is automatically engaged and disengaged by the movement of the tumbler lever.

Portable Grinder: Safety Emery Wheel Co., Springfield, Ohio. Electrically-driven portable swinging-frame grinder for grinding the fins from castings and doing similar work. The frame containing the motor and abrasive wheel is mounted on a pair of 42-inch steel wheels, and it is well balanced so that the grinder can easily be operated by one man. The grinding wheel is 24 inches in diameter and 2 inches thick; by omitting the safety collars the thickness may be increased to 3 inches.

Twenty-Four Inch Planer: Putnam Machine Co., Fitchburg, Mass. Motor-driven 24- by 24-inch planer built in various lengths to plane work ranging from 5 to 10 feet in length. The motor is mounted above the housings and is rigidly supported. All the bearing surfaces of the planer are scraped, and all shafts, etc., used in the construction are of steel. The head has a traverse of 10 inches, and its feed-screw is provided with a micrometer dial. This machine is also equipped for belt drive when desired.

Heavy Press: Ferracute Machine Co., Bridgeton, N. J. Large press designed to give a pressure of 200 tons. The height from the bed to the ram at the top of the stroke and adjustment, is 22½ inches. The ram has a stroke of 8 inches and a downward adjustment of 6 inches made by a ratchet that imparts a simultaneous movement to the two pitman screws. A side punch having a stroke of 2 inches enables punching and shearing operations to be performed while the main press is in use. The total weight of this press is about 40,000 pounds.

Upright Drilling Machine: Superior Machine Tool Co., Kokomo, Ind. In the department of New Machinery and Tools for November, 1910, we illustrated a Superior upright drilling machine equipped with a compound table, having both cross and longitudinal feeds. This machine is now being built with a positive geared feed, similar in construction to that illustrated in the February, 1911, number. The feed box is mounted on the head and the feed changes are made by conveniently-located handles. This machine can be used for either drilling or milling operations, and it is capable of handling a wide range of work.

Die-stock: The Hart Manufacturing Co., 10 Wood St., Cleveland, Ohio. Pipe threading die-stock fitted with adjustable dies and guides or centering jaws which are adjusted simultaneously to all sizes of pipe. The dies are of the chaser form which is easily sharpened, and one set of the double-ended style is used for diameters varying from ¼ to ¾ inch. The method of setting the dies to size enables them to be located with accuracy, and they are positively locked in position. They may be quickly released, which avoids turning them back over the threads. A device for cutting off pipe will be included in the equipment, if desired.

Power Hacksaw: North Wales Machine Co., Inc., North Wales, Pa. Power hacksaw equipped with tight and loose pulleys and a direct-geared drive, the gears being machine cut and guarded. The work-holding vise may be swiveled, so that stock as large as 3¾ inches in diameter may be cut at any angle not exceeding 45 degrees. The maximum capacity for straight cuts is 5½ inches. A 10-inch blade is ordinarily used, but the telescopic connecting-rod enables the use of a 12-inch blade when cutting bevels. The machine has a gravity feed, and an automatic stop which shuts off the power when a cut is completed.

Riveting Machine: F. B. Shuster Co., New Haven, Conn. Special riveter for riveting wire or round rod spokes to the rims of wheels, such as are used for agricultural machinery, etc. The wheel to be riveted is mounted on a mandrel which is adjustable on the column of the machine, for different diameters, and the spoke and wheel rim is supported by an anvil having jaws which fit and grip the spoke. As the distance between the anvil and hub mandrel remains constant for a wheel of given size, the radius of the wheel as it is turned from one spoke to another is kept practically the same. This machine will rivet spokes ranging in size from 3/16 to ½ inch.

Double-Spindle Boring Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Double-spindle machine designed for plain boring operations requiring a simple but rigid tool. The spindles are driven by a three-step cone-pulley having a pinion meshing with a large driving gear, on the hub of which is mounted a pinion that engages gears on the spindles. There are three changes of in-and-out geared feed with an automatic release and a hand adjustment. The working surface of the table is 18 by 20 inches, and cylinders having a bore 14 inches deep can be machined. Additional spindle heads can be placed on the machine for different center distances when required.

Rotary Planer: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Rotary planing machines specially adapted for finishing the ends of cast-iron and structural steel columns. The machine has two heads, each of which is driven by a 7½-horsepower motor, the power being transmitted through spiral gears to a driving worm-wheel. One of the heads is stationary on the bed, and the other can be adjusted to distances varying from 6 feet 3¼ inches, to 30 feet. This adjustment is by power, a 5-horsepower motor being used for the purpose. The cutter heads of this machine measure 26 inches over the tools, and the maximum distance between their cutting faces is 30 feet.

Hydraulic Pneumatic Pump: Nash Engineering Co., 248 Gates Ave., Brooklyn, N. Y. Hydraulic pneumatic pump adapted to exhausting or compressing air. The construction is very simple and the principle of operation ingenious. The pump consists principally of a rotor, having solid blades, which revolves within a casing of elliptical form. All the displacing and joint-forming functions are effected by water which revolves with the rotor. As this water follows the walls of the casing, it recedes and then advances toward the rotor, thus acting as a kind of water piston which does the work of compressing or exhausting air through suitable ports. The machine is both compact and durable, and the speeds are such that it may be connected directly with an electric motor.

Cylinder Grinding Machine: Brown & Sharpe Mfg. Co., Providence, R. I. Cylinder grinding machine with grinding spindle which travels in a circular path so that the work can remain stationary. This feature is particularly desirable on multiple cylinder work, or for parts which do not have the weight distributed evenly about a central axle. The work table extends beneath the spindle head and has an exceptionally long support. The drive to the spindle is by belt from a floor stand having a swinging idler which takes care of the spindle's rotary movement. This machine has a capacity for cylinders up to 7 inches in diameter and 14 inches long. The dust incident to the grinding operation, is exhausted by a fan, hose, and receiver which forms part of the equipment.

Sprue Cutter: J. C. Busch, 136 Ferry St., Milwaukee, Wis. Power-driven sprue cutter built principally for cutting gates, runners and risers on steel castings and also for trimming fins. The construction is high-grade throughout, the frame and flywheels being of cast iron, and the gears, connecting-rods, crosshead, and table of cast steel. The shafts are of forged high-carbon steel and run in bronze bushings fitted into seats bored in the castings. The gears are cut, and the knives are made of 3-inch square steel. The machine is driven by a 10-horsepower motor or its equivalent, and it has a capacity for shearing 1½-inch square stock, or a piece of equal area. This shear has successfully cut a bar measuring 1¾ inch by 3½ inches, and having a carbon content of 0.3 per cent.

Hand Punch: Whitney Metal Tool Co., 222 East State St., Rockford, Ill. Rotary hand punch which is operated by turning a spindle having a ball bearing in a bushing mounted vertically in the frame. As the ball races are in the form of a screw, the spindle has a longitudinal as well as a rotary movement, and the elimination of friction enables a maximum of pressure to be transmitted to the punch. The latter is so attached to the end of the spindle that it is prevented from rotating and simply has a vertical movement. The punch frame is pivoted and it can be inclined to various angles. This style of punch is now manufactured in three different sizes, the smallest of which will punch a ¾-inch hole in boiler plate of the same thickness, while the largest punch has a capacity for ¾-inch holes through ¾-inch boiler plate. The weight of the largest size is 20 pounds.

Motor-Driven Grinder: The Springfield Mfg. Co., Bridgeport, Conn. Electrically-driven dry grinder having a motor that is entirely enclosed and a heavy base to absorb vibration as much as possible. This grinder is made in three sizes having 12 by 2 inch, 18 by 2 inch and 24 by 3 inch wheels. Wheels having wider face widths may, however, be used. The machines are made with or without safety hoods. Each grinder is equipped with large and long spindle bearings which run in self-oiled boxes. The principal dimensions of the smallest and largest sizes are, respectively, as follows: Height to center of spindle, 36 inches in each case; length of spindle bearings, 10 inches and 12 inches; diameter of spindle in bearings, 1½ inch and 2¼ inches; distances between grinding wheels, 35½ inches and 43½ inches; horsepower of motors, 2 and 5; weights of machines, including hoods, wheels, and motor, 1050 and 2060 pounds.

Duplex Miller: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. No. 1½ duplex milling machine designed for general work and adapted for both facing and slabbing operations. The two horizontal spindles with which the machine is equipped are mounted on each side of the platen and are adjusted vertically. These spindles are driven through worm gearing having casehardened driving worms and bronze-rimmed wheels. The spindles are threaded externally for face cutters and have internal tapers for the insertion of cutter arbors. The arbors are driven by broad-faced keys and held by retaining bolts. The minimum and maximum distances between the spindles are 3 and 28 inches, respectively. The maximum distance from the spindle center to the top of the work table is 12 inches, and the minimum distance, 1 inch. The machine has a capacity for face milling cutters up to 12 inches in diameter. The width of the work table is 15 inches, and the length, 13 feet.

Presses: Fred J. Swaine Mfg. Co., 7th & O'Fallon Sts., St. Louis, Mo. Recent improvements in inclinable open-back presses, including the use of vanadium steel in the clutch parts and shaft; lugs for tie-rods which may be easily inserted or removed; increase of die space from slide to bolster-plate, and larger beds. An additional locking point for the clutch insures the use of the press, should one of the clutch bolts or connections break or get out of order, as the defective parts can be quickly removed and the press operated with the remaining bolt. Inclining the press does not raise the front of the bed to an awkward height for the operator, as the swiveling point is near the front of the bed, thus keeping this part at practically the same height regardless of its position. All the bearings are carefully scraped, and there is an improved bearing of large size for the slide end of the pitman. When inserting dies, the crank may be turned off center without stopping the flywheel, and it is impossible for the clutch to engage. After the dies are set, the crank is turned back by hand to the starting point. These presses are made in eleven different sizes of either the geared or plain type, and have weights ranging from 350 to 9500 pounds.

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MONOPLANE CARRIES TWELVE PERSONS

Louis Breguet made a record performance March 23, at Douai, France, when he carried eleven passengers in his monoplane a distance of two miles. The flight was made at a height varying from fifty to seventy-five feet. The total weight of the twelve persons was 1315 pounds, and the combined weight of the machine and its occupants was 2602 pounds. The best previous performance of the kind was made by M. Le Martin, who on February 2 took up seven passengers on a five-minute trip.

* * *

Since the announcement of the erection of the Woolworth Building in New York was published in the December number the plan has been changed by the acquisition of the corner on Broadway, and a much larger and higher structure will be erected. The building will occupy the entire frontage on Broadway between Barclay St. and Park Place. It will be 138 feet higher than the Metropolitan tower and, of course, the highest commercial structure in the world.

LARGE BRONZE DRUM CASTING

The accompanying illustration shows an interesting and rather exceptionally large bronze drum casting. The drum is 12 feet long, 5 feet in diameter, and is used as the drying surface in a large vacuum rotary drum dryer. The drums are generally made of dense air furnace iron, but in this case, it was necessary to use a high-quality bronze drum, owing to the fact that the vegetable extract to be dried on the drum would become discolored if it came in contact with the iron.

The mold for this casting was swept up in dry sand, the core being swept up in loam. When the casting was poured, the mold was in a vertical position, thus accounting for the very clean surface free from any blow-holes. It required 16,000 pounds of metal to pour the casting, and on account

Large Bronze Drum Casting, 12 feet Long, 5 feet Diameter, Weight 16,000 Pounds

of this large quantity, it was necessary to melt the metal in a 48-inch cupola.

The practice of melting bronze in a cupola is unusual, but the Buffalo Foundry & Machine Co. of Buffalo, N. Y., who made the casting, has been very successful in following this practice where large quantities of metal are required.

* * *

The National Metal Trades Association holds its thirteenth annual convention at the Hotel Astor, April 12 and 13. "A wider scope—multiplied influence—a progressive and constructive policy, supported by a responsive membership, all have assisted in coping with the many cooperative problems which will be dealt with at this convention." An important feature of the program will be welfare work, including sanitation, safety devices, first aid to the injured, employes' clubs and employes' dining-rooms. The program will include papers on other topics of interest to the members. Robert Wuest, commissioner, New England Bldg., Cleveland, Ohio.

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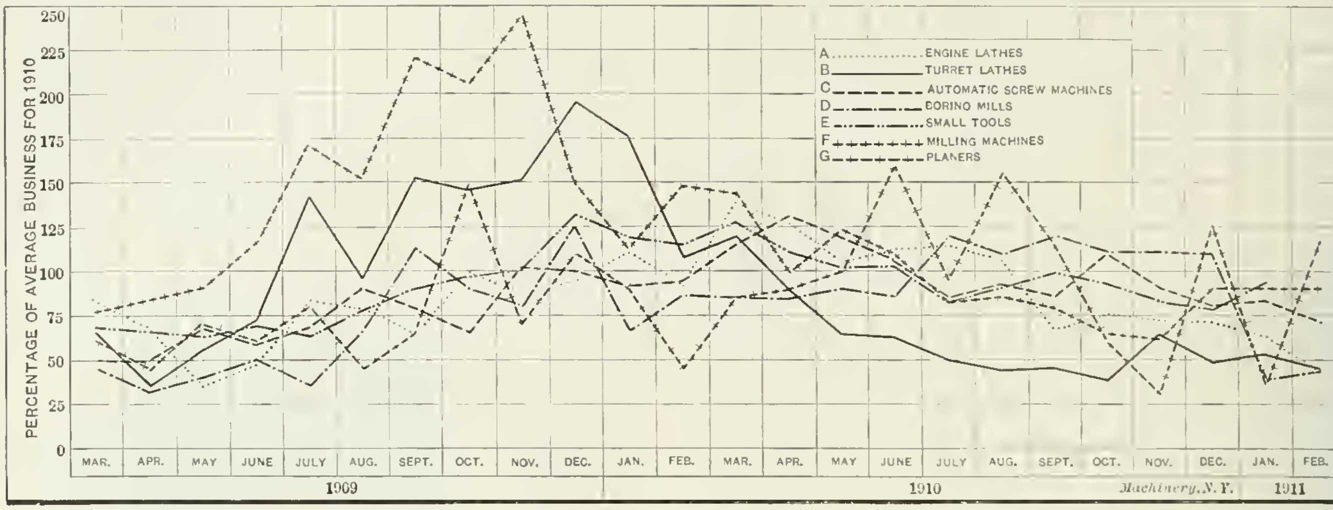
The assembling of a $1250 automobile built in one well-known Western factory costs $16.50.

MACHINERY'S CHART OF TRADE FLUCTUATIONS

Showing the variations of business in the Machine Tool industry for twenty-four months, based on information furnished by seven large manufacturers. This list will be extended to cover other lines. The curves are plotted in percentages, taking the average monthly sales of 1910 as the base.



PERSONALS

James R. Mansfield, superintendent of the Bay State Brass Co.'s foundry, Haydenville, Mass., has resigned.

Irving S. DeRochement of New Haven, Conn., has taken the position of superintendent of the Bay State Brass Co.'s foundry, Haydenville, Mass.

J. A. B. Patterson, secretary of the Standard Gauge Steel Co., Beaver Falls, Pa., returned about the middle of March from a month's sojourn in Florida.

George W. Armstrong has been made superintendent of the newly-organized Lester & Wasley Co., Inc., Norwich, Conn., manufacturers of "Leader" envelope machines.

Charles Napier, of the Quality Saw & Tool Works, Springfield, Mass., sailed in March for a four weeks' business trip to England and Scotland in the interests of the company.

Carl Falk, late sales manager for the Herman Pneumatic Machine Co., has become the Buffalo representative of the Mumford Molding Machine Co., 30 Church St., New York.

L. F. Hussey has resigned the position of advertising manager for the Wells Brothers Co., Greenfield, Mass., to fill the position of advertising manager for the Standard Tool Co., Cleveland, Ohio.

J. W. Bourn, who for several years was foreman, and later instructor of apprentices, for the Geo. V. Cresson Co., Philadelphia, Pa., has resigned and taken a position with the Curtis Publishing Co., Philadelphia, Pa.

A. Pawling, president of the Pawling & Harnischfeger Co., crane builders, Milwaukee, Wis., has gone with his family on an extended automobile trip through the Southern and Pacific Coast states. They will return to Milwaukee next June.

Prof. W. F. Schaphorst of the mechanical engineering department of the New Mexico College of Mechanic Arts, has resigned his position there to become a technical writer on the staff of A. Eugene Michel, advertising engineer, New York.

A. E. Martin has resigned the position of assistant superintendent with the Quincy, Manchester, Sargent Co. of New York and Chicago, after eight years of service, to take the position of general superintendent of the John H. McGowan Co., Cincinnati, Ohio.

L. W. Orr, formerly of Mercer, Pa., has purchased an interest in the Modern Tool Co. of Erie, Pa., and has been made general manager of the company. Mr. Orr has had a large business experience and expects to greatly enlarge and develop the activities of the company.

Carl J. Rolander, who for twenty-four years has been in the employ of the Prentice Bros. Co., as a foreman, recently resigned to enter business for himself. He has seen the Prentice Bros. shop grow from small beginnings to its present state, as one of the largest firms of its kind in Worcester.

W. R. Hulbert, manager of sales, Goldschmidt Thermit Co., addressed the Cleveland branch of the American Chemical Society at its March meeting on the subject of the thermit welding process. Mr. Hulbert gave an actual demonstration of the process by making a number of welds on wrought iron and steel sections and pipe.

G. Hüttner, partner of M. Koyemann, Düsseldorf, Germany, importer of machine tools, sailed for home March 16 after spending four weeks in America in the interests of his firm. Mr. Hüttner found conditions in our machine tool trade better than in Germany, and sees unlimited possibilities here for manufacturing growth.

Robert L. Windholz, who for several years was vice president of the Vandyck Churchill Co., has resigned his position and will soon open an office in New York. Mr. Windholz will act as special Eastern representative for several prominent machine tool builders. His temporary address is Room 1558, 50 Church St., New York.

John O. Simpson assumed the duties of equipment engineer of the Remington Arms Co., Ilion, N. Y., March 1. He will have charge of the engineering and drafting departments and toolroom, machine shop and blacksmith shop. Mr. Simpson comes from Waterbury, Conn., where he was connected for several years with the New England Watch Co. Prior to that connection, he was with the Pratt & Whitney Co., Hartford, Conn.

George H. Adair, who has been manager of the Seattle branch of Fairbanks-Morse & Co. for the past five years, has resigned from that company, and, in connection with his father, George B. Adair, and others, has purchased the business of the Kilbourne & Clarke Co. The new concern will be known as the George B. Adair & Son Co. One of the first lines to be handled will be the products of the Foos Gas Engine Co. of Springfield, Ohio.

F. Mandon, general manager of Fenwick Frères & Co., Paris, France, arrived here on March 11, for a stay of six or seven weeks. Mr. Mandon, who is well known here, and has many friends in the trade, says that his company has recently increased its capital stock and enlarged and strengthened its selling organization, which covers France, Belgium, Spain and Portugal, Switzerland and Italy, working each territory from its own headquarters with its separate trained staff. Fenwick Frères & Co. handle American machine tools exclusively, and have the utmost faith in the ability of American tools to hold the foreign market against imitations, if American manufacturers generally will cooperate effectively with their foreign representatives, as some of them are now doing. One of the chief objects of Mr. Mandon's visit is to arouse American machine tool builders to the necessity for making energetic efforts, intelligently and systematically, to hold and increase their foreign trade, by demonstrating the higher efficiency of American tools. Mail for Mr. Mandon should be sent in care of Brown & Sharpe Mfg. Co., Providence, R. I.

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OBITUARIES

Charles H. Wilson, general manager of the United Shoe Machinery Co., died at his home in West Medford, Mass., February 20, aged fifty-three years.

Leroy S. White died at his home in Waterbury, Conn., February 17, aged eighty-two years. Mr. White was the inventor and patentee of many valuable machines, processes and improvements, particularly along the lines of manufacture of silverware and brass novelty ware.

Edward J. Pennington, inventor and promoter, died at his home in Springfield, Mass., March 5, aged fifty years. Pennington was one of the early inventors of flying machine apparatus, and although he did not succeed in practical develop-

ment, his improvements of the light gas engine undoubtedly helped later inventors to solve some of the problems of aviation. In 1891 he produced a four-cylinder motor of eight horsepower, which weighed only thirty-two pounds. This motor was not a success when attached to a dirigible balloon and was applied to a bicycle, but the idea did not then meet with favor for bicycles. The engine was applied to road vehicles but, finding the conditions unfavorable in this country, he went to England, where in 1896 he gave successful exhibitions of a kerosene motor driven carriage in London.

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COMING EVENTS

April 3-5.—Triple joint convention of the Southern Supply and Machinery Dealers' Association, National Supply and Machinery Dealers' Association, and American Supply and Machinery Manufacturers' Association, at Louisville, Ky. Seelbach Hotel, headquarters. Alvin M. Smith (Smith-Courtney Co., Richmond, Va.), secretary-treasurer, S. S. & M. D. A.; Thomas A. Fernley (Philadelphia, Pa.), secretary-treasurer, N. S. & M. D. A.; F. D. Mitchell (309 Broadway, New York), secretary-treasurer, A. S. & M. M. A.

April 10-11.—Congress of Technology, Boston, Mass., celebrating the fiftieth anniversary of the granting of the charter to the Massachusetts Institute of Technology. The Congress promises to be of unusual interest not only as marking a period in the development of one of the world's great technical schools, but because it marks also the rise and high development of all that is now included under the names "engineering" and "applied science."

April 11. Monthly meeting of the American Society of Mechanical Engineers, 29 West 39th St., New York, to discuss paper, "Economic Importance of the Farm Tractor," by L. W. Ellis. Following this paper, Dr. Charles E. Lucke will give a talk upon the mechanical equipment of farm tractors, illustrated by views taken at the Canadian Industrial Exhibition held in Winnipeg, Manitoba, last summer.

April 12-13.—Thirteenth annual convention of the National Metal Trades' Association at Hotel Astor, New York.

April 12-13.—Meeting of the National Association of Cotton Manufacturers at the Massachusetts Institute of Technology, Boston, Mass. C. J. H. Woodbury, P. O. Box 3672, Boston, Mass., Secretary.

May 18-19—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J. Marlborough-Blenheim Hotel, headquarters. Charles L. Hildreth, secretary, Worcester, Mass.

May 18-19.—Semi-annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, Youngstown Ohio. Prof. Frank E. Sanborn, Columbus, Ohio, secretary-treasurer.

May 30-June 2.—Sixty-third meeting of the American Society of Mechanical Engineers, at Pittsburg, Pa. Office of local committee, 2511 Oliver Bldg., Pittsburg, Pa.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics', and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

September 1-December 1.—Exhibition of machinery, at Bush Terminal, New York City, under the auspices of the Bureau of National Industries, 11 Broadway, New York City.

NEW BOOKS AND PAMPHLETS

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boston, Mass., Volume 46, No. 2, for January, 1911, containing the president's report.

AN INVESTIGATION OF BUILT-UP COLUMNS UNDER LOAD. By Arthur N. Talbot and Herbert F. Moore. 64 pages, 6 x 9 inches. 28 illustrations. Bulletin No. 44. Published by the University of Illinois, Urbana, Ill.

STATISTICS OF RAILWAYS IN THE UNITED STATES. Interstate Commerce Commission. 978 pages, 6 x 9 inches. Edw. A. Mosely, secretary. Prepared by the Bureau of Statistics and Accounts, Washington, D. C.

FEATURES OF PRODUCER-GAS POWER-PLANT DEVELOPMENT IN EUROPE. By R. H. Fernald. 27 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 4.

BULLETIN OF THE UNIVERSITY OF MISSOURI, SCHOOL OF MINES AND METALLURGY, Volume 3, No. 1, for December, 1910, contains an article entitled "Some Relations Between the Composition of a Mineral and Its Physical Properties."

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York. Year book for 1911, containing constitution and by-laws, with general information and a list of members of the society. Ralph W. Pope, secretary, 29 W. 39th St., New York.

PROCEEDINGS OF THE EIGHTEENTH ANNUAL CONVENTION OF THE INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION. 284 pages, 6 x 8½ inches. A. L. Woodworth, secretary, Cincinnati, Hamilton and Dayton Railroad, Lima, Ohio.

ARTS-CRAFTS LAMPS. By John D. Adams. 87 pages, 5 x 7 inches. Illustrated. Published by Popular Mechanics Co., Chicago, Ill. Price, 25 cents.

This is one of the series of hand-books on industrial subjects being published by *Popular Mechanics* and should prove useful to people who are fond of making small art pieces at home.

CURRENT RAILWAY PROBLEMS. By Samuel O. Dunn. 85 pages, 5 x 6½ inches, paper. Published by the *Railway Age Gazette*, New York.

At the present time when railways and their methods are constantly in the limelight of the Interstate Commerce Commission's investigations, this little pamphlet published by the *Railway Age Gazette* for free distribution, appears opportunely. The articles contained are: Valuation of Railways, with Especial Reference to the Physical Valuation of Minnesota; Shall Railway Profits be Limited? Railway Rates and Railway Efficiency; and The New Long and Short Haul Law.

HEAT. By J. Gordon Ogden. 113 pages, 5 x 7 inches. Illustrated. Published by the Popular Mechanics Co., Chicago, Ill. Price, 25 cents.

This book consists of a series of articles, each complete in itself, yet all pertaining to heat and its relation to modern mechanics, written in a simple form for popular reading. It cannot in any sense be considered a treatise on the subject, the treatment being very superficial, as it must necessarily be in such a small book. However, it is admirably suited for the purposes for which it is intended, the aim being to give the layman a general knowledge of thermodynamics.

HOW TO READ PLANS. By Charles G. Peker. 104 pages, 5 x 7½ inches. 81 illustrations. Published by the Industrial Book Co., New York. Price 50 cents.

This is a simple little book on the fundamentals of reading drawings, dealing more particularly with architectural work, and therefore intended for artisans connected with the building trades. This issue is the second edition of the work, revised and enlarged. The contents are as follows: Different Kinds of Drawings; Plans, Elevations and Sections; Shade Lines; How Sections are Represented; How Different Materials are shown in Section; Dimensions; Center Line; Projection Lines; Reading Dimensions; Checking Dimensions; Scales; General Drawings; Elevations and Plans; Relation of Different Parts of a Drawing to Each Other; Views Necessary for a Working Drawing; Detail Drawings; Blueprints; Mounting Blueprints; Altering Blueprints; Coloring Blueprints; Reading a Simple Plan; Perspectives; and Conventional Methods and Devices.

ENGINEERING INDEX ANNUAL. 471 pages, 6½ by 9½ inches. Published by *The Engineering Magazine*, New York and London. Price $2.00.

This index has come to be recognized as an essential feature of every engineering library where it is desired to have much technical information readily available. It is compiled from the monthly index sheets published as a part of *The Engineering Magazine*, and also in separate pamphlet form, printed on one side for filing purposes. This annual compiles all these indexes for the year 1910, in one book, giving the title of the article, a brief statement of its contents, the approximate number of words it contains, and the name and date of the publication in which it appeared. The subjects covered include civil, electrical, mechanical, marine and naval, and railway engineering, and industrial economy, mining and metallurgy, and street and electric railways. A useful feature has been added to this volume in the form of an assembly of the significant words in the titles of the various articles, under their respective general heads and sub-groupings. This series of leading words adds materially to the usefulness of the book from the busy engineer's standpoint.

SCIENTIFIC MANAGEMENT. By Louis D. Brandeis. 92 pages, 6½ by 9½ inches. Published by *The Engineering Magazine*, New York and London. Price $1.00.

The name of Mr. Brandeis is so well known from the publicity he obtained by the contentions he advanced that a saving of $1,000,000 a day might be effected on the American railroads by scientific management that no further introduction is necessary. This seemingly broad statement was made at the hearing given the railroads and shippers by the Interstate Commerce Commission, when the railroads early last year made an attempt to raise the freight rates. This book is part of Mr. Brandeis' brief, constituting a digest of the testimony given by Emerson, Gantt, Gilbreth, Hathaway, Dodge, Towne, Scheel, Kendall, Going, and others at this hearing, showing just what testimony was offered as to the profitable results accruing from the use of the efficiency methods that have been proved in manufacturing concerns, and it discloses the basis for the much-quoted and much-misunderstood statement regarding the possible $1,000,000 a day saving. To all interested in these new theories of scientific management and its possibilities, this book will prove both valuable and interesting.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTE, 1909. 751 pages, 6 by 9 inches. Illustrated. Published by the Smithsonian Institute, Washington, D. C.

This work published annually by the Smithsonian Institute, as has been the custom for years, contains in addition to the usual reports, a long series of valuable articles on the different phases of scientific development, gleaned from world-wide sources; it is cosmopolitan in its make-up, emphasizing the fact that science knows no country. Among the articles contained are the following: "The Future of Mathematics," by Henri Poincaré; "What Constitutes Superiority in an Airship," by Paul Renard; "Researches in Radiotelegraphy," by J. A. Fleming; "Recent Progress in Physics," by Sir J. J. Thomson; "Production of Low Temperatures and Refrigeration," by L. Marchis; "The Nitrogen Question from the Military Standpoint," by Chas. E. Munroe; "The Mechanism of Volcanic Action," by H. J. Johnston-Lavis; "Conservation of Natural Resources," by James Douglas; "Albert Gaudry and the Evolution of the Animal Kingdom," by Ph. Glangeaud; "Charles Darwin," by August Weissman; "Recent Discoveries Bearing on the Antiquity of Man in Europe," by George Grant MacCurdy; "European Population of the United States," by W. Z. Ripley; "The Republic of Panama and its People," by Eleanor Yorke Bell; "The Relation of Science to Human Life," by Adam Sedgwick.

AN INVESTIGATION OF BUILT-UP COLUMNS UNDER LOAD. By Arthur N. Talbot and Herbert F. Moore. 64 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 44.

The investigation covered by this bulletin had in view the experimental determination of: (1) the way in which the compressive stresses in built-up columns vary over the cross-section of the channels or other component parts, and throughout their length; (2) something about the amount and distribution of stress in the lattice bars of columns, and also the action of similar bars under separate tests with similar conditions of fastening and eccentricity; and (3) the general relation which exists between the component parts and the column as a whole. Emphasis is placed on measuring the distribution and range of stress over the various parts of the column. The investigations include tests on a steel column built up of angles, plates, and lattice bars, all parts being light with respect to the size of the column, and four wrought iron bridge posts which had seen long service in a bridge truss, these two tests being made in a testing machine. A third test was made on three posts and a top chord in a railroad bridge under service, where actual working conditions were maintained by using a locomotive and cars as the load. Some interesting conclusions have been drawn from the experiments.

ELEMENTS OF GRAPHIC STATICS. By Wm. L. Cathcart and J. Irvin Chaffee. 312 pages, 6 by 9 inches. 159 illustrations. Published by D. Van Nostrand Co., New York. Price $3.00.

This book differs from the majority of text-books on the subject, in that it is primarily written for students of mechanical and marine engineering. Most treatises, after developing the necessary underlying principles, go on to show their application to structural work, such as bridges, steel buildings, etc., where in practice they meet with their greatest application. For this last reason, the field of use among mechanical and marine engineers has been more or less neglected from the text-book standpoint. This treatise, while dealing with the customary applications to steel structures, pays particular attention to mechanisms. The chapter on the graphics of friction and the one on moment diagrams for shafting, are particularly good, all the examples being illustrated fully with line drawings. The graphical solution of frictional problems becomes very simple by a study of the book. The chapters are as follows: Graphic Arithmetic; Graphic Measurement of Areas; Forces: Concurrent, Non-Concurrent, Non-Parallel; Parallel Forces; Couples, Center of Gravity; Moments; The Fundamental Theory of Beams (two chapters); Framed Structures; Rod Trusses, Braced Cantilevers; Bridge Trusses; The Graphics of Friction; and Moment

Diagram for Shafting. In addition to the text matter, there are a considerable number of test questions by which the student may apply what has been learned.

MECHANICAL ENGINEERING. By Charles M. Sames. 220 pages, 4 x 6½ inches. Published by Charles M. Sames, Jersey City, N. J. Price, $2.00.

This hand-book is a compact and up-to-date digest of mechanical engineering science, embracing a wide range of subject matter. It is printed on rice paper, and has flexible leather covers. Weighing only 6 ounces and with a thickness of slightly over ½ inch, it may be conveniently carried in the pocket. This is the fourth edition, and is very materially revised and enlarged and contains a great deal of new matter. The book is the result of the writer's endeavor to arrange a greater part of the reference information usually required by mechanical engineers, into as small a volume as possible, and in its preparation various standard treatises have been consulted. An idea of the contents of the book may be gained when it is mentioned that there are over 900 items in the index. The general divisions of the book are as follows: Mathematics; chemical data; materials; strength of materials, structures and machine parts; energy and the transmission of power; heat and heat engines; hydraulics and hydraulic machinery; shop data and electro technics. It is probably one of the most compact hand-books on the market, containing an infinite amount of very valuable information in remarkably small space. The manner in which it is kept thoroughly up-to-date is emphasized by the fact that a small dissertation is included on aeroplane design. The very latest information on the power required by machine tools is also included. This edition is worthy of the continuance of the reception heretofore accorded it.

ENGINEERING DIRECTORY, 1911. 1379 pages, 4¾ x 6¾ inches. Published by The Crawford Publishing Co., 209-213 N. Jefferson St., Chicago, Ill. Price $5.00.

This useful engineering directory is now passing into its eighteenth year, under a new name, formerly being called the "Domestic Engineering Directory." The aim of the publishers is to put forth a book that will be a complete directory of the plumbing, heating, lighting, power plant and mill supply industries in the United States, and is intended for the daily use of the jobber, manufacturer and retailer of these goods. The contents of the book are given in the following: Directory of jobbers of plumbing and heating supplies; directory of jobbers and dealers in mill, steam, mine, railway and heating supplies, tools and machinery; directory of wholesale dealers in machinery; directory of wholesale dealers in electrical supplies; directory of electric light and power plants; directory of waterworks companies; directory of gas companies; directory of prominent architects; directory of purchasing agents of principal railroads; alphabetical list of manufacturers of plumbing, heating, lighting, power plant, mill, mine and railroad supplies, tools and machinery; classified list of products of manufacturers of plumbing, heating, lighting, power plant, mill, mine and railroad supplies, tools and machinery, giving trade names or brands by which the goods are known. The last division is necessarily the greatest, and is divided and subdivided to such an extent that very few things required by the classes to which this directory applies are omitted. In general make-up it resembles engineers' handbooks, being printed on fine paper, with red leather binding. Being only 1½ inch thick and of the previously stated superficial size, it is very convenient to handle.

THE SLIDE RULE. By Charles N. Pickworth. 118 pages, 5 x 7 inches. 34 illustrations. Published by D. Van Nostrand Co., New York. Price, $1.00.

Little need be said of the value of this practical little manual of the slide rule, for its popularity is evidenced by the fact that it is now passing into its twelfth edition. While practically the same as the last edition, it has been slightly revised, and the contents extended so as to include descriptions of several new slide rules. A section explaining the significance of various gage points and other markings on slide rules has also been added. It is a thoroughly practical book in every sense, especially from the standpoint of new uses, for it is full of practical applications of the slide rule, making it possible for anyone to become acquainted with its use by a perusal of the book. The sections are as follows: Introductory; Mathematical Principle of the Slide Rule; Notation by Powers of 10; Mechanical Principle of the Slide Rule; Primitive Slide Rule; Modern Slide Rule; Notation of the Slide Rule; Cursor or Runner; Multiplication; Division; Use of the Upper Scales for Multiplication and Division; Reciprocals; Continued Multiplication and Division; Multiplication and Division With Slide Inverted; Proportion; General Hints on the Elementary Uses of the Slide Rule; Squares and Square Roots; Cubes and Cube Roots; Powers and Roots by Logarithms; Other Methods of Obtaining Powers and Roots; Combined Operations; Hints on Evaluating Expressions; Gage Points; Examples in Technical Calculations; Trigonometrical Application; Slide Rule With Log-log Scales; Special Types of Slide Rules and Long Scale Slide Rules; Circular Calculators; Slide Rules for Special Calculations; Constructional Improvements in Slide Rules; Accuracy of Slide Rule Results; and Appendix.

MECHANICAL DRAWING FOR HIGH SCHOOLS. By Berthe E. Spink, Percy H. Sloan, Albert W. Evans, Carl Durand, and Fred W. Zimmermann. Book I, 90 pages; book II, 185 pages; 10½ by 7 inches. Illustrated. Published by Atkinson, Mentzer & Grover, Chicago, Ill. Price: part I, 65 cents; part II, 80 cents.

There are so many textbooks on mechanical drawing, that unless each new one has something decidedly distinctive, it is coming into a field already over-supplied. However, these two books on mechanical drawing actually meet a demand that has been more or less imperfectly filled by other books; this demand is for a book that will meet the requirements of secondary schools, and which will therefore require to be much less technical than that commonly used in engineering colleges. As the preface states, the authors have long felt that a printed text in the hands of the pupils is essential to the proper presentation of the subject, to the same extent that texts are necessary to the right teaching of other branches of mathematics. As previously mentioned, the books are primarily intended for use in high schools. Book I is devoted to the first three years' work, and is the result of the collaboration of the five authors. This book explains and illustrates the rudiments of drawing in a complete and simple manner, interspersing just sufficient descriptive geometry without making a puzzle-book, as many books on the latter subject prove to be for students. Book II is on advanced work for use by the fourth year high school students. Instead of being collaborated like the first book, it has been prepared in sections by the individual authors. The sections of this part are: Shadow projection and linear perspective; machine drawing; and architectural drawing. All are well treated, especially the mechanical section, where the rudiments of machine design are considered in conjunction. For books to be used in secondary schools, they appear to be well suited, and should be in demand.

APPLIED THERMODYNAMICS FOR ENGINEERS. By Wm. D. Ennis. 438 pages, 6¼ by 9½ inches. 316 illustrations. Published by D. Van Nostrand Co., New York. Price $4.50.

The very term, "thermodynamics," is looked upon by most people at all familiar with engineering, with a remarkable degree of awe, no doubt caused by the number of text-books that have been published in which the solution of problems involving the differentiation of independent variables, seems to be the predominant feature. This subject seems to have offered a remarkable field for a master of the calculus to expand upon, as there are so many correlated qualities that some wonderful mathematical treatments are possible. This, therefore, has tended towards the practical application of thermodynamics being lost sight of, and the subject becoming an Eldorado for mathematicians. Realizing the need for a book occupying a midway position between these highly mathematical text-books, and those which run too much toward empiricism, Prof. Ennis has prepared this book, and we can fully endorse it as filling the field for which it is intended. Higher mathematics are used as little as is possible, and only where the solution demands their use. In addition, the practical application of the theory is fully dealt with for numerous thermodynamic machines, such as engines of all kinds, ice machines, etc., showing the modifications that the theory must receive to be put to practical use. While Prof. Ennis is an authority on the subject, numerous treatises have been consulted in preparing this book. In addition, the standard practice of many engineering firms is represented by the numerous drawings included in the work. The chapters are as follows: The Nature and Effects of Heat; The Heat Unit, Specific Heat, First Law of Thermodynamics; Laws of Gases, Absolute Temperature, The Perfect Gas; Thermal Capacities, Specific Heats of Gases, Joule's Law; Graphical Representations, Pressure-Volume Paths of Perfect Gases; The Carnot Cycle; The Second Law of Thermodynamics; Entropy; Compressed Air; Hot-air Engines; Gas Power; Theory of Vapors; The Steam Engine; The Steam Turbine; Results of Trials of Steam Engines and Steam Turbines; The Steam Power Plant; Distillation, Fusion, Liquefaction of Gases; and Mechanical Refrigeration.

INDUSTRIAL PLANTS. By Charles Day. 294 pages, 5½ x 7½ inches. Illustrated. Published by the *Engineering Magazine*, New York. Price, $3.00.

This treatise on industrial plants and their arrangement and construction by such a prominent authority as Mr. Day should be well received, especially in this present day when competition is becoming so keen that efficient works management is an absolute necessity. This volume forms a valuable addition to any library on works management. The main purpose of the book is to prove that efficiency and economy in manufacture are of equal importance with the mere operation of the plant in which the processes of production are carried on. The factors considered by Mr. Day are the primary ones which should be considered, being the arrangement and construction of the works. They concern the organic constitution of the factory and are hence of more potential importance even than systems of management which concern functional conditions. The major portion of the book is founded upon a series of lectures delivered by the author before the Graduate School of Business Administration, Harvard University, and the engineering students at Columbia University. The chapters included are as follows: General Classification of the Work; Determination of Specific Requirements; Selection of the Site and Definition of Building and Equipment Features; Detailed Plans and Specifications; Construction Work and Installation of Equipment; Period of Occupation and Commencement of Operation; Routing, a Prime Factor in Layout; Metal-Working Plants: Machine Shops and Their Specific Requirements; Modern Industrial Plants; Value of an Engineering Organization to the Project; Compensation for Engineering and Construction Service. This book is of especial value to the metal working industry, as the last few chapters are devoted specifically to problems dealing with the laying out of such plants. The matter is treated from a practical standpoint, actual successfully operating examples of the principles laid down in this book being cited to prove the points that the author is attempting to emphasize as being essential to a proper system of works management. The book is indeed one that should find its way into all libraries of works management.

THE STEEL WORKERS. By John A. Fitch, edited by Paul N. Kellogg. 380 pages, 6 by 9 inches. Illustrated. Published by the Charities Publication Committee, New York, under the Russell Sage Foundation. Price $1.50; postage, 21 cents extra.

In this interesting book, the complete industrial conditions under which the steel operatives work are dealt with in detail. The book from every standpoint is comprehensive, and depicts vividly the body destroying nature of the steel industry, with its insatiable desire for new and greater production records. Mr. Kellogg, the director of the Pittsburg Survey, states in his foreword: "The issues which Mr Fitch takes up are of a sort which are not publicly discussed in the mill towns of the Pittsburg district. Old employes do not dare to petition their employers to consider them. Mr. Fitch makes articulate what the steel industry means to the men employed in it—for whom it makes up the matter of life, and who have no voice." The subject is discussed in eighteen chapters, divided into four divisions: The Men and the Tools; The Struggle for Control; The Employers in the Saddle; and The Steel Workers and Democracy. These titles practically speak for themselves; in them is told a tale of terrible truths that the majority of people have preferred to be blind to rather than help alleviate the troubles by recognizing their existence. The terrible struggle for existence is particularly emphasized. Our own conclusions can best be drawn from a notice quoted in the book to the effect that the works were to accept "no more men over forty years of age in any department." The speeding-up system is summed up in the remark that "Over each gang is a foreman who is commonly referred to as the 'pusher,' because his main duty is to 'push' the men, and urge them to keep up a rapid pace." Speaking of the risks incurred by the operatives, Mr. Fitch says: "Men are not recompensed according to the degree of risk involved in their trades." This refutes the commonly accepted idea regarding such matters. The whole work deals most masterfully with the chain of wage cutting, twelve-hour day, seven-day week, abnormal heat conditions, and relentless speeding, bringing these features very prominently into the limelight; very strongly indeed, for Mr. Fitch's remarks are in no wise modified, he has figuratively taken the bull by the horns and painted the conditions in their true light—not through rose-colored glasses. The book is worthy of careful study.

HOMESTEAD; THE HOUSEHOLDS OF A MILL TOWN. By Margaret F. Byington, edited by Paul N. Kellogg. 292 pages, 6 x 9 inches. Illustrated. Published by the Charities Publication Committee, New York, under the Russell Sage Foundation. Price $1.50; postage, 20 cents extra.

One often hears in a vague way, through the newspapers or similar sources, about the industrial conditions that exist in the Pittsburg district, but it has remained for this book to point out—not in a brief, superficial manner, but after a year's study by the author—the conditions as they actually exist. The stupendous character of the work undertaken, which is one of a series of six, called The Pittsburg Survey, can best be appreciated by a study of the book. Miss Byington, who was well-known as a scientific charitable worker in Boston and New York previous to taking up this important study, has devoted the best part of a year to gathering data for this work, and the conclusions drawn can best be realized by quoting her single-sentence summary to the effect that the toilers "turn daily from twelve hours in the din of the huge mills to home, supper, a smoke and bed." In her investigations, a complete and authentic interpretation of the household end of the wage problem was obtained, the facts being based on the expenditures of ninety families, representing every nationality and wage group among the mill town people. Data showing the relation of cost of living to wages in both hard and good times are the outcome of this wage study. In the investigation, Miss Byington found that the mill towns are divided into two great groups—the English-speaking, including Northern European as well as native Americans, and on the

other hand, the Southern European races. These two great classes are in a state of antipathy, thus hindering the solution of the great American problem—the assimilation of the hordes of foreigners. This is still further hampered by these classes segregating into racial and religious groups. The testimony offered in the book does not speak very favorably for the working conditions, which tend to disrupt the home, the length of working hours keeping the men away from it except for the plain necessities of eating and sleeping. The book is significant in representing the conditions at the end of what has been one of the most prosperous decades on record. When conditions are as terrible as those depicted—conditions which can only be realized by a perusal of the book—the question naturally arises, "What would become of the district should a prolonged period of hard times develop?" The book emphasizes the tremendous problem confronting the American commonwealth.

POPULAR HANDBOOK FOR CEMENT AND CONCRETE USERS. By Myron H. Lewis and Albert H. Chandler. 430 pages, 6 x 9 inches. 126 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.50.

This book has been introduced into a field already pretty well supplied with technical literature because of a belief on the part of the publishers that nothing heretofore published has filled the want of a semi-popular book of the general type. The objection to the existing books is that they are either too technical and based on unproved theories, or else that they are too general, and contain no data that would be available to an engineer who desired to design a cement and concrete structure from the information at hand. The authors of this book have succeeded in providing a text-book intelligible to all who have a slight knowledge of the subject. Not only are the principles explained, but there is also much specific cost data based on reliable information gleaned from various sources, principal among which are the leading civil and concrete technical papers. To the mechanical engineer, the book is of interest, containing several chapters on reinforced concrete building construction. The chapters are as follows: Introductory; Kinds of Cement and How They are Made; Properties, Testing, and Requirements of Hydraulic Cements; Concrete and Its Properties; Sand, Broken Stone, and Gravel for Concrete; How to Proportion the Materials; How to Mix and Place Concrete; Forms for Concrete Construction; The Architectural and Artistic Possibilities of Concrete; Concrete Residences; Mortars, Plasters, and Stuccos, and How to Use Them; The Artistic Treatment of Concrete Surfaces; Concrete Building Blocks; The Making of Ornamental Concrete; Concrete Pipes, Fence Posts, etc.; Essential Features and Advantages of Reinforced Concrete; How to Design Reinforced Concrete Beams, Slabs, and Columns; Explanation of the Theory of the Design of Reinforced Concrete Beams and Slabs; Systems of Reinforcement Employed; Reinforced Concrete in Factory and General Office Construction; Concrete in Foundation Work; Concrete Retaining Walls, Abutments, and Bulkheads; Concrete Arches and Arched Bridges; Concrete Beam and Girder Bridges; Concrete in Sewerage and Drainage Works; Concrete Tanks, Dams, and Reservoirs; Concrete Sidewalks, Curbs, and Pavements; Concrete in Railroad Construction; The Utility of Concrete on the Farm; The Waterproofing of Concrete Structures; Front or "Liquid Concrete" and Its Uses; Inspection of Concrete Work—A Summary of Essential Rules and Principles of Construction for Securing Good Concrete Work; and Cost of Concrete Work.

CATALOGUES AND CIRCULARS

CROCKER-WHEELER CO., Ampere, N. J. Small hanger illustrating the Remek transformer.

E. G. SMITH, 134 N. 3rd St., Columbia, Pa. Leaflet bulletin No. 28 describing the Columbia caliper, No. 2.

AMERICAN SPIRAL PIPE WORKS, Chicago, Ill. A four-page pamphlet giving illustrations of some of the lap-welded steel pipe made by this company.

WILLIAMSON FREE SCHOOL OF MECHANICAL TRADES, Williamson School P.O., Delaware Co., Pa. Bulletin No. 7 describing the shop course in bricklaying.

WASHBURN SHOPS, Worcester, Mass. The Worcester drawing stands made in the Washburn shops of the Worcester Polytechnic Institute are described in catalogue F.

BRISTOL CO., Waterbury, Conn. Bulletin No. 127 describing Bristol's Class 3 recording thermometers which have ranges of temperature from 60 degrees below zero to 800 degrees F.

CINCINNATI GASKET & PACKING CO., 1536-1538 Plum St., Cincinnati, Ohio. Catalogue and circulars describing and giving dimensions of gaskets and packing made by this company.

COLLINS AXLE MFG. CO., 319 Frick Bldg., Pittsburg, Pa. Four page bulletin, describing the direct-drive axles made by this company. Data of tests made on these axles are included.

STANDARD GAUGE STEEL CO., Beaver Falls, Pa. A little booklet published by this concern gives the prices and shapes of steel bars for the cold drawn shafting which the company has recently put on the market.

PENNSYLVANIA RAILROAD CO., Philadelphia, Pa. A pamphlet No. G-40 entitled, "Hints on First Aid to the Injured," which is supplemental to some lectures delivered to the employes by the medical examiners of the relief department.

HARRIMAN BROS., 53 State St., Boston, Mass. A booklet gotten out by this firm is probably one of the first of a new line which is gradually developing. It describes the new Harriman type of aeromobile and aerocar.

NEW ENGLAND LINES, South Station, Boston, Mass., have issued a forty-page pamphlet entitled, "Remaking a Railway; A Study in Efficiency," written by Sylvester Baxter. It deals with the new transportation epoch in New England.

WILLIAMS TOOL CO., Erie, Pa. This company has published two pamphlets on the transverse current feed water heater in its application to the gas engine and to the steam engine. The constructional features are not dealt with to any great extent.

GARVIN MACHINE CO., Spring and Varick Sts., New York City, has published a large wall poster containing the decimal equivalents in very prominent type for reference purposes. This should prove useful in the drawing-room, 5/8-inch type being used.

NATIONAL SEWING MACHINE CO., Belvidere, Ill. Catalogue of automatic screw machines with illustrations and descriptions of machines, tools, attachments and products. It is well illustrated and should be of interest to automatic screw machine operators.

ADAMS CO., 850 White St., Dubuque, Iowa. Circular No. 805 is a new complete pamphlet on the Farwell gear hobber, covering both the Nos. 1 and 3 sizes. The pamphlet explains at some length the method of producing gears by the hobbing process, detailing the advantages.

THOMAS H. DALLETT CO., York and 23rd Sts., Philadelphia, Pa. This firm which manufactures air compressors has issued three new bulletins: No. 200, General Construction Details; No. 201, Straight Line Belt-driven Machines; No. 202, Straight Line Steam-driven Machines.

CARLYLE JOHNSON MACHINE CO., Manchester, Conn. In this neat catalogue E, the Johnson friction clutch is dealt with in a clear concise manner. Several auxiliary appliances used in connection with the clutch are also described, and of all these parts the standard dimensions are given.

HANNA ENGINEERING WORKS, 2059 Elston Ave., Chicago, successor to the Electric Machinery Sales Co., Milwaukee, Wis. Bulletins Nos. R 1 and R 2 on the Ajax electric riveting machines of the bench, pedestal, portable and "holder-on" types and the semi-portable-yoke and "holder-on" types.

VANADIUM SALES COMPANY OF AMERICA, Frick Bldg., Pittsburg, Pa. The first issue of *American Vanadium Facts*, the new house organ of this company, made its first appearance in March. It is a bright little publication which will be published periodically in the interests of "Amervan" ferro-vanadium.

COOPER HEWITT ELECTRIC CO., Eighth and Grand Sts., Hoboken, N. J. Bulletin No. 36 superseding bulletin No. 23, describes the Cooper Hewitt electric lamps, type P, direct current, for indoor service. Another pamphlet entitled, "Better than Day-Light," deals with the advantages accruing from the use of this means of illumination.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Bulletin 1120, Type A Electric Rock Drill; No. 1122, Small Motors and their Applications; No. 1123, Single-Phase Prepayment Induction Watthour Meter; No. 1126, Fort Wayne Electric Fans. This latter is a fine example of the printer's art. An index for bulletins Nos. 1001 to 1125 has also been prepared.

LUCAS MACHINE TOOL CO., Cleveland, Ohio, has just issued a circular No. F-5 describing the new model No. 32 "precision" horizontal, boring, drilling and milling machine. This model has quick power movements to all parts, having feeds so arranged that no matter what feed is used the quick return is obtained by simply moving the "feed and quick return lever."

GARDNER MACHINE CO., Beloit, Wis. Gardner disk grinding machinery and accessories are described in this latest catalogue, all the different sizes of machines being listed, giving their general characteristics and dimensions. The general constructional features are described and the application of the machine to different classes of work illustrated with a number of photographs.

GENERAL ELECTRIC CO., Schenectady, N. Y. "Motor Drive for Metal Working Machinery," is the title of bulletin No. 1815 superseding No. 4548. In this catalogue the general application of electric motor drive for metal working machines is illustrated very completely, practically every type of machine tool being shown in its adaptation to this means of drive. It might well be considered a text on the subject.

MICHIGAN TWIST DRILL CO., Detroit, Mich. Circular of "Michigan" hot forged twist drills made of carbon and "Novo" high-speed steel, comprising straight and taper shank drills, jobbers' drills, taper square shank drills fitting ratchets, Coes' drills, Sliver and Deming drills, wood boring brace drills, bit stock drills, etc.; also fluted shell reamers, rose shell reamers, taper reamers, three-groove chucking reamers and solid or hand reamers.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. The different types of rivet heating furnaces which this company manufactures are described in bulletin No. 227; brief illustrated descriptions are also given of their other miscellaneous furnaces. Bulletin T describing the Moyer tramrail in modern foundry practice has for its main feature a paper on this subject presented by Mr. Moyer before the American Foundrymen Association, June, 1910.

LANDIS TOOL CO., Waynesboro, Pa. The 1911 catalogue on grinding machines for cylindrical and conical surfaces is a fine sample of catalogue printing, being handsomely made up. In addition to the numerous illustrations of machines manufactured, there are several illustrations showing specific uses to which the machine can be advantageously put. Valuable grinding data are also included which should be in the hands of grinding operators generally.

CROCKER-WHEELER CO., Ampere, N. J. Polyphase induction motors, constant speed, 60 cycle, with horsepowers varying from 1/2 to 250, are described in bulletin No. 126, which supersedes former bulletin No. 115. Numerous applications of these motors are included. An interesting pamphlet entitled, "Should Terms of Payment be Enforced?" written by the treasurer of the company, Mr. W. L. Brownell, which was presented before a meeting of the National Association of Credit Men has been published

CHICAGO MACHINE TOOL CO., 127 N. Canal St., Chicago, Ill. General catalogue of the Chicago milling machines comprising a variety of styles of equipment of the bench and column type machines, ranging from a bench machine weighing 235 pounds to a column type machine with overhanging arm, automatic feed, etc., weighing 990 pounds. The style with vertical spindle attachment offers the manufacturer a machine embodying both horizontal and vertical spindles, economically adaptable to a great variety of manufacturing operations.

JACOBS MFG. CO., Hartford, Conn., has just issued an attractive and comprehensive catalogue of the Jacobs improved drill chucks, showing half-tone illustrations—actual size—of the ten different sizes and forms of Jacobs drill chucks manufactured. The Jacobs chuck is operated by a wrench carrying a toothed pinion which engages teeth cut in the sleeve. The advantage of this construction is that there is no tendency to turn the spindle when tightening or loosening the chuck jaws. The catalogue will be mailed free to any one requesting it.

SHORE INSTRUMENT & MFG. CO., 555-557 West 22nd St., New York. Catalogue and treatise on the Shore scleroscope, an instrument for testing the hardness of metals by measuring the rebound of a small falling weight. This interesting device is described and illustrations of its use are given. It is employed to measure the hardness of metals and to determine generally the characteristics of metals before and after hardening, and of alloys, which have an important influence on the manufacturing operations or the finished product. Seldom does a piece of trade literature contain the valuable informrtion to be found in this treatise.

FOOS GAS ENGINE CO., Springfield, Ohio. Catalogue No. 23 illustrating and describing the Foos horizontal single-cylinder gas engine built in sizes from 3 to 90 H.P.; also the new Foos oil engine designed for operation on kerosene and other heavy liquid fuels. A few shop views are included showing typical machining operations on Foos engines, of general interest. The remarkable stability of the horizontal engine is illustrated by a view showing a test in which the engine was mounted on polished steel rollers resting on two I-beams. A photograph was taken of the engine running at full speed and no vibration of the frame is indicated in the picture.

BAYONNE CASTING CO., Bayonne, N. J. Booklet on monel metal, brass, bronze and other alloys. The booklet treats of monel metal, forms in which it is sold; its uses; adaptability for castings, rods, sheets, forgings; physical properties; government specifications, etc. Monel metal is a natural alloy containing approximately 67 per cent nickel, 27 per cent copper and 6 per cent of other metals, principally iron and manganese. In appearance it cannot be distinguished from pure nickel and its great strength and extreme incorrodibility admirably adapt it for use in marine work and engineering construction, for parts that come in contact with salt water and for valves and fittings that are subjected to superheated steam.

CONTENTS FOR APRIL

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition.

TRADE NOTES

West Haven Mfg. Co., West Haven, Conn., maker of hack saws, was burned out March 8.

J. Wyke & Co., East Boston, Mass., have gone out of business. The future address of Mr. Wyke will be South St., Wilmington, Mass.

Union Caliper Co., manufacturer of small tools, has moved from Fitchburg, Mass., to Orange, Mass., where a factory building has been bought. The company will enlarge its business and add to its present line of manufacture.

Bosch Magneto Co., New York, has completed its large reinforced concrete factory building at Springfield, Mass., and is installing machinery. The company will begin manufacturing magnetos in the new plant early in April.

Standard Gauge Steel Co., Beaver Falls, Pa., has completed a large new plant which greatly increases its capacity. The company has taken on a new line consisting of cold rolled and finished shafting, screw stock and rounds.

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y., has built a four-story addition of concrete construction to its factory, which will materially add to the facilities now on hand for handling the company's die-casting business.

General Electric Co., Schenectady, N. Y., has recently obtained an order for 60 two-motor 70 H. P. cars for the Detroit United Railways of Detroit, Mich. The Northern Ohio Traction Co., of Akron Ohio, has also placed a large order for new equipment with the company.

Joseph Dixon Crucible Co., Jersey City, N. J., states that it supplied graphite and graphite lubricants to 210 steam roads during 1910, showing an increase of 53 per cent. The same lubricants were sold to 91 automobile manufacturers, showing a business increase of 260 per cent.

Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill., has made a contract with the Electric Machinery Sales Co., of Milwaukee, Wis., to succeed it as general sales agents for the Ajax electric riveting machines, including the Ajax yoke riveter, the first line of light yoke riveters offered to the trade.

Pawling & Harnischfeger Co., Milwaukee, Wis., crane builder, at a recent meeting of its board of directors elected S. H. Squier director and secretary; W. H. Hassenplug, sales manager, was elected a director and second vice-president; and F. P. Breck, associated with the company for many years, was elected a director.

Institute of Operating Engineers, 29 W. 39th St., New York, formed a new branch at Yazoo City, Miss., called "Col. Goethal's branch, No. 1," on January 28. F. C. Holly is branch chairman, and L. B. Smith, secretary-treasurer. The address of the secretary and treasurer is P. O. Box 297, Yazoo City, Miss.

Richardson-Phenix Co., Milwaukee, Wis., has recently opened a branch office in the Keystone Building, 324 Fourth Avenue, Pittsburg, to care for its constantly increasing business in the Pittsburg district. The office will be under the management of Mr. H. M. Laughlin, who has been with the Richardson-Phenix Co. for several years.

Westinghouse Machine Co., Pittsburg, Pa., has recently obtained an order for two 3750 K. W. steam turbines for the Northern Indiana Gas and Electric Co. of Chesterton, Ill. The turbines will operate with a steam pressure of 175 pounds, with 100 degrees superheat, exhausting into 28 inch vacuum, and will be connected to Westinghouse generators.

Grand Rapids Machine Tool Co., Grand Rapids, Mich., has been incorporated with $20,000 capital, $10,000 of which is subscribed and paid in. The officers are Matthew Lund, president; J. F. Nellist, vice-president; and G. C. Mason, secretary and treasurer. The company manufactures plain milling machines and no further equipment will be added now.

Reed Mfg. Co., Erie, Pa., manufacturer of machinists' vises and steam fitters' tools, has just completed a large three-story addition to its factory which increases the capacity 80 per cent. The equipment is modern in every respect. The company's business has grown very rapidly, its records showing a net increase each month for over twenty-four months.

American Motor Truck Co., Findlay, Ohio, announces the consolidation of the Lockport Stamping Co., the Findlay Motor Co., and the American Motor Truck Co. The Lockport Stamping Co. and the American Motor Truck Co. are being moved from Lockport, N. Y., to Findlay, where the executive offices of the consolidated concerns will be located also.

Lester & Wasley Co., Inc., Norwich, Conn., has been incorporated to manufacture "Leader" envelope machines, and other light machinery, with a capital of $25,000. The incorporators and directors are: Frederic W. Lester, president; H. L. Stanton, vice-president; Percival W. Chapman, treasurer; Franklin H. Allen, secretary; and George W. Armstrong, superintendent.

Bowman Blackman Machine Tool Co., 720 N. Second St., St. Louis, Mo., is the successor of Albert B. Bowman, dealer in machine shop equipment. The change is due to the entrance into the firm of Mr. G. H. Blackman, a graduate of the mechanical department of the Missouri State University and an experienced machine tool man. He has been with the Bowman concern for several years.

Ahrens Iron Works Co., Cincinnati, Ohio, is a new corporation which succeeds the Union Iron Works Co. of that city. The new company has been regularly chartered under the laws of the state of Ohio and the business will be conducted in the modern and extensive plant recently constructed by the Union Iron Works Co. The business is the manufacture of structural and ornamental steel and iron work.

Manheim Mfg. & Belting Co., Manheim, Pa., is a new company which has recently been formed. The officers are: Chas. Bond, president; George H. Danner, vice-president; M. M. Pfautz, secretary; and M. G. Hess, treasurer. The principal object of this company is to manufacture Veelos Balata belting, a product which has up to the present time been imported by the Chas. Bond Co. of Philadelphia, Pa.

Reliance Electric & Engineering Co., Cleveland, Ohio, has removed to its new offices and shops on Ivanhoe Road. The new plant is of reinforced concrete construction with saw-tooth roof and other features of the modern up-to-date manufacturing plant. The company manufactures the Reliance alternating-current and direct-current motors and direct-current adjustable-speed motors, which latter are being used advantageously for machine tool driving in combination with simple mechanical changes.

Wilmington Institute Free Library, Wilmington, Del., is making a special effort to develop its department of applied science. The circulation of technical books used by the working men of the city has increased nearly 200 per cent in five years. The department has been seriously handicapped in not having the trade catalogues of the various manufacturing concerns throughout the country and the librarian requests that manufacturers send their catalogues to the library. Any trade catalogue published in the country will be valued.

Yale & Towne Mfg. Co., 9 Murray St., New York City, has been awarded the contract for installing a complete monorail overhead tramway system for the J. H. Ladew Co.'s new large tannery, Plank Road and Passaic River, Newark, N. J. The equipment comprises about three-quarters of a mile of I-beam, three traveling cranes, transfer devices, automatic fire-door attachments, etc., and is notable as showing the tendency toward overhead or "aerial" transportation for the handling of materials in up-to-date manufacturing establishments.

Buffalo Forge Co., Buffalo, N. Y., reports that the New Jersey Zinc Co. has recently placed an order for fifty-four large special fans. These fans were purchased after a competitive trial of several makes under identical conditions. The saving of power effected in the

MEAN ABSOLUTE PRESSURES—I

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure: 18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
$\log_\varepsilon R$		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+\log_\varepsilon R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
8		1.83	2.45	3.00	3.48	4.17	4.77	5.04	5.29	5.74	6.13	6.77	7.25	7.60	7.91
12		2.76	3.68	4.49	5.21	6.26	7.16	7.56	7.93	8.61	9.20	10.16	10.88	11.40	11.86
16	1.3	3.66	4.91	5.99	6.95	8.35	9.55	10.08	10.58	11.48	12.26	13.55	14.50	15.20	15.82
20	5.3	4.58	6.13	7.49	8.69	10.44	11.93	12.60	13.22	14.35	15.33	16.93	18.13	18.99	19.77
24	9.3	5.49	7.36	8.99	10.43	12.52	14.32	15.12	15.87	17.22	18.40	20.32	21.76	22.79	23.72
28	13.3	6.41	8.59	10.48	12.16	14.61	16.70	17.64	18.51	20.09	21.46	23.70	25.38	26.59	27.68
32	17.3	7.32	9.81	11.98	13.90	16.70	19.09	20.16	21.16	22.96	24.53	27.09	29.01	30.39	31.63
36	21.3	8.24	11.04	13.48	15.64	18.78	21.48	22.68	23.80	25.83	27.59	30.48	32.63	34.19	35.59
40	25.3	9.15	12.27	14.98	17.38	20.87	23.86	24.20	26.45	28.70	30.66	33.86	36.24	37.99	39.54
44	29.3	10.07	13.49	16.47	19.12	22.96	26.25	27.72	29.09	31.57	33.73	37.25	39.89	41.79	43.49
48	33.3	10.98	14.72	17.97	20.86	25.05	28.64	30.24	31.74	34.44	36.79	40.64	43.51	45.59	47.45
52	37.3	11.90	15.95	19.47	22.59	27.13	31.02	32.76	34.38	37.31	39.86	44.02	47.14	49.38	51.40
56	41.3	12.81	17.18	20.97	24.33	29.22	33.41	35.28	37.03	40.18	42.92	47.41	50.76	53.18	55.36
60	45.3	13.73	18.40	22.46	26.07	31.31	35.80	37.80	39.67	43.05	45.99	50.80	54.39	56.98	59.31
64	49.3	14.64	19.63	23.96	27.81	33.40	38.18	40.32	42.32	45.92	49.06	54.18	58.02	60.78	63.26

Contributed by C. C. Carles

MEAN ABSOLUTE PRESSURES—II

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure: 18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
$\log_\varepsilon R$		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+\log_\varepsilon R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
68	53.3	15.56	20.86	25.46	29.55	35.48	40.57	42.84	44.96	48.79	52.12	57.57	61.64	64.58	67.22
72	57.3	16.47	22.08	26.96	31.28	37.57	42.96	45.36	47.61	51.66	55.19	60.96	65.27	68.38	71.17
76	61.3	17.39	23.31	28.45	33.02	39.66	45.34	47.88	50.25	54.53	58.25	64.34	68.89	72.18	75.13
80	65.3	18.30	24.54	29.95	34.76	41.74	47.73	50.40	52.90	57.40	61.32	67.73	72.52	75.98	79.08
84	69.3	19.22	25.76	31.45	36.50	43.83	50.11	52.92	55.54	60.27	64.39	71.11	76.15	79.77	83.03
88	73.3	20.13	26.99	32.95	38.24	45.92	52.50	55.40	58.19	63.14	67.45	74.50	79.77	83.57	86.99
92	77.3	21.05	28.22	34.44	39.97	48.01	54.89	57.96	60.83	66.01	70.52	77.89	83.40	87.37	90.94
96	81.3	21.96	29.44	35.94	41.71	50.09	57.27	60.48	63.48	68.88	73.58	81.27	87.02	91.17	94.90
100	85.3	22.88	30.67	37.44	43.45	52.18	59.66	63.00	66.12	71.75	76.65	84.66	90.65	94.97	98.85
104	89.3	23.80	31.90	38.94	45.19	54.27	62.05	65.52	68.76	74.62	79.72	88.05	94.28	98.77	102.8
108	93.3	24.71	33.12	40.44	46.93	56.35	64.43	68.04	71.41	77.49	82.78	91.43	97.90	102.6	106.8
112	97.3	25.63	34.35	41.93	48.66	58.44	66.82	70.56	74.05	80.36	85.85	94.82	101.5	106.4	110.7
115	100.3	26.31	35.27	43.06	49.97	60.01	68.61	72.45	76.04	82.51	88.15	97.36	104.2	109.2	113.7
120	105.3	27.56	36.80	44.93	52.12	62.61	71.59	75.60	79.34	86.10	91.98	101.6	108.8	114.0	118.6
125	110.3	28.60	38.34	46.80	54.31	65.23	74.58	78.75	82.65	89.69	95.81	105.8	113.3	118.7	123.6

Contributed by C. C. Carles

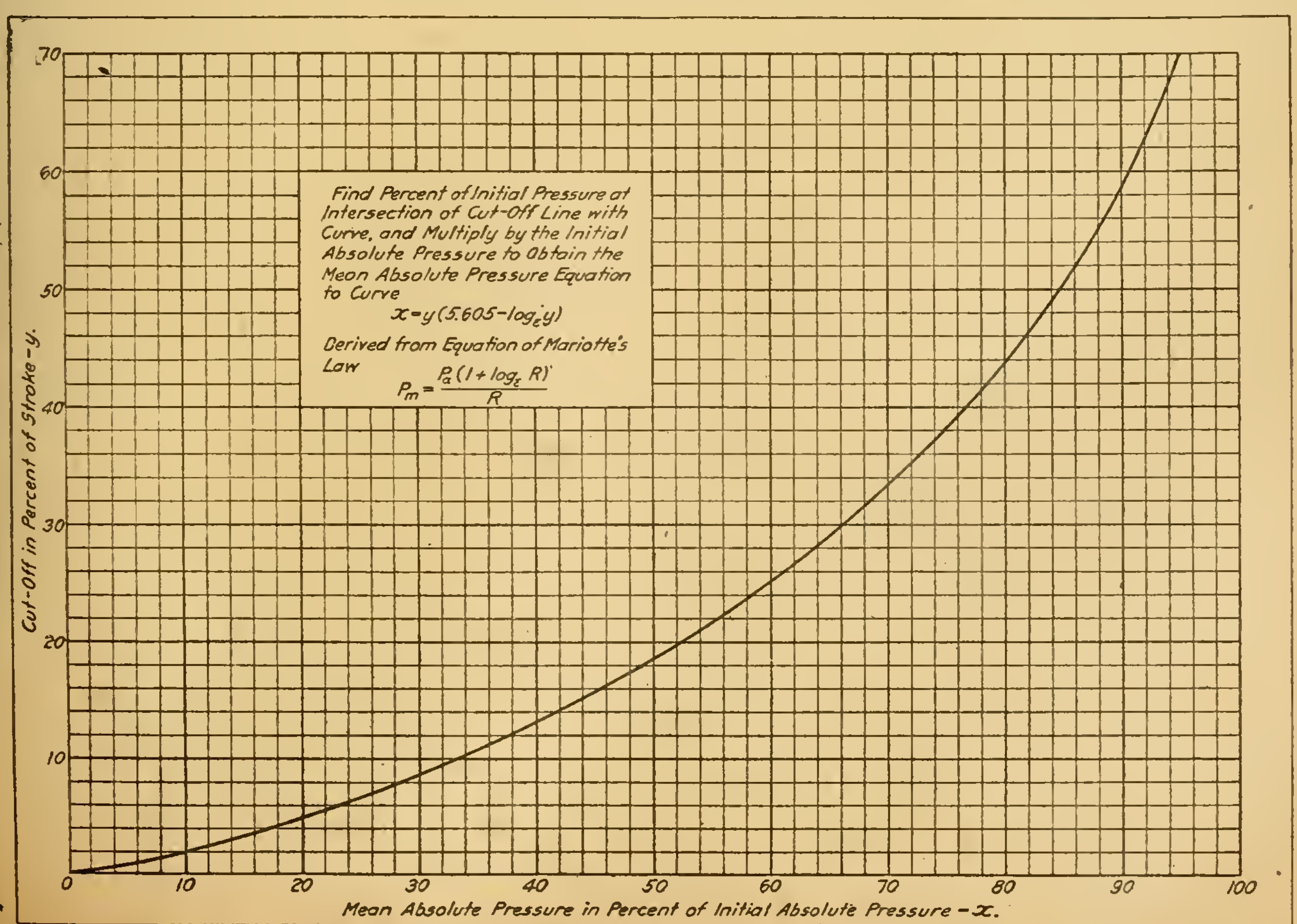
MEAN ABSOLUTE PRESSURES—III

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure: 18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
$\log_e R$		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+\log_e R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
130	115.3	29.74	39.97	48.67	56.49	67.83	77.56	81.90	85.96	93.28	99.65	110.1	117.8	123.5	128.5
135	120.3	30.89	41.40	50.54	58.66	70.44	80.54	85.05	89.26	96.86	103.5	114.3	122.4	128.2	133.4
140	125.3	32.03	42.94	52.42	60.83	73.05	83.52	88.20	92.57	100.5	107.3	118.5	126.9	133.0	138.4
145	130.3	33.18	44.47	54.29	63.00	75.66	86.50	91.35	95.87	104.0	111.1	122.8	131.4	137.7	143.3
150	135.3	34.32	46.01	56.16	65.18	78.27	89.49	94.50	99.18	107.6	115.0	127.0	136.0	142.5	148.3
155	140.3	35.46	47.54	58.03	67.35	80.88	92.47	97.65	102.5	111.2	118.8	131.2	140.5	147.2	153.2
160	145.3	36.61	49.07	59.90	69.52	83.49	95.46	100.8	105.8	114.8	122.6	135.5	145.0	152.0	158.2
165	150.3	37.75	50.61	61.78	71.69	86.10	98.44	104.0	109.1	118.4	126.5	139.7	149.6	156.7	163.1
170	155.3	38.90	52.14	63.65	73.87	88.71	101.4	107.1	112.4	122.0	130.3	143.9	154.1	161.4	168.0
180	165.3	41.18	55.21	67.39	78.21	93.92	107.4	113.4	119.0	129.2	138.0	152.4	163.2	170.9	177.9
190	175.3	43.47	58.27	71.14	82.56	99.14	113.4	119.7	125.6	136.3	145.6	160.9	172.2	180.4	187.8
200	185.3	45.76	61.34	74.88	86.90	104.4	119.3	126.0	132.2	143.5	153.3	169.3	181.3	189.9	197.7
215	200.3	49.19	65.94	80.50	93.42	112.2	128.3	135.5	142.2	154.3	164.8	182.0	194.9	204.2	212.5
230	215.3	52.62	70.54	86.11	99.95	120.0	137.2	144.9	152.1	165.0	176.3	194.7	208.5	218.4	227.4
245	230.3	56.06	75.14	91.73	106.5	127.8	146.2	154.4	162.0	175.8	187.8	207.4	222.1	232.7	242.2

Contributed by C. C. Cariss

MEAN ABSOLUTE PRESSURES—IV



Contributed by C. C. Cariss

MACHINERY

May, 1911

MACHINING A MILLING MACHINE COLUMN

By FRED E. ROGERS*

THE prevailing practice of American machine tool builders is the use of jigs and fixtures for practically all the principal machining operations, and the leading concerns provide a jig or fixture for all drilling, boring, planing and milling operations whatsoever. The use of jigs insures interchangeability and greatly reduces the cost of quantity production. On that all are agreed, but the practice varies considerably as to form of jigs and the way they are employed. The box jig originally developed for manufacturing firearms, in which the part operated on is partly or entirely enclosed in a cast-iron box having a hinged cover or the equivalent, is the form commonly used for the smaller machine tool parts, but obviously the box jig becomes very heavy and cumbersome when applied to the larger castings such as frames, slides, etc., and while the box construction of the jig has certain advantages over all other forms, its cost, the space required for storage and other drawbacks have led the machine tool maker to the use of sectional or piece jigs, which are supported by the work itself, instead of enfolding and supporting the work. The piece jig, of course, is located and supported by a previously machined surface usually made either by planing or boring. An excellent example of simple but accurate piece jigs is the equipment used by Kearney & Trecker Co. of Milwaukee, Wis., for the manufacture of its well-known knee-type milling machines, and in the following article we have illustrated and described the jigs, tools and operations on a No. 3 column in their regular order.

An operation sheet is made up by the drafting and planning department for each part, in the form shown here, and accompanying the operation sheet is a drawing of the part, showing where the operations are to be performed as well as the dimensions and other data commonly given on shop working drawings. The operation sheet gives the order of operations, the tool-room number of the jigs and tools and their shelf locations in the tool-room. The drawing of the column, reproduced in Fig. 1, shows the position of the parts to be machined. They are indicated by reference letters and the same references are used herewith.

The first operation on the column is rough planing the face A, which is done on a Gray planer. Two tools are used in one tool-post on the roughing cut, as can be seen in Fig. 2. The cut is thus divided between two tools, the leading tool being set deeper than the following tool, of course. After roughing the front face, the column is cleaned and painted. The rough planing operation not only relieves the strains in the casting, but it serves also as a thorough inspection of it. Should serious defects be found that cause rejection of the casting, the loss is not so great as it would be if the cleaning and painting had been done first. (See the following article describing the painting operations in detail.) The column is then returned to the planing department and the back of the column, *B*, and door frame *C* are rough and finish planed. See Fig. 3 for set-up on planer, tools, etc.

The fourth operation is milling the surface *D*, as shown in Fig. 4, and sawing the ⅛-inch slots *M* required for the overhanging arm clamps. (See Fig. 5.) These operations are designated as a and b on the operation sheet, both being milling operations on the same special machine—a larger size of the Milwaukee miller. The fifth operation is drill-

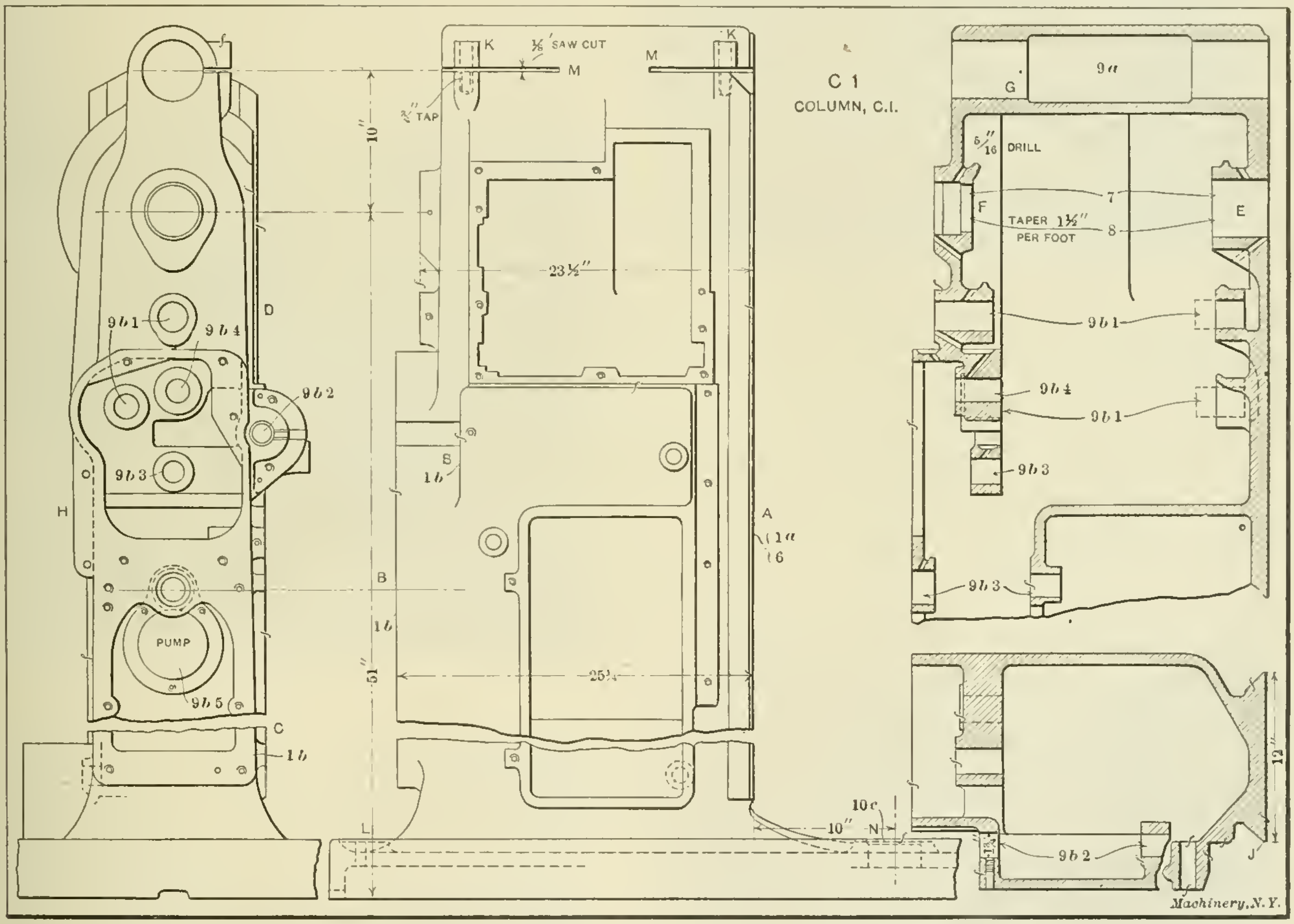


Fig. 1. Drawing locating the Machining Operations listed in the Operation Sheet on the Next Page

* Editor of MACHINERY.

ing the holes K and L. Filler pieces are slipped into the slots M before drilling, and after drilling, the holes are tapped and the clamp screws screwed down tight. This is done to prevent change of shape after boring the overhanging arm hole, which was found to take place if the slots were cut after the hole was bored. The column then goes to the planer for finish planing the surface A, Fig. 1. During the time that elapses between the rough planing of the face and the finish planing, the internal stresses in the castings are relieved and little or no change need be anticipated afterwards.

Form O-81 OPERATION SHEET
KEARNEY & TRECKER CO. C1
Machine No. 3 Part Name Column Part No C1
Laid Out By T.T./W.M. Date 11/19/10 Drawing No C1

No	Operation	Jig No	Tool Box No	Shelf No	Machine No	Speed	Feed
		1841		B			
1	(e) Rough Plane at A —	667	252	B			
2	Cleen & Paint						
		1842		B			
1	(b) Plane at B B & C	1115	252	B			
4	(a)-Mill at D	2165	267	71			
	(b)-Saw at M M						
5	Drill et K K & L						
6	Finish Plane at A						
		1769	170	45			
7	Bore E & F	1850	170	47			
		1853	75	A			
8	Hand ream F	1850	75	A			
		566	72	37			
9	(a)-Bore G						
		613	73	37			
	(b)-Bore with Jigs	658	74	41			
		659	73	37			
		1809	254	24			
		742	107	40			
		723	174	23			
10	(e)-Drill at D & C						
	(b)-Drill at H	1573	191	50			
		1864	90	61			
	(c)-Bore & Face N	1860	255	A			
		1858	97	45			
11	(e)-Drill with Jigs at B	733	76	50			
		1747	74	41			
		729	76	50			
		860	107	40			
	(b)-Drill oil holes on Press						
12	Filler Paint						
13	Drill oil holes with portable Drills						
14	Scrape						

Operation Sheet listing All Operations on Milling Machine Column

The gages shown in Fig. 6 are used for testing the shape and dimensions of the vees and dovetail.

After the finish planing the column goes to an upright drill press to have the spindle holes E and F bored and reamed. It is clamped face down on a carefully leveled bed,

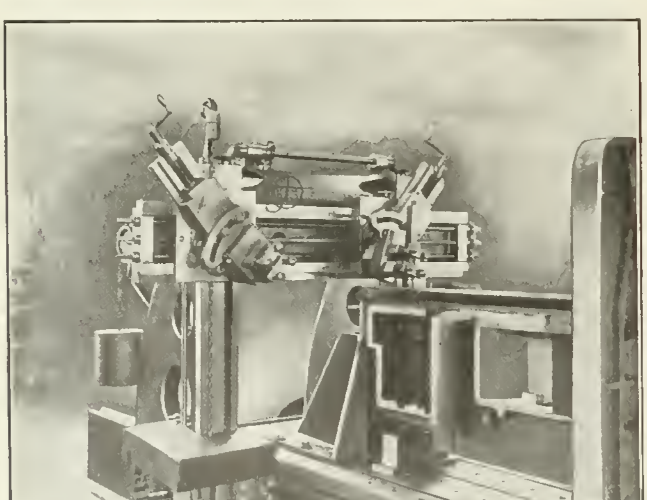


Fig. 2. Rough Planing on Face to take out Spring and inspect the Casting

Fig. 7; the boring-bar, of the form shown in Fig. 8, is supported at the bottom by a bushing that is located by the front face, the vee and the ledge that was milled in operation 4. The pin, bearing against the ledge, is shown near the base and in front of the opening in Fig. 7. The column, of course, must be accurately located under the drill press spindle inasmuch as the boring bar is aligned and supported at the upper end by the spindle that drives it. The straight and taper reamers and cutters for stepping out the taper hole are shown on a stand at the left with wooden base and top, in which latter a number of holes are bored for the reception of tool shanks. These stands, provided for holding boring

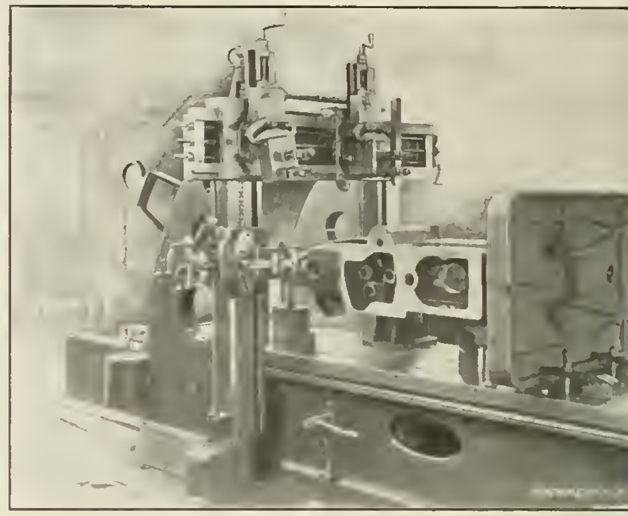


Fig. 3. Rough and Finish Planing Back of Column, Door Frame and Vertical Trip Slot

tools, reamers, drills, counterbores, etc., are shown supporting various tool equipments in a number of the illustrations.

After the spindle hole is bored and reamed, the column is

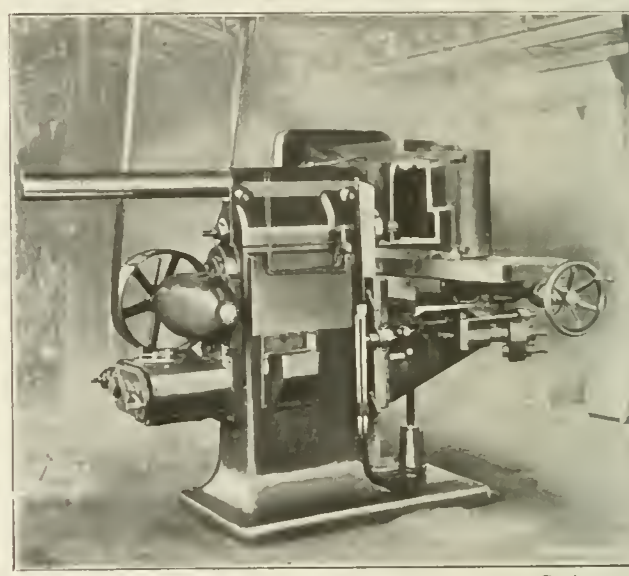


Fig. 4. Milling Edges of Opening into the Change-gear Cavity

laid down on its back and the ingenious hand reaming jig shown in Fig. 9 is put in place, as illustrated in Fig. 10. The

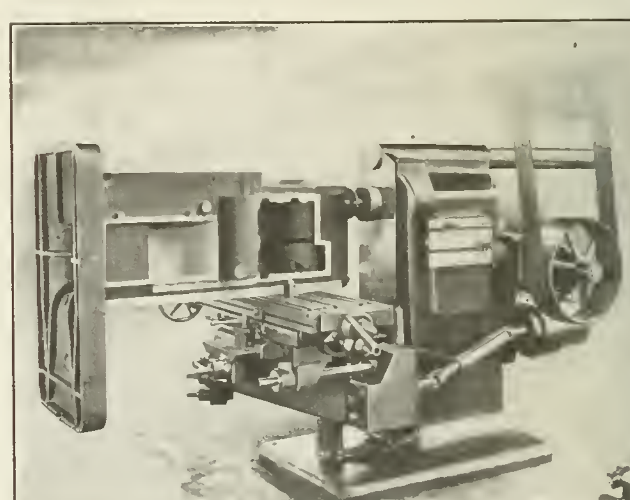


Fig. 5. Sawing Slots for Overhanging Arm Clamp

jig is supported by a narrow bearing in the spindle hole in the front and the abutment screws in the four points

of the spindle. These screws are set out against the inside walls of the column, the adjustment being made with reference to the column face by the straightedge and micrometer mounted on the end of the 18-inch arm. When the reaming jig is accurately set, the test bar is removed and the reamer and reamer bar inserted, as shown in both Figs. 9 and 11, the latter view showing the men at work reaming the back taper bearing for the spindle box. Of course, this operation is simply scraping the taper bearing to correct the slight inaccuracy of alignment that may have been found with the test bar.

Having bored and reamed the spindle hole square with the front face of the column, the following boring and ream-

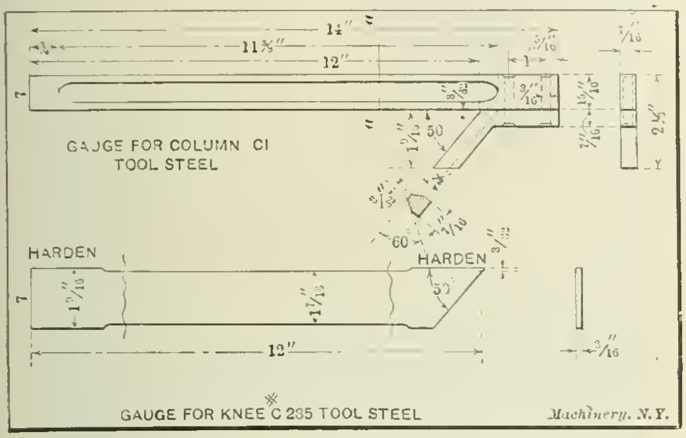


Fig. 6. Gages for Testing Column and Knee Vees

ing operations are done, using this hole as the starting point and means of location and alignment. Operation 9, displayed in Fig. 13, this being the boring of the arm hole, is also done under an upright drill press. The jig, which embraces the top of the column, is located by a ground bar with bushings fitting the spindle hole, and the boring bar is of the same form as that illustrated in Fig. 8. The arm clamp screws are set up, clamping the filling pieces snugly before this boring operation is started, the reason being, as before explained, to avoid changes of shape and alignment that were invariably

The subsequent operations under 9 are designated here as 9 b 1, 9 b 2, 9 b 3, 9 b 4 and 9 b 5, respectively. The operation 9 b 1 is illustrated in Fig. 14, and reference to Fig. 1 will show the reader more clearly where the holes are located and the nature of the work. The jig is located by

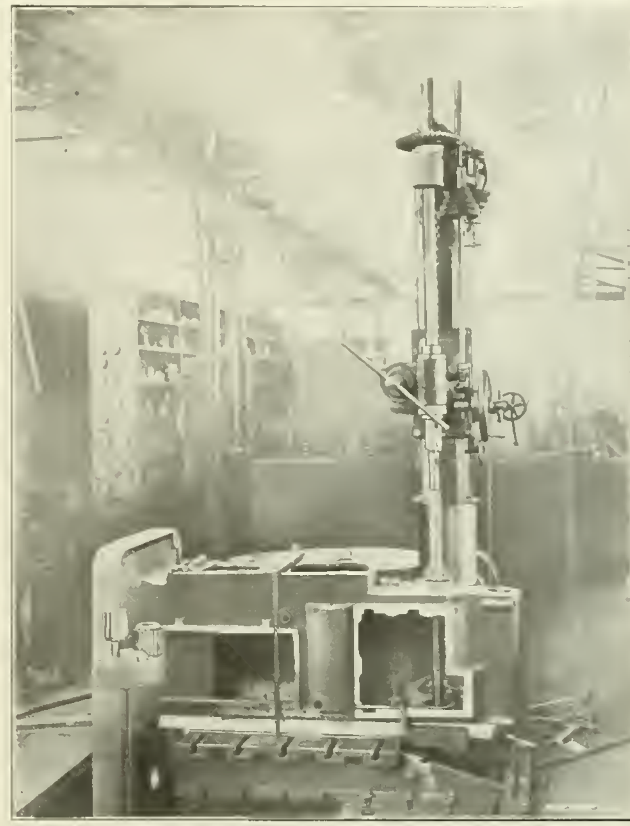


Fig. 7. Boring the Main Spindle Hole

the spindle hole and the milled surface *M*. As this hole is cut from the solid, a twist drill is used to open it. The accurate location of the column under the spindle is obtained by means of the plug shown standing at the right of the drill,

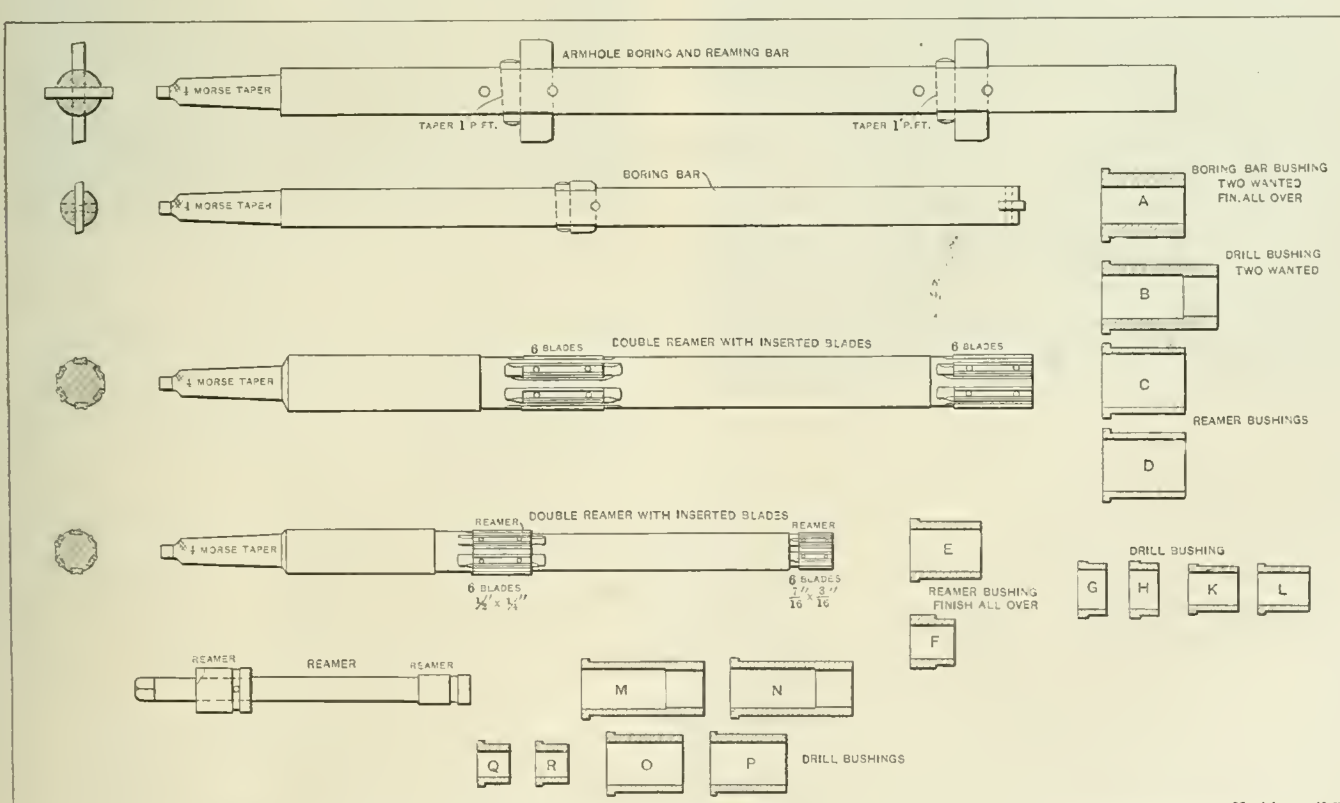


Fig. 8. Boring-bars, Reamers, Bushings, etc., constituting Part of Tool Equipment for Boring Column

developed if the slots were cut after the arm hole was bored. The general construction of this jig, bars, etc., is indicated in the sectional view, Fig. 12, which shows the jig in place; and also an end view of it.

this being placed in the spindle when the jig is aligned. The plug fits closely in the jig and the column and jig must be in close alignment before it will enter and pass through freely. The boring bar, facing tools, reamer and bushings for

the operation also appear in the illustration on the stand at the left, and the details of the reamer are given in Fig. 8. The small cast-iron ribbed plate leaning against the base, having three slots, is a convenient and reliable gage for controlling the depth of cut of the facing tools. This plate is laid

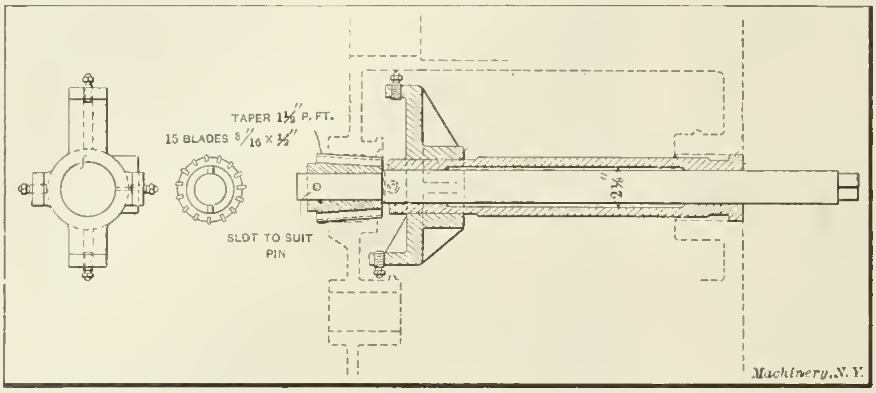


Fig. 9. Reaming Jig for Locating and Supporting Hand Reamer in Spindle Bearings

on the planed surface of the column with the sides of a slot astride the facing tool bar, and the collar on the tool limits the downward travel. Leather collars are provided for the boring bars to prevent chips falling into the bushing below and destroying the accuracy of fitting. These collars, though simple features, are very important in keeping the tools in first-class condition.

In Fig. 16 the column is seen undergoing operation 9 b 2, the location of which is indicated in Fig. 1. The bars and tools are at the left mounted in their stand ready for use, and the details of the jig appear in Fig. 15. The construction of this

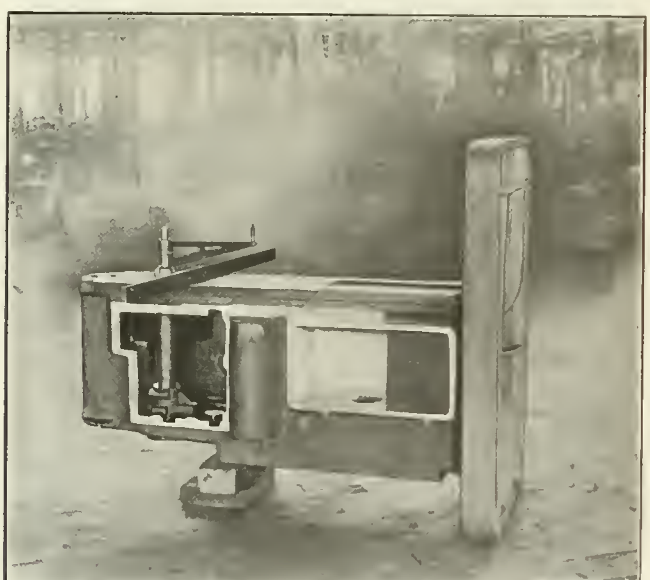


Fig. 10. Showing how Reaming Jig is set to Face of Column

jig is somewhat peculiar because of the necessity of inserting a supporting bar and clamping the jig to it after insertion. The jig, of course, supports the boring bar at the top and bottom.

Operation 9 b 3, seen in Fig. 17, requires the bars, reamers and facing tools on the two stands at the right; and the jigs and tools for operation 9 b 4 appear in Fig. 18. In Fig. 17 the bar in front inserted in the hole previously bored acts as a stop against which a pin in the jig plate abuts. The small holes in the jig shown in Fig. 18 for tap bolts are drilled under a radial drill, the important bearings only being bored under the upright drills.

Operation 9 b 5, illustrated in Fig. 19, is boring and facing the seats for the spur-geared pumps that circulate the lubricating oil to all the internal bearings, and the fluid for cooling and lubricating the cutters. The character of the operations is shown by the form of the tool in the drill spindle and the one lying on its side on the column, at the left.

Operation 10-a is also done under the radial drill, Fig. 20. The jig in place is located by the horizontal milled ledge and one vee. The jig for the door frame and the vertical trip strip are leaning against the jack and the column, and the tools for the operations are in the two stands at the left. Operation 10-c is boring the hole for the elevating screw and facing the boss, Fig. 21, in which a long bushing for the nut is fitted. The reason for not making this boss for the nut integral with the casting is that it would seriously interfere with planing the front face of the column.

Fig. 22 shows another radial drilling job, this being the tap holes for the feed-box and pulley bracket. This illustration shows the jig, standing on edge, that is used in operations 9 b 1, 9 b 3 and 9 b 4, and illustrates the principle of supporting and locating jigs by plugs fixed to the jig plates. The line illustration Fig. 23 gives further details of this jig.

Last but not least the operation 11-b, drilling the oil-holes,

Fig. 11. Hand Reaming the Spindle Bearings

completes the list of machining operations. Notwithstanding the fact that practically all have to be performed within limits of one-thousandth inch and some are difficult of access, the equipment is extremely simple. The peculiar internal construction of the column is due, of course, to the all-geared drive and automatic lubrication, the latter being an exclusive feature of the Milwaukee miller.

The tool equipment briefly described in the foregoing is

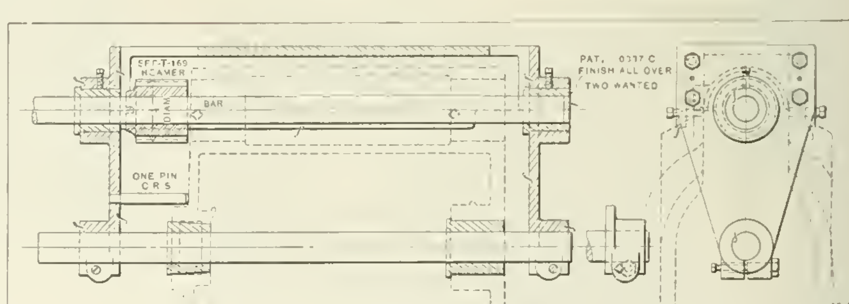


Fig. 12. Showing Construction of Arm Hole Jig and the Spindle Bar

of admirably simple design and is adapted for the use of skilled mechanics. In this respect it is at a disadvantage, perhaps, with the more costly and cumbersome box jigs that are

practically fool-proof. But users of these milling machines generally will not be sorry to learn that though they are the product of a highly developed manufacturing plant, plenty of good old-fashioned ideas still prevail here, as to the character of men and methods employed in doing work, that satisfy

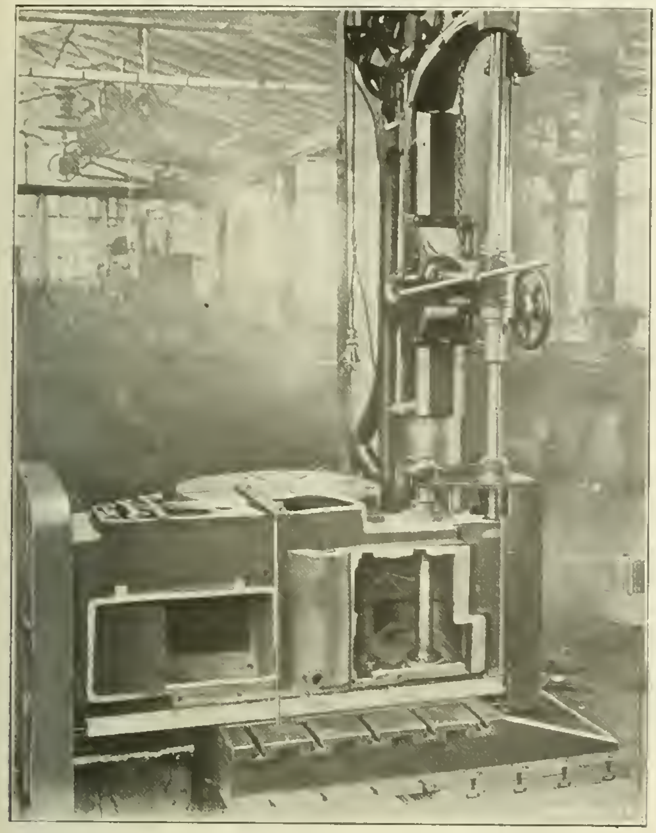


Fig. 13. Boring the Overhang Arm Hole. Clamp Screws are snugly set before Boring

the ideals of the two enterprising partners who have built up this flourishing business.

* * *

PAINTING MILWAUKEE MILLING MACHINES*

Most *good* mechanics at some time or other in their mechanical careers have been greatly impressed with the diffi-

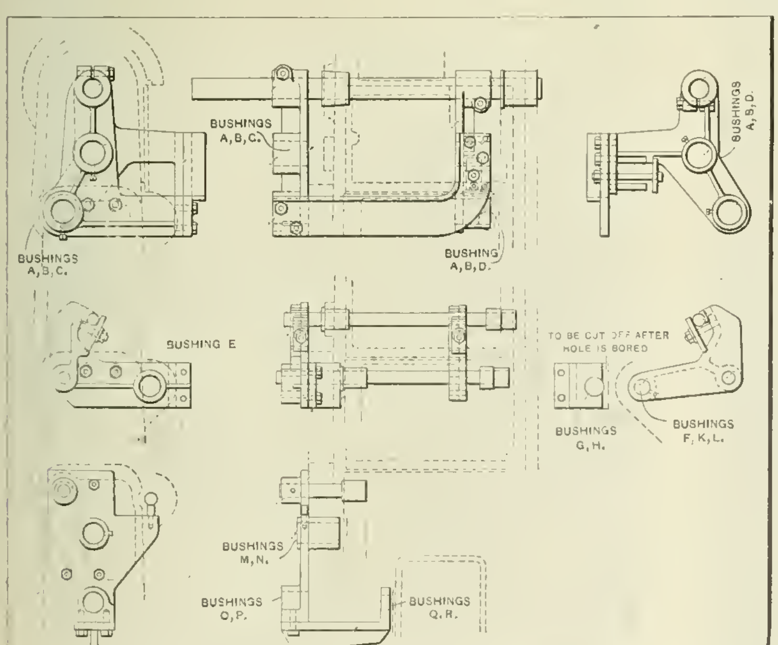


Fig. 15. Jigs for Operations 9b1, 9b2 and 9b3, respectively See Fig. 8 for Bushings

culty of finishing a machine or tool satisfactorily. In fact it may be truthfully stated that it is far easier for the average mechanic to *build* a good machine than to finish it in keeping with its use and purpose. The product of the individual is generally recognizable as "homemade" until he has acquired the faculty of carrying his work clear through the finished stage with that indescribable something known as

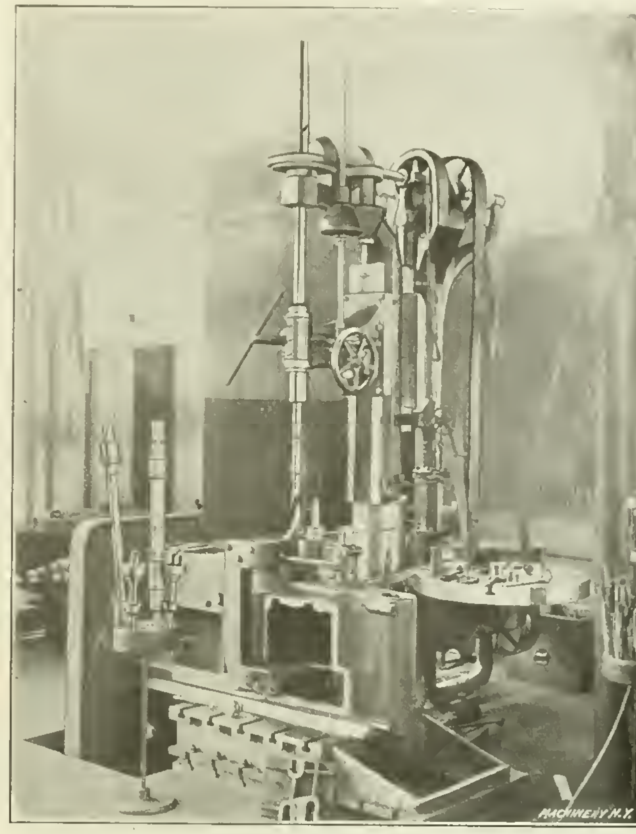


Fig. 14 Operation 9b1. Bar located by Spindle Hole and Milled Surface at Edge of Opening

"taste." Many of us who are not "strong on finish" take comfort in saying that it counts for little, and a machine will do its work just as well whether well painted or not. The truth is that finish, although something apart from mechanical excellence, is that which marks its climax, requiring both the skill of the mechanic and the taste of the artist to secure the most pleasing result. The effect on the intelligent prospective buyer is two-fold.

It is not uncommon to hear a buyer of machine tools say that he does not care anything about how a machine is painted so long as the important parts and the general workmanship are satisfactory. While this man is quite correct in his choice—preferring a well-made to a well-finished machine—it is a noteworthy fact that the number of buyers making this distinction is steadily diminishing, and it is becoming generally understood that a manufacturer who exercises the care necessary to *finish* his machines nicely will be pretty sure to exercise the same care with the *details of construction*. The most cold-blooded buyer is affected favorably by a well-painted machine in spite of his blustering statement to the contrary—just as he is affected by the lines and distribution of the parts of the machine that go to make a harmonious design. This, however, is another story—how machine tools are painted by one successful concern.

It is strongly recommended that a beginner in the machine tool field pay close attention to the matter of good painting. In the early days of their venture both Messrs. Kearney and Trecker of the Kearney & Trecker Co., Milwaukee, Wis., makers of the Milwaukee milling machines, studied the problem carefully and did the work with their own hands, learning that proper materials was only part, and that painstaking care was needed at every step. Interested critics suggested that paint was the only good thing about these machines, but the man who bought had opportunity to test for himself, and the good painting was one of the

* For further information on the subject see: "Painting and Filling Machine Tools," April, 1908.

things that induced him to give the machine a trial.

Objection is sometimes made on the ground of cost but this will not hold good as the expense is far less on a percentage basis than it is in the case of a hay rake, and the added value to the user is just as great in one case as it is in the other.

At the solicitation of the editor the Kearney & Trecker Co. has given the steps of painting the Milwaukee milling machines, and the materials used. It should not be inferred, of course, that other paints cannot be used with equal success but these are what have been found uniformly satisfactory after years of trial. The company emphasizes the fact that materials and tools do not give results without painstaking care any more than a scraper and surface plate in the hands of a careless workman will produce a flat surface.

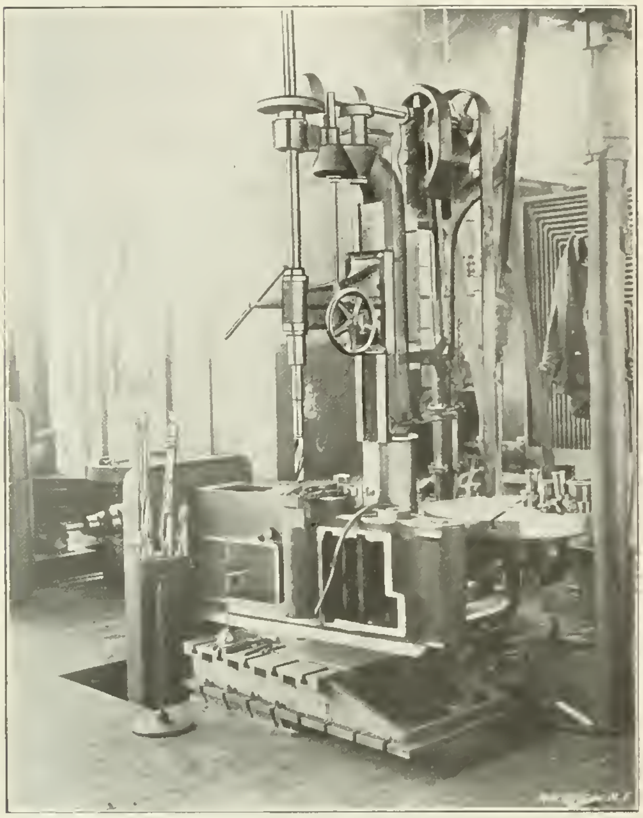


Fig. 16. Operation 9b2. Notice Compressed Air Hose—Compressed Air used to blow away Chips

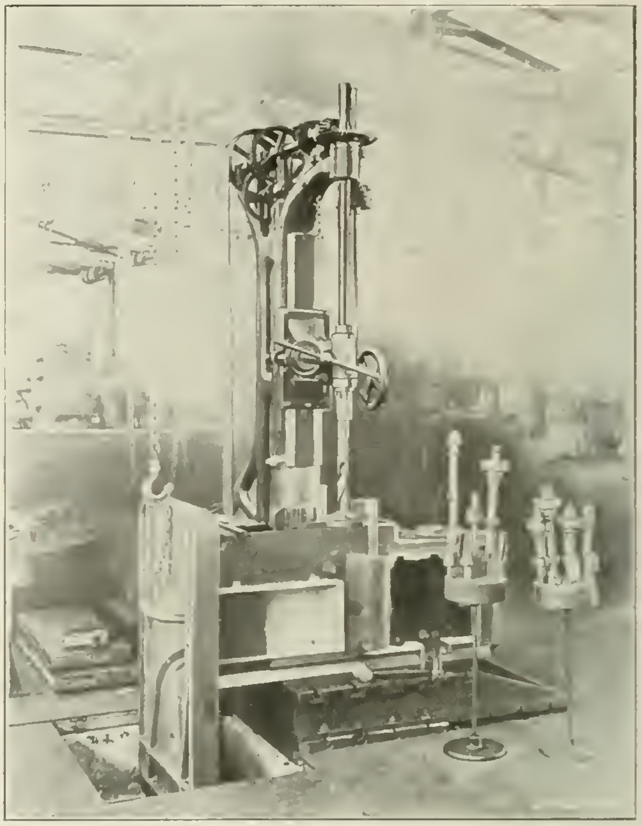


Fig. 17. Operation 9b3. Note the Reamers, Counterbores and Boring-bars

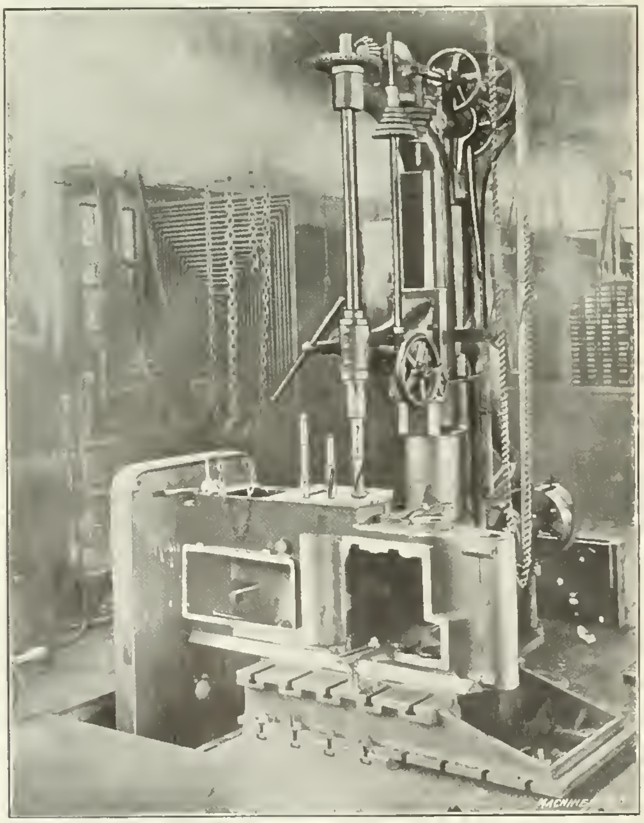


Fig. 18. Operation 9b4. Bars located from Holes produced in Operations 9b1 and 9b3. Depth Gage shown in Fig. 14 also used

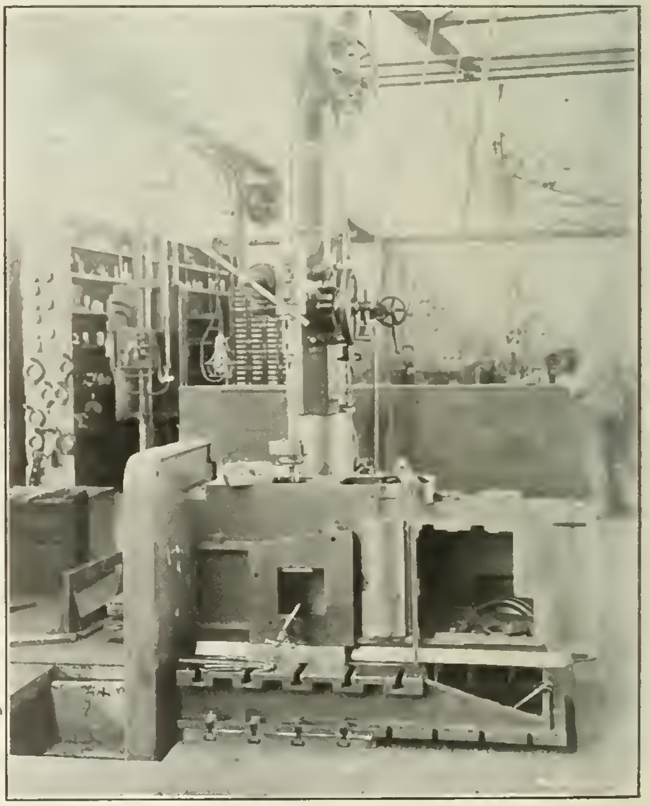


Fig. 19. Operation 9b5. Boring and Facing Pump Seats

1. Clean castings free from rust, graphite and oil.

2. Give castings one priming coat made with 16 pounds Patek Bros. No. 1470 paste primer and one gallon of turpentine. Brush on, and let stand over night.

3. Cardboard coat as thinly as possible with Patek Bros. No. 1427 machine filler, followed in 24 hours by a brush coat of the same. Allow this to dry for 24 hours.

4. Rub down with No. ½ emery cloth. Use water where dust is objectionable.

5. One coat Sherwin-Williams No. 7682 oil-proof paint.

When this coat is dry the parts are ready to be assembled.

6. Putty all imperfect places where the surface has been

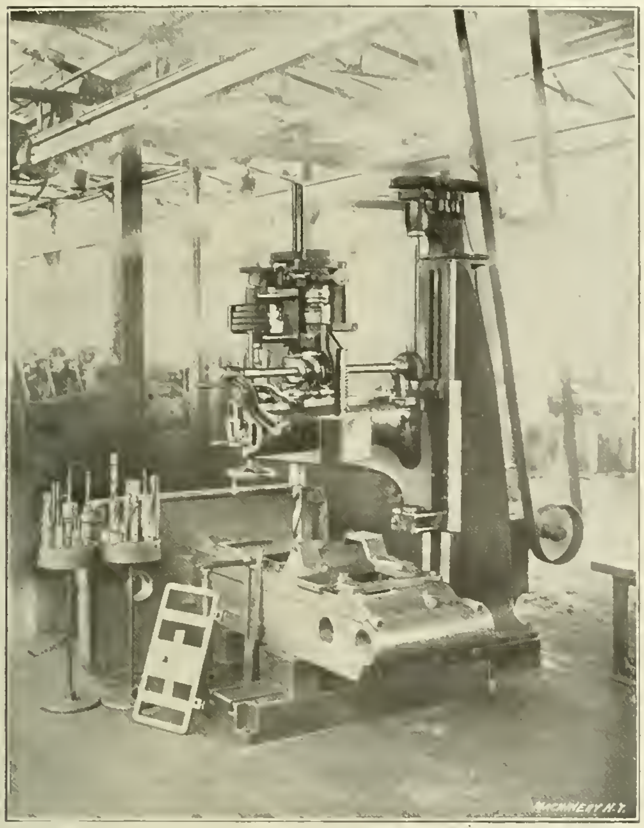


Fig. 20. Operation 10-a. The Jig on Top is located by Horizontal Milled Ledge on Side of Column. The Door Jig leans against the Clamp Jack

marred during the assembling operations, using hard drying putty.

7. Sand with No. 0 sandpaper.

8. Coat with grain alcohol orange shellac very thin—merely

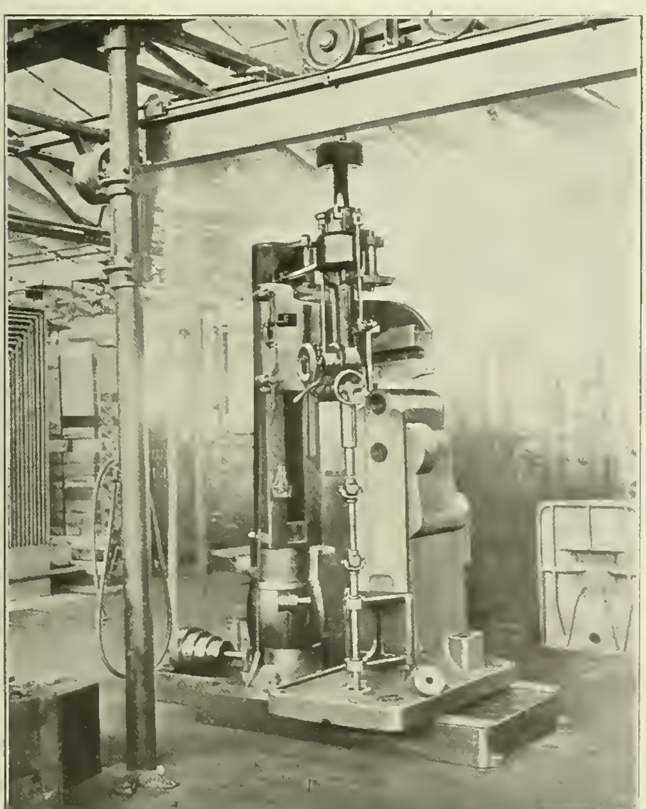


Fig. 21. Operation 10-c. Boring the Boss for the Elevating Screw Nut

a wash—to prevent any oil that may have soaked into the filler from interfering with the finishing coat.

9. One finishing coat Sherwin-Williams No. 7682 oil-proof paint. Use Fitch hair brush.

The large castings such as the columns are rough machined before any painting whatever is done. The reason is to find imperfections, if there be any, which would cause their rejection, before doing unnecessary work that would be lost in case a piece was scrapped.

* * *

GERMAN EXPORTS AND IMPORTS OF MACHINE TOOLS

The exports of machine tools from Germany during 1910 aggregated 59,166 metric tons (1 metric ton = 2204 pounds).

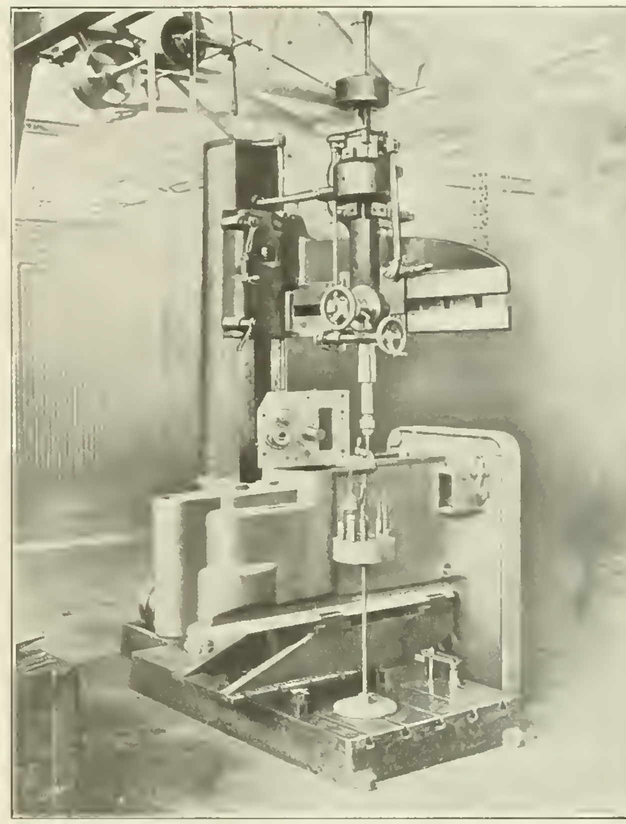


Fig. 22. Operation 11. Drilling Small Holes. Note Locating Plugs on Jig shown standing on Edge

This is the highest record so far obtained, the highest previous record being for 1908, when the exports amounted to 58,522 metric tons. During the past year Austria-Hungary

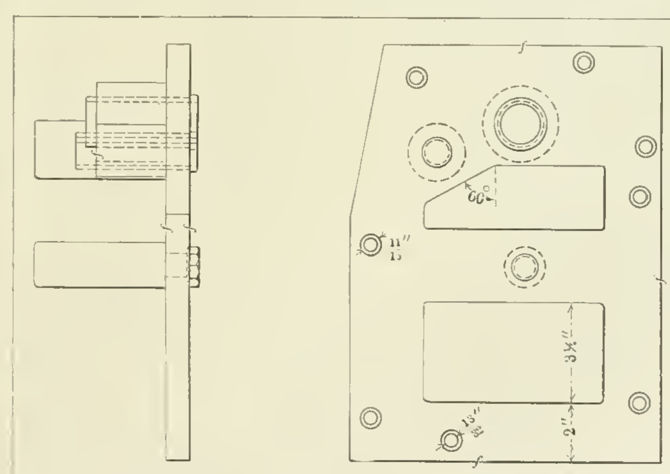


Fig. 23. Details of Jig shown standing on Edge in Fig. 22. Note Principle of Locating

was the best customer of German machine tools, one-fifth of the exports being to that country. Italy and France occupy the second and third places, respectively. Of the total imports of machine tools to Germany, the United States furnished about 60 per cent, or 3500 metric tons out of a total of 6000 tons. The imports of American machine tools to Germany were greater in 1910 than in 1908 or 1909, but considerably less than in 1906 and 1907. Ten years ago, in 1900, the exports of German machine tools were only 10,892 tons, while the imports to Germany were 6981 tons.

POWER-PRESS CONSTRUCTION—USES AND ABUSES

By HART PRESTON

Would you ever think of running your automobile or the engine in your shop without thoroughly lubricating it? Then why not give the power-presses in your shop the same attention? Would you ever allow your engineer to run your engine at 1500 revolutions per minute when the maximum safe limit of speed is but 900? Then why run at 250 revolutions per minute power-presses that are built to operate only at a maximum speed of 125?

How often do you permit operators to take a ¼-inch cut on a lathe having a maximum capacity of a ⅛-inch cut at the normal speed? Not very often! But how often, on the other hand, do you knowingly have the power-presses in your shop cutting the equivalent of three, four or five square inches of metal in spite of the ever-present fact that the machines doing such work were bought under a rigid guarantee of having a maximum capacity of one-half, or three-quarters of the strain to which they are subjected?

As in the selling, so in their use, power-presses should be looked after by men who know their goods, know how they are made, what strains each and every component part is designed to withstand and to what particular range of operations each press may be adapted. Yet the number of press-users is by no means limited who, although fully equipped for building their own power-presses, prefer (?) to have them built by press-builders whom they acknowledge as being expert mechanics in their line. But, notwithstanding these press-users assume to dictate what should be the shaft diameter, section of uprights, diameter of connection-screw, ratio and size of gearing, etc., on presses for certain work for which the builder has for an indefinite time furnished their competitors *standard* presses that have proved entirely satisfactory! It is a sad fact that although there is such a broad, unlimited field in this line of machine building, there are but

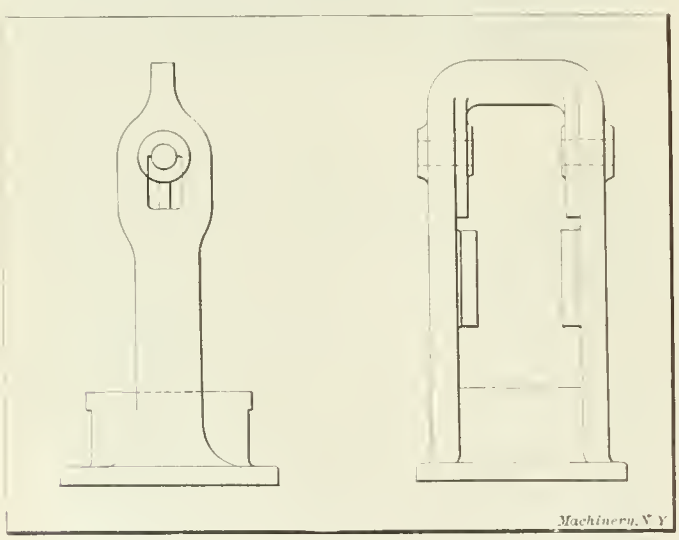


Fig. 1. Straight-sided Press—One-piece Construction

few men who can properly qualify as successful designers and builders of power-presses. Yet in spite of this, we find few, very few, power-press users who credit themselves with such indisputable knowledge and authority as to dictate "what's what" in power-press design, building their own presses or even as much as controlling any of the stock of any of the sheet-metal working machinery corporations.

As in other lines, there is strong competition in the press-building industry; the ever-increasing substitution of steel and other stampings and forgings for castings and solid metal and wooden parts brings to established press-builders an increased volume of business which at the same time is an incentive to others to engage in power-press building. These firms can be classified about as follows:

Builders of small presses only, for tin and other light work;

Builders of medium weight presses for producing brass, aluminum and the lighter grade of steel stampings, also for light forging work; and

Builders of presses for general sheet metal working and forging work, embracing anything from a tobacco tag to a seamless drawn steel barrel or bath tub, and in forging work, from a typewriter bar to the heaviest automobile axles.

It is to be regretted that with the stamping and forging business increasing by leaps and bounds in its scope, and hence almost compelling progressive press-builders to be constantly developing new and larger presses, there should be such a wide variation of opinion as to the safety factor to be observed in the construction of these heavy presses,

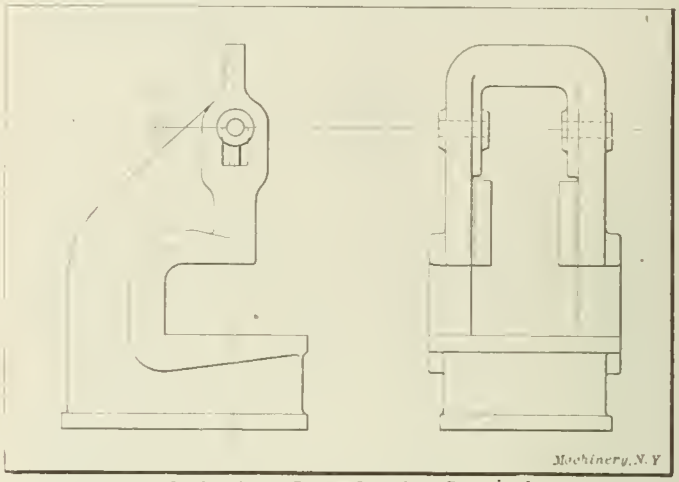


Fig. 2. Gap-frame Press One-piece Construction

some manufacturers at times often basing this as low as 3 to 1, and others as high as 6 to 1.

In the scrap-heaps about the country we find:

Frames cracked at the shaft bearings, through not having sufficient metal at this point;

Uprights fractured just above the bed, clearly showing a frame out of proportion to the shaft and gearing;

Arches of frames broken, due to the same cause as the foregoing; and

Shafts twisted off entirely, due to the same cause, and thus necessitating the discarding of presses, as the frames may not be sufficiently strong at shaft-bearings to permit using shafts of greater diameter.

Giving the press-user the benefit of the doubt in the majority of these breakages, and assuming that these presses, when broken, were operating on work within their guaranteed capacity, it is to be readily seen that one cannot be too conservative in installing rationally designed and proportioned power-presses, particularly for heavy work.

In endeavoring to secure business one press-builder will lay particular stress on the large section of the uprights of his presses, another on the diameter of the shafts he furnishes and the quality of the steel used in them, while another (to humor a customer believing in the common fallacy of buying the greatest weight for the least money, a policy, however, that is not pursued in the purchase of any other machine tools) agrees to stiffen the bed and arch of a press to get this additional weight, although in doing so he knowingly unbalances his other proportions.

It is the general practice to use straight-sided presses as shown in Fig. 1 in preference to the gap-frame presses in Fig. 2 for the heavier classes of stamping and forging work. The grade of steel to be found in the shafts of the different makes of presses analyzes at from 0.30 carbon in the cheaper, to 0.55 carbon in the better, makes. On shafts with comparatively short strokes it is possible to determine very closely the maximum pressures that can be exerted with shafts of given diameters, and the frames must naturally be so proportioned as to withstand the full limit of the shaft pressure. The strain which a straight-sided frame will withstand is another point on which press-builders differ, some figuring this as great as 5000 and others as low as 2000 pounds per square inch of upright section. In the straight-sided frame, the pressure is transmitted in a straight line, and the design of this style of frame is such as to more uniformly distribute the pressure or strain over the entire section of frame than in the other style. The frames of the smaller presses of this style, that is to say, presses ranging in weight up to about 50,000 pounds, with the frames proper weighing approximately 25,000 pounds, are usually

cast in one piece and designated as "one-piece" frames. Frames above the weight mentioned are usually of the "built-up" type, shown in Fig. 3, having the bed, arch and uprights cast separately and tightly bound together by means of powerful steel rods, onto which the jam or check-nuts are shrunk in place while the rods are hot. With the elastic limit of these steel tie-rods definitely known, it is not difficult to determine the diameter of the rods required to lend sufficient stiffness to these built-up frames to fully and safely resist the maximum pressure of the shaft. However, as it is extremely difficult (due to the cooling and contraction of these rods) to tighten each of the nuts uniformly, the diameter of these rods should also be so proportioned to take care of any undue strain on any of the rods through having the nuts bearing tighter on one than on another and thereby subjecting it to a greater constant strain.

It is interesting to note here the rapid advancement being made only in very recent years on this style of construction. Unlike the purchase of a lathe (using this as an example only) in which the customer knows that the range of his work will be limited by the size of the lathe he installs, press-users often figure that instead of tying up the amount of money actually required for a suitable press for certain work, they can afford to take a little risk and purchase a somewhat lighter press for the same job. To the discredit of some press-builders, such manufacturers were until very recently encouraged in this by the builder's offering to help the customer out by reinforcing (?) the lighter frame by shrinking steel tie-rods through it. True, they certainly stiffened the frame, but so much out of proportion to the shaft diameter that the writer has actually seen presses so constructed with the shafts twisted off entirely, close up to the main bearings.

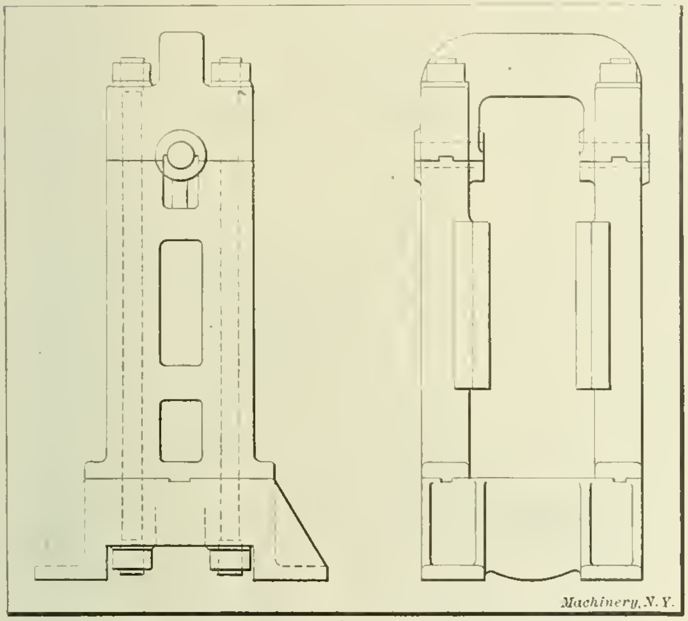


Fig. 3. Straight-sided Press—Built-up Construction

From the above it will be seen that up to the point where frame castings are so large and heavy as to prevent castings being as dense and hard as are required, it is not only cheaper but safer to use frames without steel tie-rods, but with the uprights designed in proportion to the shafts and other parts. However, on the larger presses, where it is almost obligatory to use the "built-up" construction, and in which the full strain of the shaft is diverted from the uprights to the tie-rods, the rods should not only be of unusually large diameter to take any reasonable overload, but the nuts on them should also be of ample proportions and the bosses on the frames on which these nuts bear should also be properly proportioned. This is indicated in Fig. 3.

Carefully comparing the relative weights and proportions of the largest presses of this pattern, the number of each make in use and the work they are producing, the writer finds that while all of the three best-known builders observe about the same proportions, each has a different opinion as to the weak point, or that part of the press which should be so designed as to give or break before any other part, in the event of the press being operated beyond its capacity. One builder figures on the shaft bending, another on the connecting-sleeve breaking, and the third on the driving-pinion giving way. It may readily be seen that the last is not only the safest construction—as far as the possible damage to the press and dies in such accidents is concerned—but also the cheapest from the point of up-keep through time lost while the tools are out of commission in making the necessary repairs, for with the gear-guard arranged with suitable clearance for the broken teeth to fall out of the way, all that would ordinarily be required would be to carry an extra pinion on hand for just such an emergency.

Another feature which should receive equally as careful attention is the clutch, which is, in reality, the heart of a power press. Various types of friction clutches, as well as block or jaw clutches, are recommended by the different builders, and while a well-designed, practical block clutch may operate with entire success even on the larger sizes of presses, a properly-designed friction clutch with friction and braking surfaces of proper proportions is not only equally as efficient but preferable on these presses, particularly on presses requiring a uniform, constant pressure (for deep-drawn and similar work) which, of course, can be obtained with a block clutch only through a portion of the travel or stroke of the shaft. The friction clutch is also more efficient for reducing and drawing operations, for testing and trying-out dies, and as all properly designed friction clutches can be started or stopped at any point of the stroke (some, however, more quickly than others), this style of clutch is preferable in case of accidents due to dies not being properly set, getting more than one blank into the dies at a time, or other causes.

Another feature is the ratio of gearing and pitch of teeth. As in the safety factor for other vital parts of presses, we find there is an equally great difference of opinion on the ratio of gearing and the pitch of teeth. However, on several leading makes of large presses of about equal weight and capacity it has been proved that with these presses running at the comparatively slow speed at which they must be operated in view of the large and heavy blanks to be fed into and removed from the dies, it is the wiser plan to use gearing of large diameter, with the diameter of pinion and ratio of gearing designed to deliver the maximum efficiency of the balance-wheel running at its safe limited speed of about 3500 feet per minute, rather than to be compelled to run the latter at a greater and unsafe speed because of the use of gearing of a lower ratio and coarser pitch, which must necessarily be lighter, smaller in diameter, less powerful and requiring greater driving power.

Other important details in the proper design and construction of power presses, particularly in the larger sizes, are:

Long slides, with gibs or ways also of ample length to properly support and guide the slide, particularly on long-stroke presses.

Main and crank bearings of shafts should be as long as possible, with the main bearings extending inward as far as possible toward the cheeks of shafts to more rigidly support them.

Connection-sleeve and screw should be amply large to easily withstand the full safe working-pressure of the shaft.

All bearings throughout the entire press should have ample means provided for a constant, unchecked flow of properly-distributed lubrication.

Various press-builders will at times give customers data on "shearing stresses" to be used by them in determining the pressure required for certain blanking or shearing work. These formulas, however, should be used most conservatively, for when used to figure other work such as forming, embossing or swaging they cannot and should not be used as the basis for determining the pressure required to perform these operations, inasmuch as, outside of ordinary blanking and shearing work, the pressure required for the various operations on stamped and forged steel work can only be definitely ascertained by actual "trying-out," combined with good, thorough tests and experience.

CARTRIDGE MAKING—3

METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO., LTD., IN THE MANUFACTURE OF SHOT SHELLS

By DOUGLAS T. HAMILTON*

A sheet of paper is in itself insignificant, but when passed through a series of apparently simple operations its transformation is sometimes marvelous. Possibly no product of paper bears out this statement to a fuller extent, than does the shot shell as now made. This consists simply of a sheet of paper formed into a tube of the required length, capped with a brass head holding a detonating agent, and then filled with powder and shot separated by wads. At the completion of these operations, a cartridge is evolved which is a general favorite with game hunters. While a shot shell does not in the true sense of the term contribute to the highest welfare of the civilized world, nevertheless the processes employed by th Dominion Cartridge Co., Montreal, Canada, in its manufacture are extremely interesting.

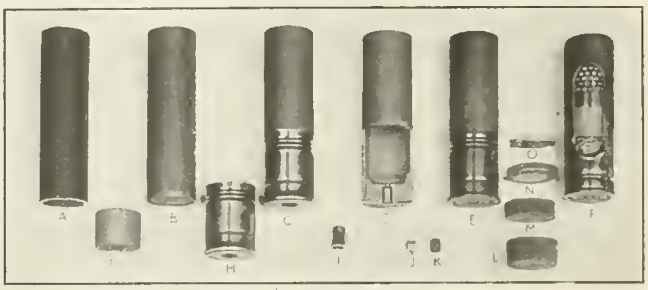


Fig. 37. The Component Parts of a Shot Shell before and after Assembling

The shot shell to be described is shown in its initial stage in Fig. 38, where *A* is the paper sheet 0.0075 inch thick by 14 5/16 by 10 3/4 inches; *B* is the sheet rolled into a tube; *C* is the tube cut into shell lengths; and *D* the trimmings. The sheet *A* is made thinner at the edges *E*, being 0.005 inch thick, so that when rolled into a tube, a smooth joint will be formed. The component parts of the shot shell dissected and assembled are shown in Fig. 37, where *F* shows the interior arrangement of the loaded cartridge. The manufacturing operations employed in making all the various parts shown will be described, except those for the anvil and primer shown at *J* and *K*, respectively. In this article Figs. 5, 8, 18 and 27, which appeared in the April and March installments, will be referred to.

Rolling and Drying the Tubes

The first operation in the manufacture of a shot shell is the forming of the sheet of paper into a tube, as shown at *A* and *B* in Fig. 38. This rolling operation is interesting, and the machine in which it is accomplished is shown in Fig. 40. A clear idea of the mechanism of this machine cannot be obtained from the illustration as it is of a rather complicated construction, but the principle on which it works is as follows:

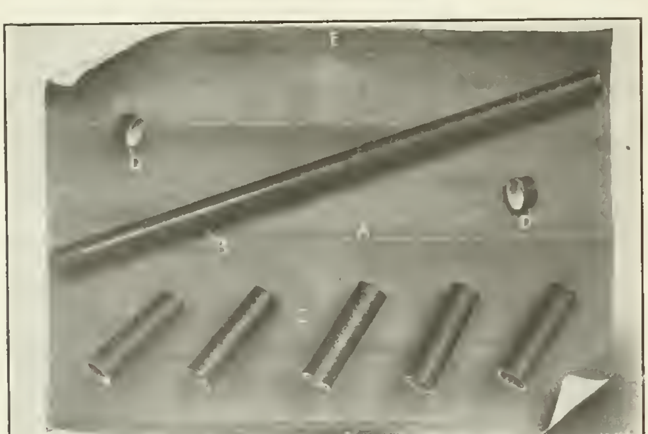


Fig. 38. Initial Stages through which a Shot Shell passes

The paper sheets, which are in pack form about 12 inches deep, are placed in a rack held on a carriage located at the rear end of the machine. The carriage on which the packs of paper are located is raised by a screw, which, in turn, is operated by a feeding mechanism. This feeding mechanism is so set that when a number of sheets have been withdrawn, a finger held on a horizontal shaft connected with the raising mechanism is tripped, and the raising mechanism operates until the carrier is raised to a sufficient height to continue the feeding operation. The sheets are withdrawn by two small rollers which travel over the pack, pick one sheet off at a time and place it on two rubber belts rotating on four pulleys. These belts carry the sheet from the pack to the table *A* located in front of the pasting and carrying rolls.

In withdrawing the sheets from the pack, they are separated from each other by a gaging mechanism, which allows only one sheet to pass through at a time. Supposing, however, that this gaging mechanism is not set correctly and that more than one sheet passes through; then when the sheets are carried to the table *A*, they will not pass under the arm *B*, as this arm if raised to a height greater than the thickness of one sheet will stop the feeding mechanism.

The sheet is fed to a stop *C* fastened to the table, and when located in this position is carried from the table to the carrying roll beneath the pasting roll *D*, by two rubber belts which also rotate on pulleys, and are located at right-angles to the belts that carry the sheet from the pack to the table. The pasting roll is corrugated, so that the paste will run freely along it and be distributed evenly over the sheet. The paste is pumped from a tank *E* through a pipe *F* to the pasting rolls, a pump being supplied for this purpose. The pasting and carrying rolls draw in the sheet, and at the same time spread the paste over it. As the sheet passes through, it travels on a rack on its way to the rolling arbors.

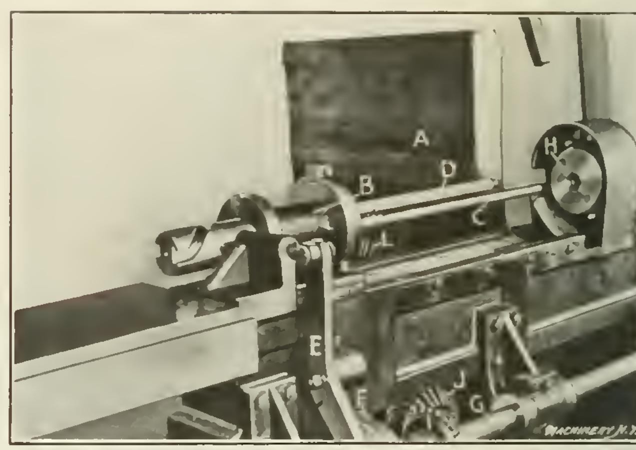


Fig. 39. Automatic Machine for Sizing the Tubes to the Correct Diameter

The method of rolling the tube can be seen by referring to the diagrammatic view Fig. 43. Here *A* is the pasting roll and *B* the carrying roll. The roll *B* is cut away so that the circumferential distance from *C* to *D* equals the width of the sheet. This provision is made so that another sheet cannot be drawn in until the one on the arbor is rolled and the arbor indexed. The carrying roll and rolling arbor mechanism are so timed that the rolling arbor makes a sufficient number of turns to complete the tube and index before another sheet is drawn in. The sheet is drawn in over the grate *E*, which consists of brass strips about 1/16 inch thick and 1¾ inch wide, located beneath the rolling arbor when in position for rolling the tube. These rolling arbors *F* and *G* govern the inside diameter of the tube.

When the paper is located on the grate it is driven forward by the carrying roll *B* and comes in contact with the rolling arbor before it leaves the rolls. As it passes the vertical center line of the arbor *F*, the flappers *H* which are rubber strips fastened in a roller *I* and rotating in the direction of the arrow, flap the paper up against the rolling arbor. The rolling arbor at the same time is driven in the direction indicated, and carries the paper around, thus forming it into a tube. As soon as the tube is completed, the indexing mechanism is

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operated, the arbor F being carried to the top and the arbor G brought down in position for rolling.

The tube which has been rolled is now located on the arbor and has to be removed. This is accomplished by a bushing located on the rolling arbor back of the tube, and connected to a rack by a short arm. This rack is driven by a spur gear, which when operated moves it along, thus carrying the bushing and stripping the tube from the arbor. While one tube is being stripped from the rolling arbor, another tube is being rolled, so that there is a continuous rolling operation. The indexing mechanism is operated by a cam G (Fig. 40), which through a lever H having teeth cut in its upper end meshing with a gear (at the rear of the ratchet-wheel L) on the arbor I, rotates the disk J carrying the two rolling arbors. The rolling arbors are located in the correct position by means of the pawl K and ratchet-wheel L. The method of driving the rolling arbor when in position for rolling is more clearly shown in the tube cutting machine, Fig. 42.

The tube as it comes from the rolling machine is wet and in a plastic condition, due to the moisture of the paste, thus making it necessary to dry the tube, so that the paste will harden and make it stiffer. This is accomplished by putting the paper tubes in a wire basket, and placing the basket in a cupboard heated by steam. This dries the paste very quickly and produces a shell which is extremely stiff, considering the material from which it is made.

Sizing and Waterproofing

When the tubes are dried sufficiently they are ready for sizing. This operation is accomplished by passing the tube through a die which is rotated at a high rate of speed. Lard oil is furnished to the die by a pipe, so that the tube is well lubricated and stripping is avoided. The use of lard oil also extends the life of the die. As one tube is being sized, that is, being forced through the die on the sizing arbor, another tube is being located on the empty sizing arbor.

The sizing machine, shown in Fig. 39, is automatic in its operation; all that is necessary in the way of operating is to place the tubes in the hopper A parallel with the spindle of the machine. From this hopper they pass down an inclined slide into a pocket. The tube is held in this pocket as it comes down the slide, and is stopped at the rear end, so that it cannot be forced out of the pocket when the arbor is being inserted in it. The tube is taken from the pocket by the empty sizing arbor at the same time that the arbor holding a tube is being forced through the die, which is held in the head H. In the illustration the slide B carrying the sizing arbors C and D has retreated from the die, and is in position for the arbors to be indexed.

The tubes before sizing are slightly larger than the finished size, and as they are forced through the die they expand somewhat and are stripped from the arbor. This machine is provided with a hollow spindle, so that the tubes pass through it and drop into a box. The arbor indexing mechanism is operated through a lever E actuated by a cam F held on the rear driving shaft G. The carriage carrying the arbors C and D is advanced by a large bevel gear L meshing with a rack attached to the arbor slide. The bevel gear L is driven by the main driving shaft G through bevel gears I and J.

After the shells are brought to the correct size they are waterproofed, so that they will resist moisture, which is necessary to preserve the powder; as those familiar with cartridges know, powder will not explode when in a wet condition. The waterproofing operation consists in putting the tubes into a wire basket A shown in Fig. 41, and then immersing this basket with the tubes in it in one of the tanks B. These tanks contain paraffine wax, which is heated and is kept in a liquid state by steam pipes passing into the tanks. The tubes are kept in this waterproofing solution until coated thoroughly. The basket is then removed from the tanks and put into the cupboard shown at C at the rear of the tanks, in which steam pipes are located for drying the tubes.

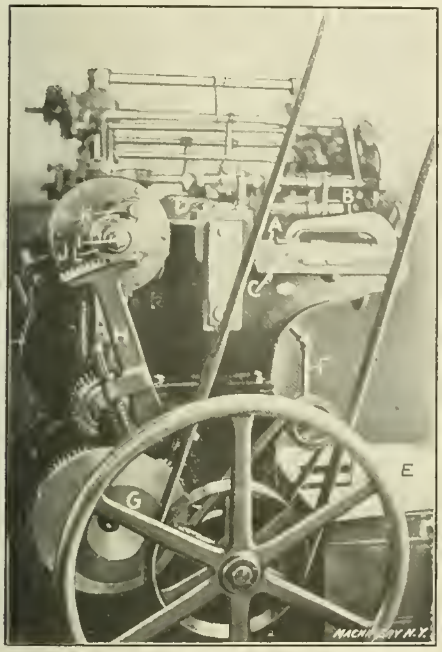

Fig. 40. Automatic Tube Rolling Machine

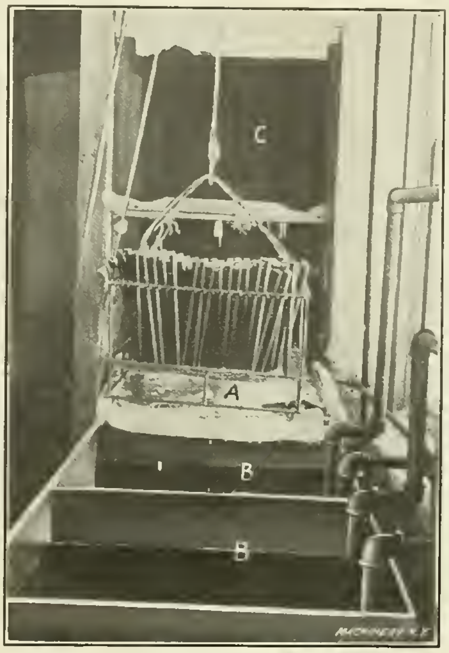

Fig. 41. Waterproofing Tanks and Drying Cupboards

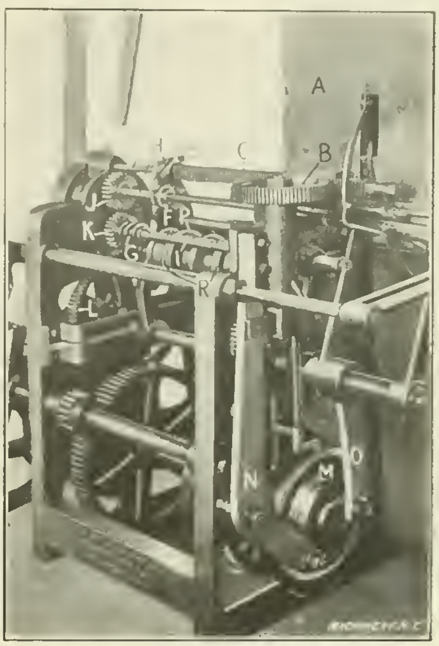

Fig. 42. Automatic Tube Cutting Machine

Cutting to Length and Inserting the Base Wad

The next operation to be performed on the tubes after sizing and drying, is cutting them to the length required for the shell. This is accomplished in an automatic tube cutter, shown in Fig. 42. The method of putting the tubes on the arbors in this machine is similar to that described in regard to the sizing machine shown in Fig. 39. The tubes are put into the hopper A, from which they come down a slide into a pocket, where they are located in position for the arbor to enter them.

The ejecting mechanism used on this machine is the same as that used in the tube rolling machine shown in Fig. 40. Here the ejecting mechanism is more clearly shown. The gear B driven from the main driving shaft through bevel gears, meshes with a rack C which slides on an arbor D. The ejecting finger E also slides on the arbor D and is connected to the rack. The lower extremity of this finger is bent, and fits in grooves formed on the ejecting bushings F and G, when rolling arbors H and I are in position for stripping the cut tube. The method of driving the cutting arbors on which the tube is held, is also similar to the mechanism used for rotating the rolling arbors in the tube rolling machine shown in Fig. 40. The arbors H and I have spur gears J and K fastened to them, which when the arbor is in position for cutting the tube mesh with a gear L. This gear, in turn, is driven by the main driving shaft through spur gears which gives it the correct speed.

The method of holding the paper tube on the arbor while cutting is interesting, and is shown in Fig. 44. When the arbor is rotated to the cutting position, the shaft Q carrying the tube cutters P is gradually advanced toward the tube by means of a cam. As the shaft Q advances, the soft-rubber bands R come in contact with the tube, acting as a driver, and thus preventing the tube from rotating on the arbor or moving longitudinally along it. The shaft Q rotates at the same speed as the cutting arbors H and I—when in the cutting position.

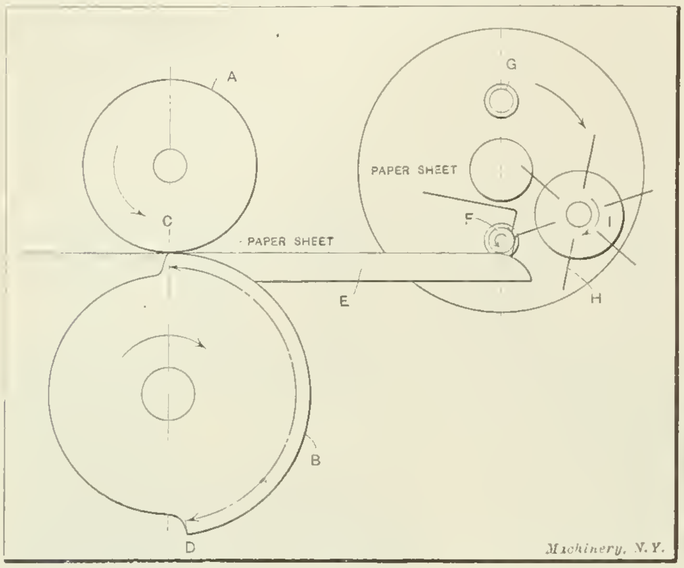

Fig. 43. Diagram showing how the Tube is rolled

The cutting arbors H and I are provided with grooves S, so that the cutters P will not come in contact with the arbor when they pass through the walls of the tube. The cutters P are plain disks made from tool steel, hardened, and ground on the faces P_1. It will be noticed from a study of the illustration that the cutters are so located, that the faces P_2 are in line with the edge of the grooves S in the arbor, but are not facing the shoulder. The reason for this is that as it is necessary to bevel one end of the shell to facilitate the putting on of the brass cap, the beveled edge P_1 on the cutter presses the tube against the arbor and acts as a beveling tool.

Referring again to Fig. 42, the ejecting and feeding mechanism is operated by the face cam M through levers N and O. While a tube is being cut, another tube is being placed on the empty arbor. This machine is entirely automatic in its operation and cuts the long tube into five different pieces, and also trims the ends as shown at D in Fig. 38.

Now that the tubes are cut into shells of the desired length, they are ready for the insertion of the base wad shown at G, in Fig. 37, which forms the head of the shell. This operation is accomplished in the hand-operated machine shown in Fig. 45. The paper for the heads is cut into strips of the correct width in another machine. These strips, which are in the form of a roll, are put in the circular box A which has a lid on top of it. The strip is brought out of the slot B in the box, and inserted in a slot in an arbor enclosed in the outer chuck C. This arbor is slightly smaller than the diameter of the battery pocket.

When the strip is inserted in the arbor, the machine is started by operating the lever D, and shifting the belt from the loose to the tight pulley. The strip is wound in the bushing C, which is of the correct size, and when this bushing is filled, the strip is cut by the sharp edge E. The shell F is now placed in the holder G and the handle H operated, carrying the shell toward the bushing. The bushing C is forced back by the carrier G, thus exposing the base wad and allowing it to be inserted into the shell. The handle H is again operated and the shell with the base wad inserted in it is withdrawn. While this is a hand-operated machine, it is marvelous how quickly these base wads can be wound and inserted in the shell.

Expanding, Piercing and Beading the Brass Heads

The shell is now in the condition shown at B in Fig. 47, and is ready for the brass cap to be placed on it. The cap which covers that portion of the shell enclosing the powder, is made from brass, and is received in the form of a cup as shown at A, Fig. 48. No drawing or trimming operations are performed on these caps previous to the expanding operation, as they are already drawn and trimmed to the exact length. The machine in which these caps are expanded is shown in Fig. 49. The operator places them mouth up in bushings A, twenty-four of which are held in the ratchet-dial B.

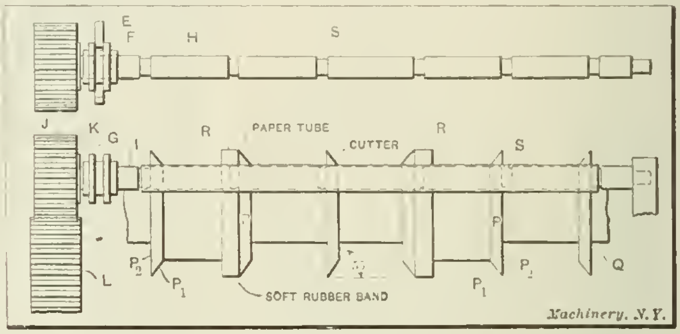

Fig. 44. Diagram showing how the Paper Tube is cut to the Desired Lengths

As the caps pass successively under the expanding punch C they are expanded. This punch consists of an outer shell which is split and held on a tapered punch by two coil springs wound around it. The expanding punch shown at C is what is called the "starting" punch. Another punch on the same principle, but not shown, is held in the ram of the press, which finishes the expanding of the head. The expanding operation is accomplished by the outer split sleeve sliding up on the tapered punch, which increases its diameter, so that the lower end, which is of the desired shape, is enlarged and forces out the sides of the head. The bottom of the bushings A are enlarged in diameter to allow the cap to be expanded.

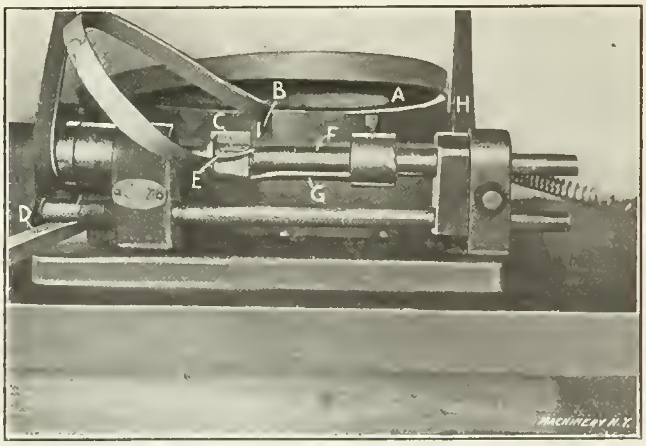

Fig 45. Machine for Winding and Inserting the Base Wad in the Shell

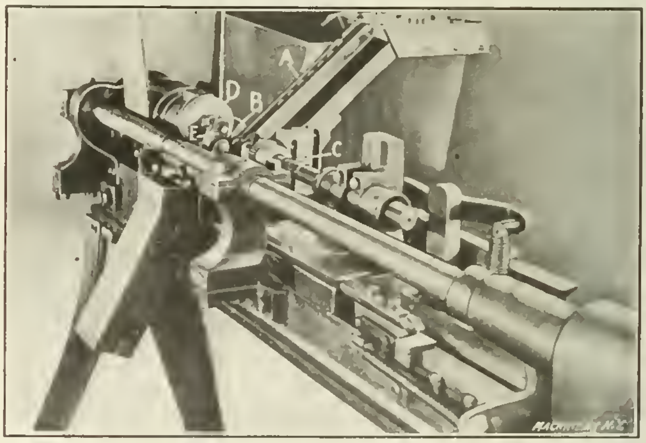

Fig. 46. Machine for Beading the Brass Caps

The cap now passes to the punch D which enters it, flattens the head, performs the stamping operation and pierces the hole, forming a seat for the battery pocket. The hole in this head is not pierced but is forced up, no die being used for cutting the material away. The shape of the cap after this operation is shown at B in Fig. 48. The stamping is done by a die having raised letters, so that the impressions are sunk into the head of the shell. This stamp is made with a hole in it, in which the piercing pin is located. As the cap passes around to the punch E it is flattened, and on further movement, the knock-out pin forces it out of the bushings into a chute, from which it drops into a box. After expanding the heads, the caps are taken to the beading machine shown in Fig. 46, which is of the semi-automatic feed type. The operator places the caps in the slide A with the mouth facing the head of the machine. As they come down this slide they are located in a pocket, from which they are carried onto a rotating arbor B by a half-bushing held on the shaft C. The beading is accomplished by a circular tool D which is not rotated, but is held stationary to the carrier E. This carrier advances when the cap has been located on the arbor, and the tool D forms the beading. The condition of the cap after the beading operation is shown at H and C in Figs. 37 and 48, respectively.

Assembling the Brass Caps and the Paper Shells

The brass caps and the paper shells are now transferred to the assembling machine shown in Fig. 50, where the cap is placed on the paper shell. Here the paper shells are placed on pins A, sixteen of which are held on the ratchet-dial B. Dies C, which are a good fit for the shell, are also held in this dial. The brass caps are placed mouth up on a friction-dial located at the rear of the machine, by another operator. This machine requires two operators to look after it, although one operator can feed the caps to two or three machines. As the paper shells are placed on the pins A in the dial B, they pass successively under the punches D, E, F and I. The spring punch D seats them partially on the pins, while the punch E seats them correctly. As the shell comes beneath the punch F, the cap is placed on it.

The cap is removed from the dial at the rear, by means of fingers held on the plate or carrier G. This carrier is held on the shaft H which is rotated by a friction gear, driven by a rack held to the ram of the press. The plate G swings through an angle of about 180 degrees, and lifts the cap from the dial by means of the fingers, transferring it to a position over the shell, where it is seated by means of the punch F. The punch I seats the cap firmly on the shell, and on the continued movement of the dial, the shell is transferred by the pick-up J from the pins to the chute K through the hollow spindle L. The pick-up mechanism is held rigidly to the ram of the press and travels up and down with it. The condition of the shell after this operation is shown at C in Figs. 37 and 47.

Heading—Forming the Base Wad and the Brass Cap to the Correct Shape

In the machine shown in Fig. 50 the brass cap and shell were only assembled but were not flattened; neither was the base wad formed to the correct shape. These operations are accomplished in the heading machine shown in Fig. 51. Here the shells are placed on pins, fourteen of which are held in the ratchet-dial A. Bushings B are also held in this dial, for forming the brass caps. As the dial is rotated, the shells pass successively under the punches C and D. The punch C seats the shell down on the pin, and the punch D forces it into the die B, flattening the head and forming the base wad.

The punches which are held in the dial A, are made to form the base wad into the shape shown at D in Fig. 47. This shape is given to the wad when in a dry condition. The shells are removed by the pick-up E which passes over the head of the shell, after it has been lifted from the die by the wad-forming pin. The knock-out motion is actuated by the rod F held to the ram of the press. This rod F operates a mechanism which forces the wad-forming pin up, thus raising the shell out of the dial to a sufficient height for the pick-up to grip it. This pick-up is operated in a similar manner to that shown on the verifying machine, Fig. 27.

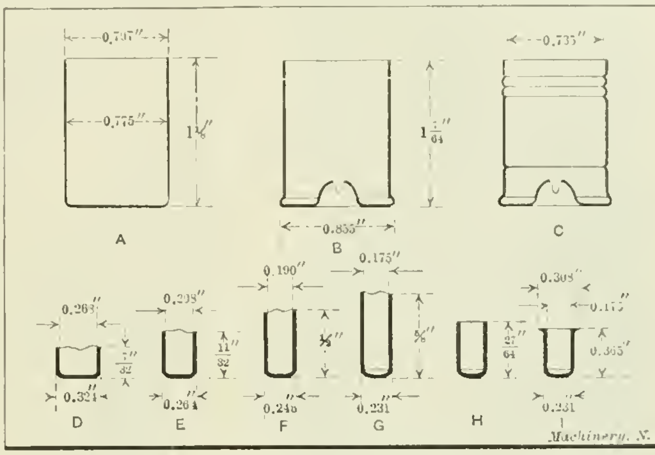

Fig. 48. Stages through which the Brass Cap and the Battery Pocket pass before Assembling

Drawing, Trimming and Flanging the Battery Pocket

The battery pocket which is used in the No. 12 gage Imperial shot shell is received in the form of a cup as shown at D in Fig. 48. This cup passes through three drawing operations as shown at E, F, and G, which increases its length to about ⅝ inch, and reduces its diameter from 0.324 to 0.231 inch. A drawing press similar to that shown in Fig. 5 is used for the drawing operation, and this cup also passes through the annealing, washing and drying operations. When drawn to the required length, as at G Fig. 48, the shell is taken to the trimming machine shown in Fig. 8, where it is trimmed to the desired length as shown at H.

The next operation is to flange the mouth, as shown at I, so that the pocket will have a head, which will seat properly in the brass cap of the shell. The flanging operation is performed in an automatic machine which is shown in Fig. 52. This machine is equipped with an automatic feeding device which is on the same principle as that used on the trimming machine shown in Fig. 8. The battery pockets pass from the

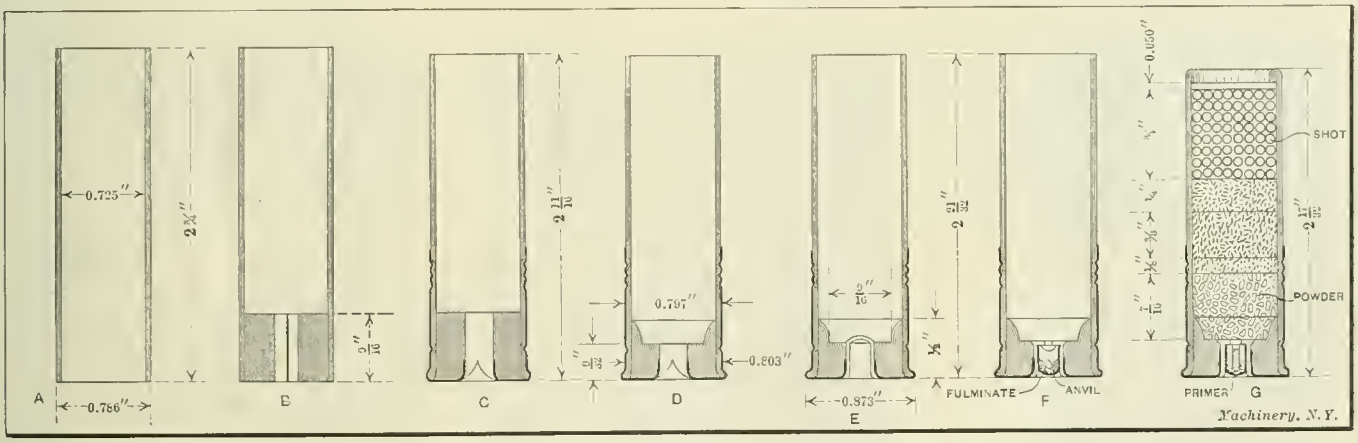

Fig. 47. Transition from the Cut Tube to the Finished Cartridge

hopper *A* through a tube located at the rear of the machine to the carriage *B*. This carriage is actuated by levers and cams from the main crankshaft, and carries the pocket from the tube to the flanging dies where the flanging is accomplished by the punch *C*, held in the ram of the machine. An ejecting mechanism operated by the lever *D* ejects the pocket out of the die when it has been flanged, and deposits it in a box.

Inserting the Battery Pocket in the Brass Cap

Now that the battery pocket is flanged, the next operation is to insert it in the brass cap. This is accomplished in the assembling machine shown in Fig. 53. The shells are placed on the pins *A*, held in the ratchet-dial *B*, and pass successively under the punches *C*, *D* and *E*. The punch *C* forces the shells down on the pins, while the punch *D* seats them down correctly. The punch *E* sizes the hole in the head of the shell, thus making it ready for the insertion of the battery pocket.

The battery pockets are fed automatically to this machine by a hopper-feeding device which is attached to the rear of the machine. The pockets pass from the hopper to a slide where they drop out. A groove is cut in this slide which is equal to the outside diameter of the pocket, thus making it impossible for the battery pockets to be located in this slide except with the flange up. As the battery pockets are located in the slide, they pass down to the feeding device, which consists mainly of two fingers. One finger carries the pocket from the slide to the second finger which carries it out and holds it central with the hole in the head of the shell. These fingers are operated by a lever, which is connected eccentrically to the driving shaft. As the finger carries the pocket out and holds it central over the hole in the shell, the ram descends and a punch held in the bolster *K*, forces the pocket out of the finger into the shell. The pick-up *L* removes the shells from the pins, and transfers them up through the hollow spindle *M*, depositing them in the chute *N*, from which they pass into a box. The condition of the shell after this operation is shown at *E* Fig. 47.

Piercing the Battery Pocket, Priming and Inspecting

The next operation on the cartridge is the piercing of the battery pocket and the inserting of the primer. This is accomplished in the machine shown in Fig. 54. The shells are placed on the pins *A*, sixteen of which are held in the ratchet-dial *B*. As the dial passes around, the punch *C* seats the shell down on the pin. This punch also flattens the head slightly and upsets the pocket in the base wad, as shown at *D* and *F* in Figs. 37 and 47, respectively. The punch *D* pierces the hole in the pocket, while the punch *E* acts as an emergency piercing punch, and also forms the inside of the bat-

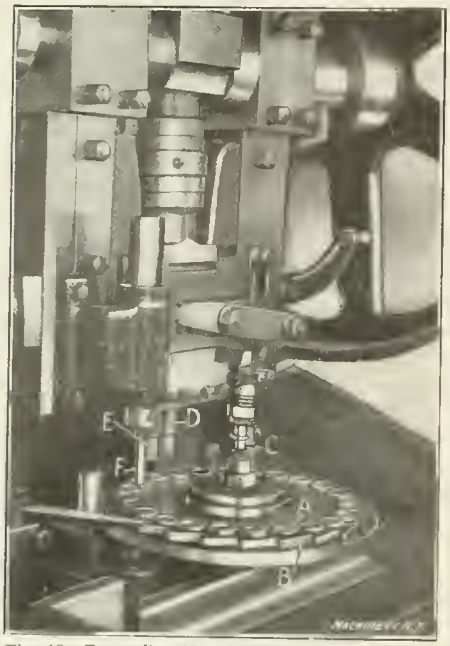

Fig. 49. Expanding Machine for partially forming the Head on the Brass Cap

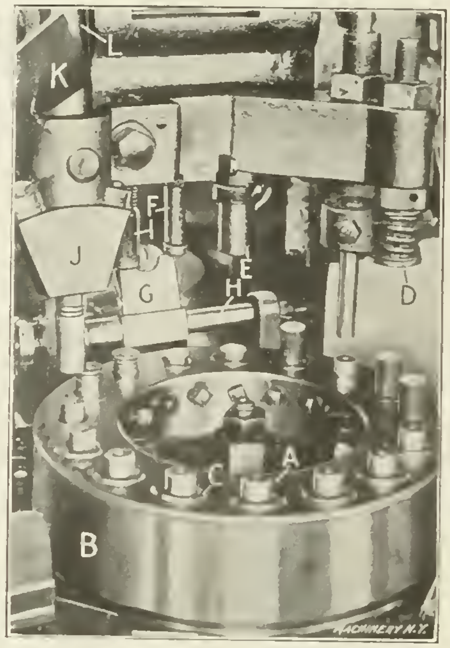

Fig. 50. Machine for Assembling the Brass Cap and Paper Shell

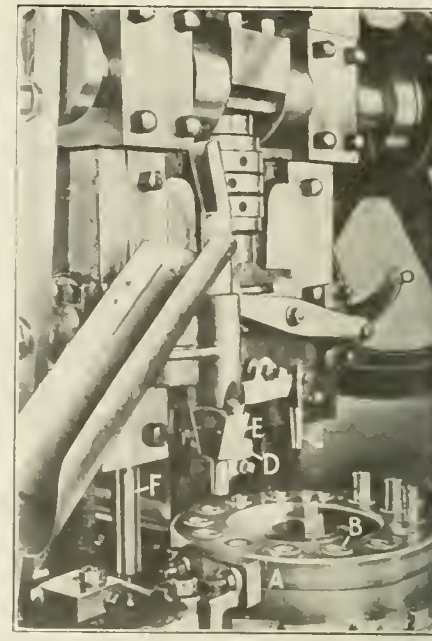

Fig. 51. Heading Machine in which the Base Wad and Brass Cap are formed to the Correct Shape

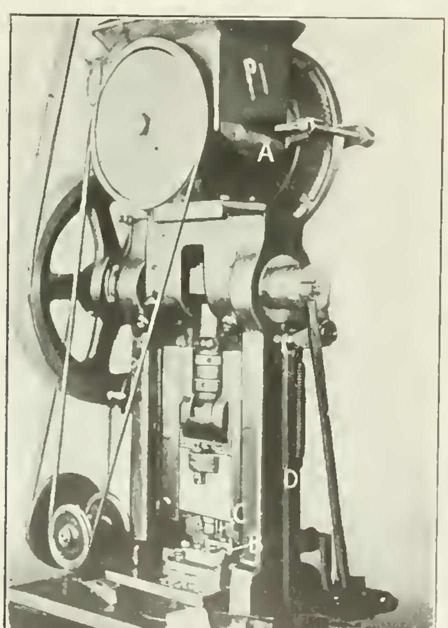

Fig. 52. Automatic Machine for Flanging the Battery Pocket

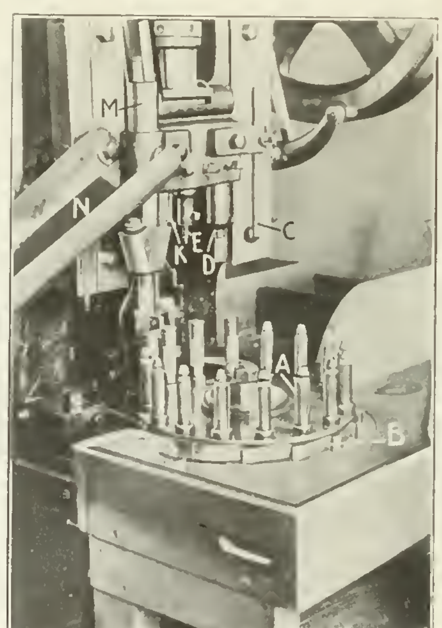

Fig. 53. Machine for Inserting the Battery Pocket

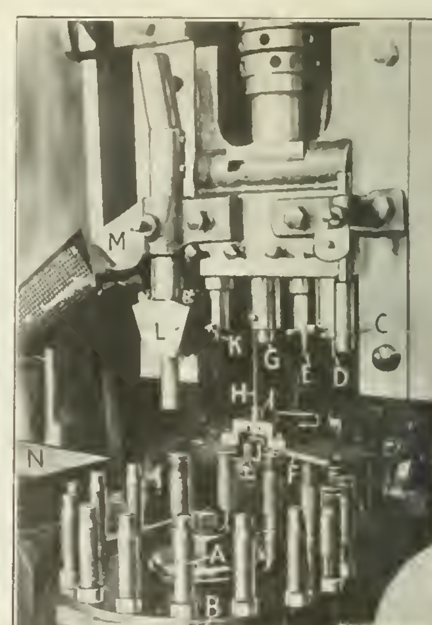

Fig. 54. Machine for Inserting the Primers

tery pocket to the correct diameter. A plate F is held over the top of the pins to prevent the piercing punches from lifting the shells, when sizing and piercing the battery pocket. The punch G again seats the shells on the pins, before the primer is inserted.

The primers are placed in the brass tube H, which is held in the bushing I. This tube passes up at the rear of the machine, and is encased by a sheet-steel plate, so that if the primers in the tube should explode, the operators would not be injured. The primers drop through this tube and are removed from it by a finger J held to a slide, which carries the primer to a central position over the pocket. This slide is actuated through levers connected to the crankshaft of the press. As the finger carrying the primer advances to a central position over the pocket in the shell, the punch K descends and forces the primer out of the finger into the pocket. The dial is then rotated and the pick-up L removes the shell from the pin and transfers it to the chute M as previously described. This chute is made from wire netting, and leather strips are placed on the side to prevent the shell from being bruised.

The object of having the wire netting is to allow any loose fulminate, which may have been removed from the primer, to drop into the box N, which is partially filled with water. If this fulminate were allowed to go into the box in which the shells are placed, an explosion might result, so that it is well to take this precaution. The pierced and primed shell is shown at F, Fig. 47. Before the shells can be transferred to the loading department, it is necessary that they should pass through a rigid inspection. This consists in seeing that all primers are located below the top surface of the head of the shell, and also that the paper case is not dented or marked in any way. Any shells which are found to have these defects are scrapped.

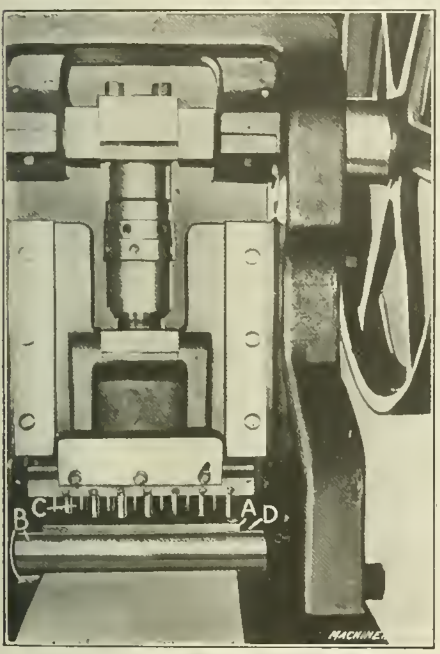

Fig 55. Machine for Cutting and Greasing the Felt Wads

Cutting and Greasing the Felt Wads

As can be seen at G in Fig. 47, three felt wads are used to separate the shot from the powder. These wads are also shown at L, M, and N in Fig. 37, and are used for two reasons: One is to separate the powder from the shot and to give it the required compression; and the other is to prevent the powder from becoming damp. To perform this latter function it is necessary to grease the wads, so as to make them waterproof. This is accomplished in the machine shown in Fig. 55 in which the wads are also cut. The felt for these wads comes in strips about 10 inches wide and is fed into the machine by the rollers B.

Fourteen punches C are held to the ram of the press for cutting out the wads, and cutting dies registering with these punches are held in the die-block D. As the wads are cut out, they pass through the dies into tubes located in the die-block. These tubes have holes drilled through them, and around their periphery, through which grease held in a reservoir in the die-block can pass in to the wads. The grease is kept at the proper temperature by means of steam pipes, which pass into the die-block. The greasing tubes pass through the bolster and down through the bed of the press, so that the wads, as they are cut out and greased, fall into a box under the machine. The three felt wads shown at L, M and N in Fig. 37, are all cut out and greased in a similar manner in this machine.

Loading and Testing

All the component parts of the shot shell, which are illustrated in Fig. 37, have been completed. The operation now to be accomplished is the assembling of these various parts in the paper container or shell, thus making a completed cartridge. The various parts as made are transferred to the shot-shell loading department where the shells are placed in the slide of an automatic loading machine. The shells pass from this slide down a chute from which they are located in holes in a ratchet-dial. As the shells are located in the dial mouth up, they first pass under a container in which is held a sufficient charge of powder.

The container which holds the charge of powder has a slide beneath it which is actuated by an eccentric rod connected to a shaft at the rear of the machine. The function of this eccentric rod is to open and close the container, so that the powder can drop out into the shell. As the shells pass around further, the wads are deposited in them. These wads are held in four brass tubes which hold the various wads in the correct order in which they are to be placed in the shell. The wads are carried from these tubes out to a position central with the shell by slides which are actuated by eccentric rods, as already mentioned. All the wads are fed to the shell in this same manner.

When the last of the felt wads is placed in the shell the shot is inserted. This is held in a container, and is removed from it in the same manner as the powder. As the dial passes around still further the cardboard wad on which the number of grains of powder and the size of the shot are marked, is taken from the last of the four tubes, and punches are used to seat the wads in the shell as they are carried out by the finger and held in a central position.

The last operation on the shell is the turning in of the top edge, or the "crimping operation" as it is called. This crimper consists of a die in which hardened pins are driven. These hardened pins are so formed that they turn over the top of the shell. The crimper is driven by a belt, which runs over two idler pulleys, and drives a pulley which is connected to the spindle holding the crimping die. After the loading and crimping operations the cartridge is in the condition shown diagrammatically at G, Fig. 47.

This completes the manufacturing operations, and the cartridges are now ready for the last inspection, which consists in testing them for accuracy. As a shot shell does not contain one bullet, but a collection of small shot, the speed of the shot is not a very essential consideration. However, the charge of shot must be confined to a certain space when fired at a specified distance. The No. 12 gage Imperial shot shell is not allowed to pass the testing inspection unless two-thirds of the charge of shot fills a 30-inch circle, when the cartridge is fired at a distance of 30 yards. As the number of grains of shot in the shell is known, it is an easy matter to determine whether these shells are loaded correctly or not. Shot shells are packed by hand in boxes which contain 25 and 50 cartridges, respectively.

* * *

An engineer has been defined as a man who can do for a dollar what the untrained man could do perhaps for two dollars, and the skill of the machine designer and builder is sometimes displayed to the best advantage on the machines that must be produced at extremely low price. If cost is not limited, a result can be attained by many designers in otherwise satisfactory ways, but the test is price with efficiency. A low-priced machine found in nearly every metal-working plant is the power hack-saw, but the small machine built by a Chicago concern beats them all in point of price. It is almost entirely a foundry product, slides and some bearings being used as cast, yet it has all the functions required of a small machine, and sells for $15. When it is considered that it meets more than the average requirements for accurate cutting-off and has provision for taking up wear, the accomplishment is remarkable.

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Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD

NEW YORK CITY

Alexander Luchars, President and Treasurer

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

MAY, 1911

PAID CIRCULATION FOR APRIL, 1911, 26,133 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

HEAVY CRANK PRESSES

One of the interesting and notable developments of modern manufacturing is the general use of heavy crank presses for work which a decade ago it was considered practicable to produce only on a hydraulic press, or in the form of castings. Crank presses capable of exerting five hundred tons' pressure are not uncommon, while several presses of this type are successfully producing work requiring a pressure of two thousand tons—a capacity which ten years ago was considered almost impossible to attain (except in the regular coining press) and almost unnecessary. In this connection it is interesting to note that ten years ago the heaviest crank press built, weighing about 150,000 pounds, could be bought for less than $12,000, while within the last two years crank presses have been built weighing about 280,000 pounds, and selling at about $20,000.

Presses of the great capacities mentioned are necessarily heavy and expensive, and when a mammoth crank press is compared superficially with a hydraulic press of the same capacity, the reason is sought for preferring the crank type. The answer is one that has decided the fate of many other types of machines—namely, greater efficiency.

The crank press is simpler, not so likely to get out of order, and quicker in its operation than a hydraulic press exerting the same pressure. An ordinary, intelligent operator can make minor repairs; all movements and adjustments are positive; there are no valves nor glands to leak, no pipes to freeze nor accumulators to require attention as in the hydraulic type. The crank press can be independently driven by electric motor or by belt from the lineshaft, the same as other machines. The hydraulic press, on the other hand, requires a special high-duty pump, high-pressure pipe lines and an accumulator—all comprising an expensive apparatus requiring the attention of mechanics of some special experience and of a higher degree of intelligence than are usually found in the average "press-room."

In view of the rapidity with which former hydraulic press users are converting their equipments to crank presses, and the ever-increasing substitution of stamped and forged steel parts for many of the heavier castings, it is not chimerical to predict that the crank press will be developed to a size approximating five thousand tons' capacity within the next ten years, and this probable development is one that should interest machinery designers generally, whether directly connected with the press-working of metals or not. The article in another part of this number, treating of the uses, abuses and construction of heavy power presses, written by an engineer of long practical experience in press design, may be considered as preliminary to further articles that will treat of rational power press design.

* * *

METHODS INSTEAD OF MACHINES

The Pratt & Whitney Co. recently established a novel record in furnishing a complete equipment for the manufacture of an army rifle for a foreign government. The contract for the equipment did not mention the machines to be furnished, its main clauses specifying that the Pratt & Whitney Co. was to furnish a detailed method, including the machines and devices required for its efficient use, in order to produce a rifle in a certain number of man-hours.

While there are probably many opportunities of this kind, they are open to only a few manufacturers, because a high order of ability and long experience are necessary before a machine tool builder could furnish such equipment profitably on the basis referred to. Instead of furnishing so many lathes, so many milling machines, so many grinding machines, etc., he must contract to furnish a method and equipment for making, say, a certain number of meat grinders or sewing machines in so many hours, the equipment to be furnished at a stated price. The *method* must be the principal consideration, and only an expert could furnish this. The machinery would, in a sense, become an auxiliary, being adapted to carry out the work in the most efficient manner according to the method laid down. It would, of course, be impracticable for a manufacturer specializing on a certain kind of machinery to accept orders based on this principle, but it is probable that the future will see a development of the idea of furnishing methods on a basis somewhat similar to general contracting. A responsible firm will contract to guarantee a required result for a certain price. It will then proceed to gather the necessary machinery from the manufacturers, and the special machinery it will either have built to order or build in a plant of its own. This development in the machine tool building business may yet be far off; but there are firms who could even now profitably adopt this plan on a small scale, provided their organization included the required mechanical experience and ability.

* * *

DIFFICULTIES IN ACQUIRING FOREIGN TRADE

In a recent editorial, attention was called to some complaints made by foreign customers regarding American methods of handling foreign trade; but American manufacturers are not always to blame, as the following extract from a letter shows:

"It is not unusual for us, and we have no doubt others have the same experience, to receive an inquiry on a postal card, and not infrequently a letter, to which it is impossible to reply, because it is absolutely impossible to decipher the signature. And frequently it is impossible to ascertain the place from which the communication is addressed. The name of a town may possibly be given, but whether it is in Germany, Russia, France or some other country, cannot be determined. The writer evidently knows who and where he is, but nobody else does, and no answer can be sent to the inquiry with any assurance of reaching its destination."

The experience of this manufacturer is not unusual. We have had similar difficulties in this office and have had considerable trouble in locating some small European town from which letters have been received. In Europe, a universal knowledge is assumed of the location of all towns, large and small, but a little thought would show that the American manufacturer is not likely to know, for example, whether the town of Obernburg is located in Germany or Austria; or the town of Lombers in France, Italy or Switzerland.

MACHINE TOOL CATALOGUES

Many machine tool catalogues and pamphlets would be of greater value to the manufacturers whose tools they illustrate if more attention were given to their preparation. Undoubtedly a prospective buyer often gets his first impression of a machine from a catalogue; but in many instances the catalogue contains so little definite information that it is impossible to arrive at any intelligent conclusion regarding the merits of the tool represented. As the superiority of a machine, as a whole, depends largely upon the superiority of its parts, what is needed is more specific information, accompanied by illustrations showing the design and construction of details. By preparing a catalogue in this way good points in the construction could be directly referred to, so that anyone interested might judge for himself as to the merits of the machine generally. This plan has been followed to some extent by manufacturers, but much of the literature of this class that is sent out contains little more, in the way of illustration, than a general view, and the description is largely made up of abstract statements which are general in their character. Catalogue writing should be done by some person having a thorough knowledge of the tools illustrated, and instead of meaningless claims of superiority, such features as the convenience of control, directness of transmission, durability, rigidity, etc., should be made apparent by detailed views and descriptive matter. A sectional view is rarely seen in a catalogue, notwithstanding the fact that such illustrations could be used to show strong features that would be entirely concealed in a photograph. Views of this kind would also illustrate noteworthy points without verbal explanation. A catalogue arranged along the lines suggested would be more effective than the conventional style, and an important adjunct to the sales department.

* * *

MAKING AND USING MACHINE TOOLS

While every maker of machine tools is also a user of them, the average machine tool builder does not place as severe strain upon the machines in his shop as is done in other metal-working plants where the pressure of competition makes it necessary to force the equipment to the utmost. Consequently such users may find defects in the machine tools which the builder using them in a less strenuous manner, would never himself detect. If it were practicable for makers of machine tools to operate plants in which the machines were tried out under the most severe conditions, the improvements required would become apparent much sooner, and many difficulties and complaints might be avoided. As a rule, such a combination of machine tool building and manufacturing, quite common in Europe, does not harmonize with the modern idea of specialization, and would generally be impracticable; but one interesting exception may be cited. The Billings & Spencer Co. of Hartford, Conn., makers of an extensive line of drop forged articles, also make for sale a line of the machines used in the company's own plant, including drop hammers; and their experience demonstrates that a great advantage results from this combination of machine building and manufacturing. The usage to which drop hammers are subjected is severe; but it appears that the machines are subjected to even more severe conditions in the company's own plant than in their customers', partly because the men use less care in handling the machines in the home shop, knowing that if anything breaks down it can easily be repaired right on the spot. In a shop hundreds or thousands of miles away from the maker's plant, greater care must necessarily be exercised in operating machines of this type, on account of the long delay which would result from a breakdown. An excellent test of the machines under actual working conditions in the Hartford works, and a very severe test at that, is thus continually in process; and the firm has an unusual opportunity to note where any improvements should be made.

* * *

When you have once acquired a good reputation, concern yourself more with protecting it than with trading on it.

THE PATENT MICROBE

By J. CROW TAYLOR*

We may have the hook worm or some germ that makes for a lassitude and laziness in this country, but if so, we have something else to offset it—something we might call the "patent microbe." This is a very active microbe too, judging from the records; it is a sort of busy-bee and it is busier in the United States than anywhere else in the world. The *Official Gazette* of the patent office has recently given out some figures that prove this, and also prove that the patent office is one of the government institutions that is a money-maker. One of the important things shown by these statistics is that there was a balance to the credit of the patent office at the beginning of this year of the snug little sum of $6,988,228.

There have been issued in the United States since the establishment of the patent office approximately a round million patents or nearly as many as those issued by all the rest of the world. During 1910 there were 63,293 applications for mechanical patents, 1155 for design patents and 181 for reissues; this is aside from trade-marks, registrations and labels. The number of patents expiring during the year was 22,768, and the number issued during the same period was 35,807; so we are about 13,000 patents to the good for last year. And there were at the time of compiling the statistics, 11,336 awaiting final fees before issuing.

Some idea of the great activity of the inventive genius and the comparatively great number of applications for patents in the United States may be had from the fact that the total in the United States is more than double the next country in importance, which is Germany. The total number of patents granted in the United States from 1871 to 1910 was 869,561; and Germany ranks second with a total of 440,898; Great Britain third with 425,374; then comes France with 248,106, Belgium with 239,500 and Canada with 136,390.

It is impossible to obtain any definite information as to what percentage of the patents issued in the United States have proved of value to the inventors. That some of them have we all know, because the conspicuous examples of success are always advertised; but there is a great multitude of patents that never pays a profit to anybody but the patent office. Sometimes unfortunately these commercial failures stand in the way of other inventions that might be commercially successful, because they cover certain features that are a bar to the planning of other inventions until the time limit expires. Some day the patent laws will probably be amended so as to eliminate what might be termed dead-letter patents, meaning thereby those patents that have not been put into general use—that have proved a failure so to speak. This will clear the road for other inventors to try their hand.

Whatever else we might say of the patent business in the United States, there is one thing certain, and that is that the inventive genius is more active here than anywhere in the world and it is accompanied by a commercial desire for profit that often leads the genius to the patent office with but a meager offering. The patent microbe does not need encouragement nor propagation; it has taken care of itself in this country and about all it really needs is a little more specific attention in the way of direction and supervision. In other words, it needs regulations like some other of our big institutions.

* * *

Pierre Vedrine, an amateur aviator who qualified only last December and formerly was a mechanic in the Gnome Motor Works, broke the world's record on March 31 in a flight from Poitiers to Issy-les-Moulineaux, France. The distance of 335 kilometers (208 miles) was covered at the rate of 94.6 miles per hour, the time of flight being only two hours and twelve minutes. Vedrine used a 50-horsepower Morane machine, which is capable of making 130 kilometers (between 80 and 81 miles) per hour. A light breeze favored the flight. The claim is made that the same speed on the best highway would have required a 150-horsepower motor.

*Address: Masonic Building, Louisville, Ky.

SHOP TRUCKS IN THE WASHBURN SHOPS

By H. P. FAIRFIELD*

In many shops too little attention is paid to the tiring of workmen. The workman's particular value to any firm is his ability to skilfully and rapidly perform his assigned work; and while fatigue may or may not alter his skill, it most certainly causes a falling off in the rapidity with which the work is done.

The order of operations as carried forward at the machines in many shops is to assign to the workman a certain number of machine parts to finish. He proceeds to hunt up a shop truck and probably a box to hold the pieces. In the snagging room, he counts out and fills his box with the requisite number of castings, and trucks them to his machine, dumping them upon

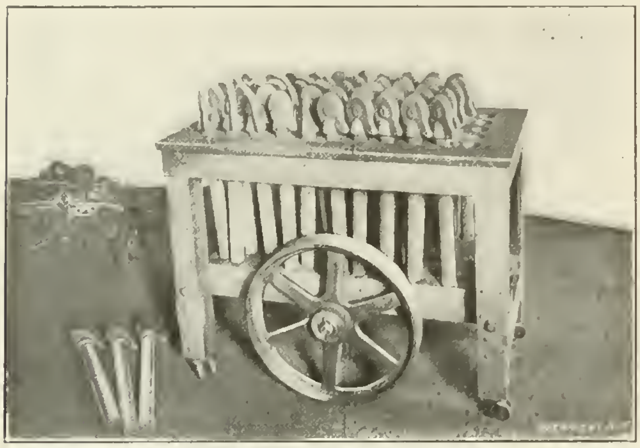

Fig. 1. Truck loaded in the Snagging Room

the floor beside him. From here he must lift the individual pieces to place them in the machine, and when one operation is finished, back they go to the floor. Here they are under foot and of necessity more or less scattered about and covered with chips and dirt. The shop sweeper brushes around and over them—perhaps shifts them about—mixing them up more or less. From this machine, the parts, after being again placed upon the shop truck, are trundled to the machine upon which the next operation is to be performed, and are again dumped upon the floor. This procedure is carried forward until the completion of the parts, when they are placed in the stock room, or, in some cases, stowed away beneath the work benches. To many, this may appear to be a somewhat overdrawn statement of conditions; however, the writer is sure that it still obtains in some shops

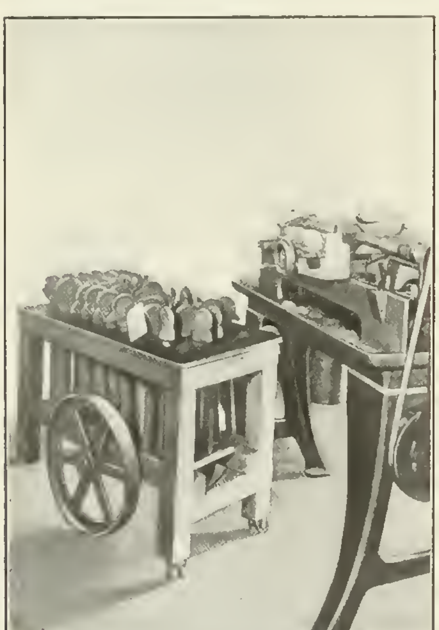

Fig 2. Truck at the Centering Machine

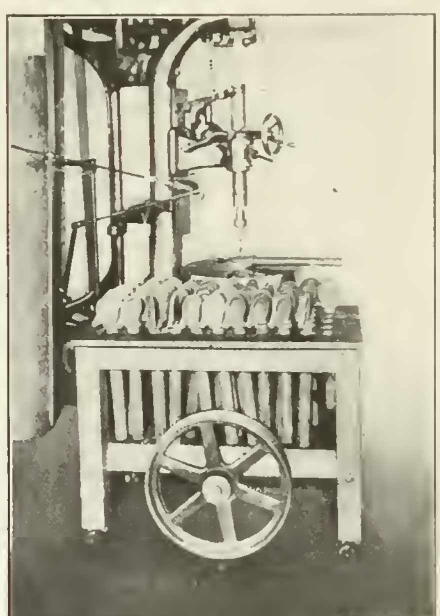

Fig. 3. Truck at the Drill Press

Fig. 4. Truck at the Grinding Machine for the Final Operation

The accompanying photographs show how this loss of time and effort, and the general unthriftiness of the above-described conditions are avoided in the Washburn Shops of the Worcester Polytechnic Institute. For the benefit of those who do not know, it might be stated that the Institute shops are operated upon a commercial basis and under normal business conditions, about forty workmen being employed in machine tool

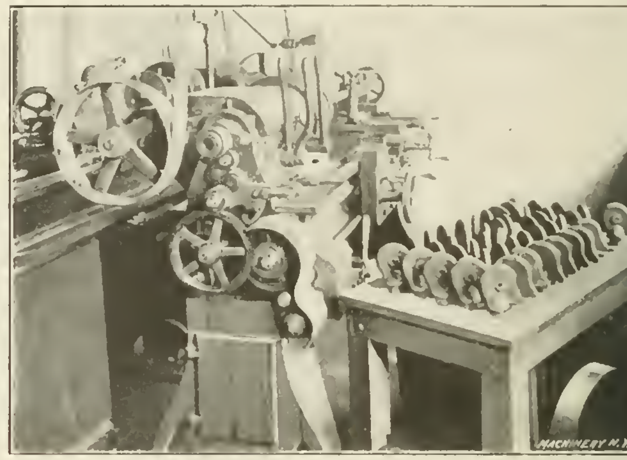

Fig 5. Truck at the Lathe where Spindles are rough-turned for Grinding

manufacturing. The problems incident to economical handling of work are thus the ones which are to be found in other shops. While the photographs well illustrate the idea, it may be pertinent to state that the parts are, when they are snagged, put into a specially constructed shop truck and remain with it until they go either to the assembling floor or to the stock room. While in a general sense the special trucks are the same, they are built to suit the kind of work which they are supposed to carry. That shown in the photographs is one of several made to carry the spindles of the Worcester drawing stands. Each of these is provided with five rows of holes of eleven holes each, or fifty-five holes in all. Fifty spindles are carried in each truck, which allows a vacant hole in each row. In use at the machine, a spindle is withdrawn from its hole, operated upon in the machine, and then replaced in the previously vacant hole. This shows, when the piece is being machined, two vacant holes in the row from which the piece is taken and one vacant hole between the replaced piece and the next in order. Thus, if the workman's attention is called from his work after replacing a piece, he can never be in doubt as to the row of parts he is selecting from or the piece which should next be taken. In other words, when the work upon the parts has begun at any particular

* Address: Worcester Polytechnic Institute, Worcester, Mass.

machine, the order of withdrawing and replacing is such as indicates the next piece even if the workman is inattentive.

When the truck is first loaded, an order tag is attached. This is shown in some of the views and remains with the lot until they are finished. Upon this tag is given the order number, part number, number of pieces, and the operations required. The face of this tag is plainly shown in Fig. 6. The foreman, on issuing, checks off the different operations for the pieces, and the tag thus becomes a routing card for the lot from machine to machine.

The trucks are strongly built and provided with castors at each corner. The larger wheels in the center are for transportation purposes and are made of sufficient size to trundle easily on the shop floor. The truck body is hung to these in such a manner as to allow of its being rocked to bring the castors clear of the floor, so that the whole truck may be easily swung or turned at the will of the user. As the trucks must be moved into a convenient position at the various machines, the size of the truck frame is considered and unless the work is to be finished at one machine only, it should seldom be larger than 2 feet by 4 feet; 18 inches by 36 inches is a good size.

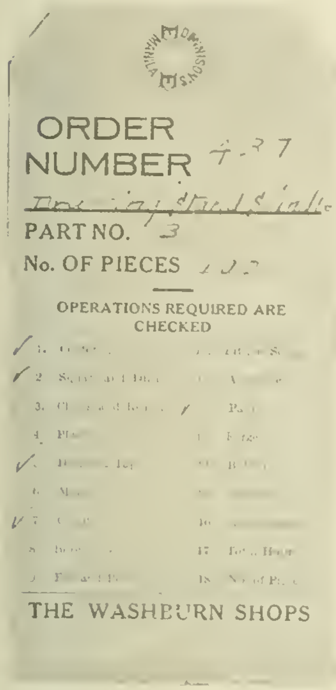

Fig. 6. Tag that accompanies the Order as it progresses through the Shop

Fig. 1 shows the truck after being loaded at the snagging room; Fig. 2, at the centering machine; Fig. 3, at the drilling machine; Fig. 5, at the roughing-out lathe; and Fig. 4, at the grinding machine, which is the final machining operation, the parts going from there to the assembling floor where they are removed from the truck.

In connection with the course in shop engineering at the Institute, a study of costs for work done with and without the use of these special trucks showed that they effected a considerable saving of time. In some cases this was of course more marked than in others, but in all cases investigated, the time-saving effect was very noticeable. The principal savings of time are from four sources: (a) The workman's energy is not sapped by unnecessary efforts; (b) in taking up and replacing the pieces, his route to and from the work table of the machine is a shorter distance than from the floor; (c) no time is lost searching for and reloading the usual shop truck to convey the parts to the next machine; (d) the arrangement of holes is such that no time need be lost in selecting the next piece to be operated upon. The foregoing saving of time may properly be considered saving time at the machines. Several other minor time savings may be mentioned as follows: An order is issued for 100 parts and this order goes to the snagging room for this number of castings. With each truck, as in this case, holding 50 pieces, the snagger simply fills two truck and trundles them to the operator, and a glance shows him whether the count is right. Also the foreman can tell at any time whether or not the workman has the number ordered by noting whether it agrees with the order tag. This obviates the annoyance of finding, when the machines are being erected, that some of the parts are short and that a small make-up order must be issued to fill the quota for 100 machines. Small orders run through in this manner are always more expensive, as the time of setting up for any operation must be divided by the small number being made, increasing thereby the piece cost, and of course the cost of the lot. Otherwise, the lot must remain incomplete, with say 97 fully completed machines and 3 partly completed. This renders doubtful and inexact all figures on the cost of the lot.

Where the firm gets its castings from an outside foundry, the trucks offer an excellent means of checking up the number and weight of parts delivered. In this case the castings are sorted into the respective trucks; as each truck holds a specified number they are self-counted. The weight of the empty trucks is known; therefore running them upon the scales easily gives the weights delivered. As before, this gives at a glance the number of each machine part delivered and any shortage in numbers or errors in weights can be corrected at once. The trucks then not only effect a saving of time, but can be made to save the foreman annoyance and loss of temper. This all makes for efficiency, and efficiency makes for a successful business.

* * *

CONVEX FLUTING CUTTERS

Quite frequently, in ordinary toolmaking practice, a regular convex cutter is used for fluting taps. In selecting a half-round (convex) cutter for tap fluting, the formula commonly recommended for determining the proper thickness of cutter is as follows:

$$T = \frac{8D}{3N}$$

in which T = thickness of cutter in inches,
D = diameter of tap,
N = number of flutes.

It is claimed by some makers of taps that a better proportion of land and flute is obtained by a modification of this formula. For taps up to ½ inch in diameter the formula should thus be:

$$T = \frac{9D}{4N}$$

and for taps larger than ½ inch in diameter:

$$T = \frac{8D}{3.5N}$$

For example, if a ¾-inch tap with four flutes is to be fluted with a convex cutter, the thickness of the cutter would be:

$$\frac{8 \times \frac{3}{4}}{3.5 \times 4} = \frac{6}{14} = 0.43, \text{ or } 7/16 \text{ inch, approximately.}$$

* * *

ABSURD SPECIFICATIONS

The maker of a disk grinder was asked to submit estimates on the job of grinding the sides of blanks for small gears used in a magneto. The blanks after grinding were strung on an arbor for cutting the teeth. Of course, the sides were required to be parallel and the specification further required that the blanks be ground to one-half thousandth inch limit in thickness. A production rate of 250 per hour was finally established on test, and the machines were ordered and accepted. In the user's plant a production rate of over 300 blanks per hour was attained, or 20 per cent more than the maker's estimate. The reason was simply that the thickness was not closely limited and the blanks were actually ground to limits of five thousandths inch or more. The original specification was absurd, and the case illustrates the need of more engineering "horse sense" in the purchasing department of large manufacturing plants. The maker was doubtful of the success of his machine under the severe terms imposed and might have declined to furnish it. Had he known the actual conditions there would have been no hesitation whatever in guaranteeing the character and number of pieces produced.

* * *

A slender hook of irregular shape used in the "stumbling" mechanism of the Barber-Colman warp-tying machine is hardened to resist wear. It is subjected to repeated shocks and has given some trouble from breakage. Many kinds of steel and processes of hardening were tried without success until the following combination was hit upon: Steel, five per cent nickel; treatment, heat thirty-five minutes in case to temperature of 750 degrees C. and dump contents of pack into oil bath. The cases are made of 3½-inch pipe cut to 3-inch lengths and closed at the ends. The hooks are packed radially with the hook ends toward the center.

HORSEPOWER OF STEAM ENGINES*

By C. C. CARISS†

In all probability no formula has been printed as frequently as the following horsepower equation:

$$I.H.P. = \frac{PLAN}{33000}$$

in which

$I.H.P.$ = indicated horsepower;
P = mean effective pressure;
L = length of stroke in feet;
A = area of cylinder in square inches;
N = number of working strokes per minute.

In this equation the only term that cannot be obtained directly is P, the mean effective pressure. This is given by the steam expansion equation of Mariotte's law where

$$P_m = P_a \left(\frac{1 + \log_e R}{R}\right)$$

in which

P_m = mean absolute pressure,
P_a = initial absolute pressure,
R = ratio of expansion,
$\log_e R$ = hyperbolic logarithm of ratio of expansion.

From this mean absolute pressure the mean effective pressure may be obtained by subtracting the absolute back pressure P_b, or

$$P = P_m - P_b$$

Now it frequently so happens that a prospective purchaser wishes to know the horsepower of an engine under different conditions of steam pressure, cut-off, back pressure and speed, both condensing and non-condensing; also a comparison might be required between the sizes of high-speed, medium-speed and slow-speed engines which would give the same horsepower. In addition, if a compound- or triple-expansion engine is decided upon, the size required is desired.

The tables given in the Data Sheet enable these questions to be rapidly and accurately answered. The first horizontal line gives the per cent of stroke at which cut-off occurs; the second line, the corresponding ratio of expansion; the third line, the hyperbolic logarithm of the ratio of expansion; and the fourth line the value of $\frac{1 + \log_e R}{R}$ for the various ratios of expansion. This latter term may be designated the *expansion factor.*

From these values the various mean absolute pressures may be derived by simple multiplication. The first vertical line gives the absolute pressures, while the second tabulates the corresponding gage pressures as measured in pounds per square inch above atmospheric pressure by the usual pressure gage.

In using these tables for a simple engine, first find the required pressure in either the first or second vertical lines, and then run the finger along that pressure line until it is directly below the required point of cut-off, at this point reading off the mean absolute pressure. From this pressure subtract the absolute back pressure, which may usually be taken as 4 pounds per square inch condensing, and 18 pounds per square inch non-condensing, this resulting value being the mean effective pressure which can be inserted in the horsepower formula. The horsepower formula may be very rapidly solved by using Hudson's horsepower computing scale, which is a special slide-rule for this purpose, sold in America by Keuffel & Esser, New York.

The method of procedure is much the same in the case of a compound-, triple- or quadruple-expansion engine. In the first place, divide the area of the low pressure cylinder by the area of the high pressure cylinder, thereby obtaining the cylinder ratio. Dividing the per cent cut-off in the high pressure cylinder by this previously determined cylinder ratio gives the equivalent per cent cut-off in the low pressure cylinder, considering all the expansion to have occurred there. Finding the mean effective pressure as before, the indicated horsepower may be determined in the same way, basing the calculation on the low pressure cylinder area.

It should be noted that in a multiple-expansion engine the areas of the intermediate cylinders have no serious effect on the power of the engine, but simply act as a series of graduated steps through which the steam passes from a high to a lower temperature. Their principal purpose is to avoid the condensation which would occur if the steam passed directly from a hot high pressure cylinder to a comparatively cold low pressure cylinder, the temperature ranges being less, the greater the number of stages.

For ordinary purposes Tables I to III will be found sufficient, but it frequently happens that intermediate values are required. These may be obtained from the curve shown in Table IV. This curve was derived from the previously determined equation

$$P_m = P_a \left(\frac{1 + \log_e R}{R}\right)$$

in the following manner:

As

$$x = \frac{P_m}{P_a} \times 100$$

then

$$\frac{P_m}{P_a} = \frac{x}{100}$$

Also

$$y = \frac{1}{R} \times 100$$

therefore

$$R = \frac{100}{y}$$

Hence

$$\frac{P_m}{P_a} = \frac{1 + \log_e R}{R}$$

and

$$\frac{x}{100} = \frac{1 + \log_e \frac{100}{y}}{\frac{100}{y}}$$

Consequently

$$x = y\,(1 + \log_e 100 + \log_e y^{-1})$$
$$= y\,(1 + 4.605 - \log_e y) = y\,(5.605 - \log_e y)$$

This gives a means of laying out the curve, both the ordinates and abscissas being in per cent.

To use the curve, find the per cent cut-off and follow the corresponding horizontal line until it it intersects the curve, noting the vertical line at that point. This gives the per cent of the initial absolute pressure. Multiply this by the initial absolute pressure, thereby obtaining the mean absolute pressure from which the absolute back pressure is to be subtracted, proceeding as before to obtain the horsepower.

Simple engines are usually rated at 25 per cent cut-off; compound single valve engines at 30 per cent; and Corliss, or other engines giving a diagram closely approaching the ideal may be safely rated up to 35 per cent cut-off. A safe rule for generator rating, is to allow 60 kilowatts for every 100 horsepower calculated at these cut-offs.

The actual indicated horsepower will be less than the calculated by an amount depending on the construction and type of engine. The actual ratio may be found from cards taken from engines of a similar type. The brake horsepower or available useful effort, is found by actual measurements with some form of transmission or absorption dynamometer, or else by deducting the power shown on a diagram taken at no load from the power shown on the diagram taken at any other load. The usual limits of the brake horsepower are from 75 to 90 per cent of the indicated horsepower at full load.

* * *

The Concrete Institute of Great Britain has decided to encourage the contribution of useful papers by awarding a medal annually for the best paper on concrete and its uses, and materials employed in its manufacture.

* With Data Sheet Supplement.
† Designing Engineer, E. Leonard & Sons, London, Canada.

THE "H" ENGINE

By R. W. CROWLY*

In the search for designs that will give motors a high ratio of power to weight and space, some exceedingly ingenious ideas have been presented from time to time; but only when the imperative needs of aviation forced the demand did engineers seek to depart from conventional lines. Since then such engines as the Gnome, R.E.P. and N.E.C. have proved that they have as great reliability as the standard automobile engine, notwithstanding the fact that they are so strikingly different. The successes of these engines have shown that it is foolish to deride any new motor of original design; therefore the advent of the H engine is not so startling, nor can its peculiar merits be doubted.

In this design there are four cylinders arranged vertically in a square pattern, the two lower ones opposed to the two upper, as illustrated by Figs. 1 and 2. Each pair of opposed pistons is rigidly connected by a steel rod between which—firmly bolted to both—is a hollow turned crosspiece. The crankshaft is carried in two bearings, one on each side of the central case which corresponds to the ordinary crank-chamber, and the single crankpin is bushed in a rectangular block that slides on the crosspiece. Though really so simple in design, the arrangement is not easily understood by a mere description, but the illustrations show the important features.

With the ordinary cycle of operations taking place in the cylinders, both the lower and upper pistons obtain a straight-line movement with their rods or mandrels. As the crosspiece is carried up and down by this motion the sliding block works from side to side and carries the crankpin round its circle. This motion is not novel; indeed it is an application of the old Scotch yoke motion still to be found on some

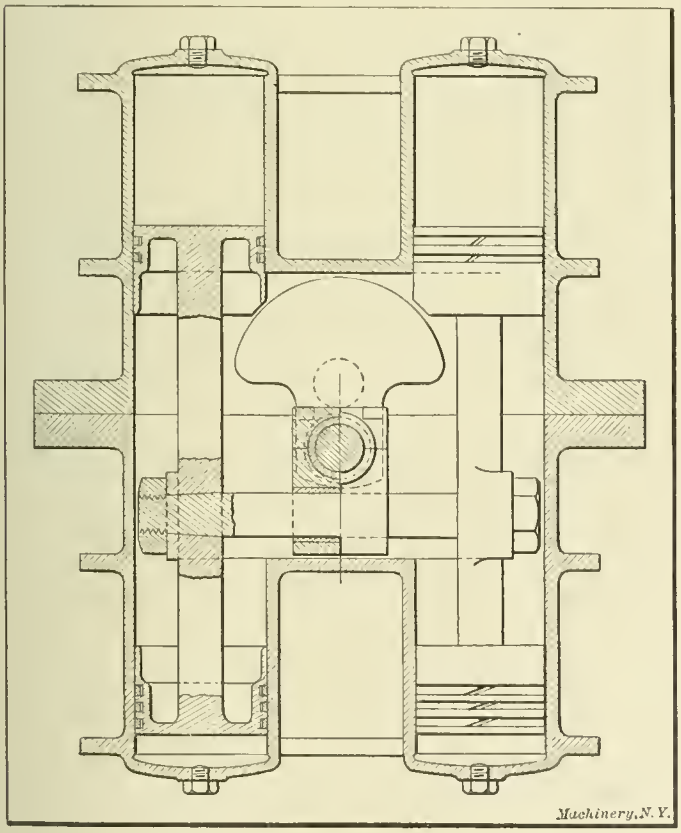

Fig. 1. Cross-sectional View of the H Engine showing Piston and Crank Arrangement

pumps. It is obvious that there must be a twisting action of the sliding block and this might be held to condemn the design. This argument has been advanced, but it is unimportant, for the block is designed to take this stress and therefore works as satisfactorily as any other part of the engine.

In so far as the valves and carbureter are concerned, they are of the ordinary poppet type found on the usual four-cycle motor. Both the water circulation and ignition are also normal, the only variation being in the water jackets, which are of copper, in order to reduce the weight. Lubrication however, is carried out in a special manner; the oil is led first to the walls of the upper cylinders and thence drips from the pistons to the crosspiece, sliding block and crank throw; dropping from there, the oil finds its way inside the lower pistons, which are drilled to permit the lubrication to reach the walls of the lower cylinders. A counterbalance weight is fitted to the crankshaft. A flywheel is also used, but this, however, would be unnecessary in a double unit having eight cylinders.

One of the most important advantages of this design is its simplicity. There are only three main moving parts and four bearings, instead of about a dozen of each as in the ordinary four-cylinder motor. From a manufacturing point of view the

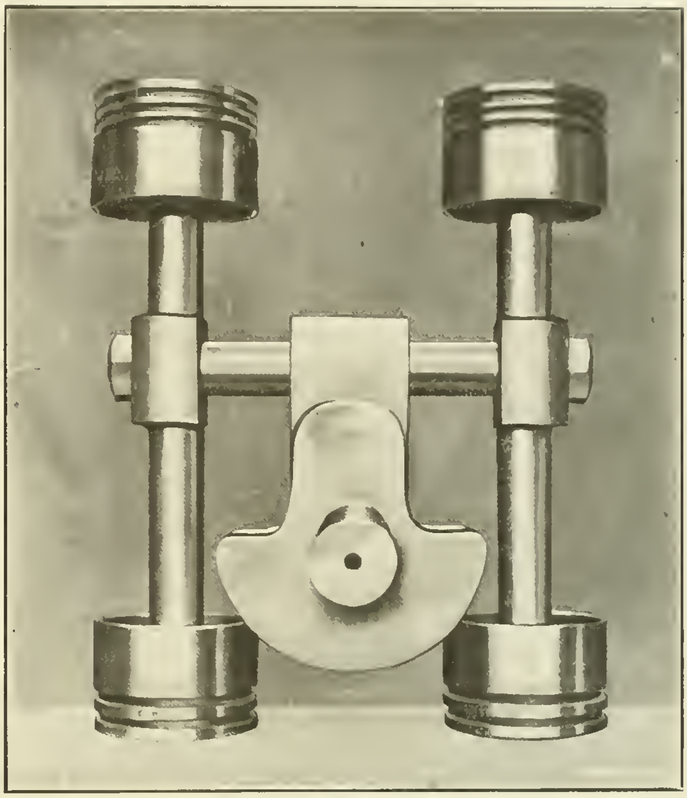

Fig. 2. Pistons, Rods, Crosspiece, Sliding-block and Crankshaft of the H Engine

saving in material and labor is a strong feature, while to the private user these same factors are of some moment, as that means a lower purchasing price.

From four cylinders, having a bore of three inches and a stroke of three inches, fully 20 horsepower is developed. As the outside dimensions are 17½ inches by 14 inches by 7½ inches and the weight only 100 pounds, inclusive of piping, carbureter, etc., the design effects a considerable reduction in two features which are of special account, and this without any of the special weight-cutting practiced by the manufacturers of aviation engines.

Publication has been made before the inventors have had time to submit the engine to exhaustive tests, but in some early trials the motor was run up to 1800 revolutions per minute, at which speed it was quiet and steady. As only one engine has yet been built, it is probable that greater improvement will be made in the matter of space and weight before the motor is placed on the market.

* * *

The importance of the manufacturing plant emergency hospital where minor accidents are treated and first relief given for serious injuries is realized from the impressive figures of the Yale & Towne Mfg. Co.'s plant. Mr. Henry R. Towne recently stated that 14,000 cases were treated during the past year at their Stamford, Conn., plant, where about 3000 persons are employed. Although the service included medical treatment for simple ailments, and a trained nurse is kept in constant attendance during the day, the cost of the hospital was only $1500 for the year. There is no doubt that a big saving of time of employes was effected through having wounds promptly and aseptically treated, thus avoiding infection.

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THE PROPERTIES OF VANADIUM STEEL

By WILLIAM E. SNOW[1]

Although vanadium has been used to a considerable extent for the past two or three years as an alloy for steel, one frequently hears the question asked: "What is vanadium, and how do vanadium steels differ from other steels?" Vanadium is an element, the existence of which was first recognized by a Mexican, Del Rio, about the year 1800. A number of years later it was discovered that the remarkable qualities of Swedish iron were due to the presence of a small amount of vanadium in the native ore. It is only quite recently, however, that vanadium has been found in sufficient quantity for commercial use.

Pure vanadium is silvery white in appearance, and of very high melting point. In the pure state it has little or no practical application; for use as an alloy it comes in the form of ferro-vanadium, which usually contains from 30 to 40 per cent of vanadium. Vanadium is such a powerful alloy that it only needs to be used in exceedingly homeopathic doses to produce marked results. The use of as small an amount as 0.05 per cent of vanadium produces a strong scavenging action that indirectly toughens the steel to a most noticeable extent, by removing the oxides, nitrides, etc. The use of a larger amount—0.18 per cent, or more—causes a portion of the vanadium to combine with the ferrite or free carbonless iron in the steel, thereby directly toughening it.

Vanadium is very volatile in its action, and considerable difficulty is experienced in getting it to mix thoroughly and evenly with the steel. When put into crucible steels it has a particularly aggravating tendency to go to the bottom of the pot in a lump, where it is frequently found after pouring. The higher the percentage of the vanadium, the greater the difficulty experienced in getting it to mix properly with the steel. It is practically impossible to put over 1.25 per cent of vanadium into steel and keep it there, while most vanadium steels do not contain more than 0.25 to 0.30 per cent of vanadium.

In order to more fully understand its specific action, consider briefly what takes place when vanadium is put into steel. Steel consists of iron, with more or less carbon as the case may be, sulphur, phosphorus, manganese, silicon, and, frequently, chromium and nickel. The carbon contained is combined chemically with a molecular portion of the iron. A molecule of this chemical compound alloys itself with twenty-one atoms of carbonless iron and the resultant alloy is distributed in spots, or patches, through the carbonless iron. This alloy is known technically as pearlite, and the free carbonless iron as ferrite. Part of the manganese unites chemically with the sulphur in the steel, forming striæ, or globules throughout the mass. The phosphorus and the silicon, also the larger part of the nickel—if used—are dissolved in the ferrite in what is known as "solid solution." The chromium is found as a constituent of the pearlite. When vanadium in a sufficient amount is used, it goes into solid solution, partly in the ferrite, which it toughens, and partly in the carbide portion of the pearlite, which it strengthens.

Vanadium is also beneficial to steel in still another way, its use securing better results from the process of annealing, as will be seen from the folowing: When heat is applied to a bar of steel, as in annealing, it becomes sensibly hotter with each degree of heat applied, up to a certain point, known as the point of calescence. When the steel reaches this point, further application of heat does not increase the sensible temperature, but instead, a change takes place in the steel itself; the pearlite becomes broken up, its carbides going into solid solution in the ferrite. When this change is completed, the sensible temperature of the steel again rises. In cooling, the reverse takes place; to a certain point, known as the "point of recalescence," the steel cools regularly, then it apparently ceases to cool, and a change takes place in the steel itself. The dissolved carbides are thrown out of solution, and alloy themselves with the ferrite to re-form pearlite. When this change is completed, sensible cooling again proceeds.

Since the object of annealing is to break up the carbide areas and distribute them in small colonies, the steel is heated above the calescence point, the temperature being maintained long enough to thoroughly decompose the pearlite—as well as to remove any mechanical strains that may have been locked up in the mass by previous manipulation under hammer and rolls. It is then cooled slowly through the recalescence point, care being taken to prevent chilling.

As a vanadium ferrite does not permit of the ready passage through it of the carbides re-precipitated at the recalescence point, the distribution of the carbides in a vanadium steel is remarkably even. This greatly increases the toughness and tenacity of the steel, in addition to the greater toughness already obtained with the background of vanadium ferrite (the portion of the vanadium that has gone into solid solution with the free carbonless iron).

The peculiar properties of vanadium steel are best shown by the following comparative table of the physical properties of vanadium and other crucible steels:

Condition of Steel—Natural, as rolled	Tensile Strength, Pounds per Square Inch	Elastic Limit, Pounds per Square Inch
Carbon Steel	82,300	56,000
Chrome-nickel Steel	102,100	69,230
Chrome-nickel-vanadium Steel	118,100	87,500
Chrome-vanadium Steel	153,220	98,560
Condition of Steel—Annealed		
Carbon Steel	61,100	43,200
Chrome-nickel Steel	81,200	56,700
Chrome-nickel-vanadium Steel	96,350	69,300
Chrome-vanadium Steel	112,000	76,160
Condition of Steel—Oil tempered at 1500 deg. F., drawn to 600 deg. F.		
Carbon Steel	126,300	101,100
Chrome-nickel Steel	150,300	134,500
Chrome-nickel-vanadium Steel	163,700	152,300
Chrome-vanadium Steel	233,090	210,500

From the above table it is seen that the two most marked characteristics of vanadium steel are its high tensile strength (breaking point), and its high elastic limit (stretching point). Another equally important characteristic is its great resistance to shocks; vanadium steel is essentially a non-fatigue metal, and therefore does not become crystallized and break under repeated shocks like other steels. Tests of the various spring steels show that when subjected to successive shocks for a considerable length of time, a crucible carbon steel spring was broken by 125,000 alternations of the testing machine, while a chrome-vanadium steel spring withstood 5,000,000 alternations, remaining unbroken.

Another characteristic of vanadium steel is its great ductility. Highly tempered vanadium steel springs may be bent sharply, in the cold state, to an angle of 90 degrees or more, and even straightened again, cold, without sign of fracture; vanadium steel shafts and axles may be twisted right around, several complete turns, in the cold state, without fracture. This property, combined with its great tensile strength, makes vanadium steel highly desirable for this class of work, as well as for gears which are subjected to heavy strains or shocks upon the teeth.

In the matter of heat-treatment, vanadium steels will stand a wider variation of temperature without detrimental effect than other steels. One particular characteristic of vanadium steel is the evenness with which it hardens. Vanadium steels forge readily, and, in the annealed state, are no harder to machine than an ordinary steel containing the same percentage of carbon. In this respect they differ greatly from other steels of high tensile strength, in which the presence of a considerable amount of nickel renders machining extremely difficult.

The usefulness of vanadium as an alloy is not confined to steel alone; it is equally beneficial to other metals. Cast iron, brass and copper are much improved by the addition of a small percentage of vanadium, their strength and endurance being greatly increased. Castings from these metals show a finer grain and greater freedom from porousness through the use of vanadium. Aluminum, a particularly difficult metal to machine, is greatly benefited in this respect by the addition of vanadium, which not only renders it easier to work, but also insures its ready flow in the mold, producing sharp, even castings from difficult shapes.

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TEMPERING APPARATUS

By JOSEPH R. WEANER*

In general practice it is usually necessary to draw the temper of tools used for manufacturing purposes, but this should be done in one heat, that is, the work should be removed from the bath while it still retains sufficient heat to draw the temper. This method of tempering, however, is sometimes impossible owing to various conditions, so that it is necessary to harden and temper the work in two heats.

The accompanying illustration shows an apparatus installed in a large manufacturing concern, which enables the temper to be drawn at a lower cost, where much of it is to be done and where it is necessary to draw the temper after the work is hardened. This device also produces better work than is usually the case.

Fig. 1 shows the arrangement, in which A is a group of three small Bunsen burners with separate stop-cocks B, and C is an ordinary galvanized-iron pail with a long handle D used in place of the ordinary handle. This handle hangs on the bracket E which is attached to the wall. Riveted into the bottom of the hook of this bracket E is a link of a chain

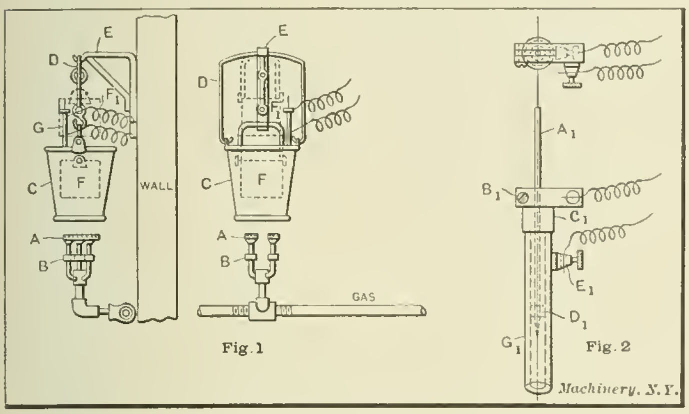


Fig. 1. Tempering Device with an Automatic Alarm. Fig. 2. Details of the Alarm for the Tempering Device

which supports the perforated pail F held in the pail C, clear of its bottom. The inner pail F may also be hooked directly to the bracket as shown at F_1 by the dotted lines, thus raising it out of the pail C.

This device should be located close to the hardening furnace, and the quenching bath should also be near, so that the operator may without moving from his place, draw the pieces from the furnace, quench them in water or other solutions, and before they are entirely cold, drop them into the inner pail F. The outer pail C should be filled to within from one-and one-half to two inches of the top with lard oil or tallow, and heated by the burners to a temperature of 200 degrees F.

When all the pieces to be hardened are in the pail F or when it is full, the burners A are turned up, thus allowing the oil and all of the pieces therein to slowly heat to about 400 to 600 degrees F. according to the kind of steel and the service required. When the desired temperature is reached the burners are turned out. After the heat has gone down to about the boiling point of water, the pail F and its contents should be raised to the position F_1, and the hot oil allowed to drain off. To accurately gage the temperature required, a so-called "chemical" thermometer may be used. These are simply glass tubes with the mercury bulb at one end, and the graduations etched in the tube, having no case. When all the work is in the small pail F this thermometer should be placed with its bulb in or on top of the work.

In my own use of this tempering device, as the tempering operation usually extended over two hours or more per lot, and other duties had to be attended to in the meanwhile, I found it almost impossible to keep it in mind sufficiently to watch the thermometer as it should be watched, and as a result was obliged to re-harden several lots, on account of allowing the heat to go too high. This annoyance led me to devise an automatic alarm.

This alarm was made by using a piece of ⅛-inch gas pipe about 17 feet long, and welded tight at one end. The pipe was then coiled by wrapping it around an old pulley and spreading it like an open-wound helical spring, so that it started in the bottom of pail C and ran around and close to the inside to nearly the top, where the end was bent to stand up straight, as shown at G. This tube was filled nearly full of mercury, care being taken to get all the air out. When the temperature in the pail rises, the mercury expands, and, rising in the tube G, makes a contact with the adjustable wire A_1 (Fig. 2). One wire from an electric bell is attached to the clamp B_1, carrying a binding post, and is insulated from the coiled pipe by the hard rubber collar-bush C_1. The small bush D_1 near the end of the wire A_1 is a loose fit in the tube G_1. The other wire to the bell is connected to the pipe coil at E_1.

After a few trials and by using the thermometer as a standard, the wire A_1 may be graduated to the temperatures mostly used. This makes a very efficient alarm, and once the work is in the pail and the fire lighted, no further thought need be given it until the bell rings, when anyone can turn out the flame.

The writer was at one time engaged in a place where many thousands of steel pieces were regularly manufactured, all of them being hardened. The work was all similar and less than half the product was tempered after hardening, while the main and cheaper part of the product was not tempered because of the prohibitive cost. In this place an experienced man, by the use of a large hot plate placed over a furnace, did about 400 pieces in 10 hours. The highest day's work ever done was 500 pieces, and the man was nearly roasted to death, especially in hot weather. After getting permission from the firm I secured an ordinary caldron kettle, such as farmers and butchers use, and made a fire under it with hard coal. Over the kettle was fitted a galvanized-iron hood with a pipe leading outside to carry off the smoke and fumes from the hot grease. Inside the kettle which was filled with tallow was a large perforated pail corresponding to F (in Fig. 1) which held the work. The temperature was regulated by a long stem-pitching machine thermometer made by Schaeffer & Budenburg of Brooklyn, N. Y.

With this device the man was not only able to do about 1500 pieces in a few hours, but did them in such a superior manner that going back to the old method was not thought of. It will be found absolutely necessary with this device to use the hood and pipe for carrying off the smoke from the oil unless the apparatus is used in the open air.

The hardening and tempering of the tools used in manufacturing operations are among the most important operations through which they pass in the making; and yet these operations seem to be least understood generally by those who make tools. The facilities for hardening and tempering are in most shops precisely the same as were used at the beginning of the manufacturing. I think it perfectly safe to say that between a cutting tool imperfectly hardened, and one done in the best possible way, the efficiency is 1 to 5. Some of the manufacturers of such tools as drills, taps, dies, milling cutters, etc., are alive to the necessity of advancement along this line, and provide the most efficient and up-to-date hardening devices, but the large majority of them and nearly all the toolrooms which make tools for their own use, employ the "good old methods."

Toolmakers, in general, are only just beginning to wake up to the fact that it takes an expert in steel to tell anything but the size of the grain from the fracture; and that the size of the grain tells nothing but the degree of heat to which it was raised in hardening. This is no guide whatever to the quality of the steel, and is of no importance except to tell that the steel is hardened and ready to use. The heat also should never be higher than will give the required degree of hardness with little or no drawing, and the drawing should be done evenly and slowly. This enables the molecules to settle, and thus relieve the strains set up in the hardening process.

* * *

The man who knows more than the boss usually gets to be the boss. The man who only "thinks" he knows more than the boss usually gets fired.—*Exchange*

* Address: 39 Clinton Ave., Plainfield, N. J.

A SIMPLE ROUTING SYSTEM

HOW THE PARTS OF THE LUCAS BORING MACHINE ARE PUT THROUGH THE SHOP

Of shop systems, like books, there is no end, and again like books, there are good and bad systems. Any shop system must be judged by what it accomplishes and the cost of its administration. The simpler a system, other things being equal, the better it is when judged from the practical man's point of view. The following system of routing work through a machine shop is that used in the building of horizontal boring machines by the Lucas Machine Tool Co., Cleveland, Ohio, and is commended for its simplicity and the complete control and knowledge of the progress of work through the shop.

The detail drawings are made on sheets 19½ by 26 inches. The sheets are divided into sections, the size varying according to the size of the parts shown. The largest number of divisions of the sheet is sixteen, these being obtained by three horizontal and three vertical lines. This size is used only for the small simple details that can be clearly delineated in the available space. In all, there are five sizes of divisions up to and including one-half the sheet. The scheme is illustrated in part in Fig. 1. At the bottom, space is reserved for the operation numbers and records of progress.

Two blue-prints are made of each group of details in the drawing room and issued for each lot of twenty-four machines. One print is made of paper and is kept in a binder in the shop office. The other print is made on cloth and is cut apart, making as many individual prints as there are separate details on the sheet. These are punched at the top and provided with a ring to which is attached a routing tag. The routing tag is filled out in the shop office and sent into the shop with its blue-print to accompany the parts until finished and delivered to the assembling floor or the storeroom.

For the purpose of illustration the 4-pitch 23-tooth first driving bevel gear has been chosen. This detail, shown on the sheet Fig. 1, is shown detached in Fig. 2 with its routing tag attached. The symbol of this part on the drawing is 32—139, in a circle. The first number is the machine number and the second is the pattern number, in case the piece is a casting. Each operation for each piece on the sheet is designated in the operation sheet at the bottom of Fig. 1, in the spaces opposite the part symbol. The operations on the chosen piece are 12-a, 12-b, 13, 16, 24, 9, 15 and 20, these being "turret chuck" (a and b) gear cutter," "keyseater" "storeroom," lathe," milling machine," and "fitting" as will be seen in the accompanying schedule of operation numbers.

It will be noted that this schedule gives the name of the operation in some cases, but in more it gives the name of the machine. The reason for this is that the individual operations on the lathe, milling machine, etc., are minutely specified in separate lists that accompany the routing tag and blue-print when required to follow out the order that has been determined in the planning department. These lists of operation are typewritten and blue-printed, and are pasted on the back of the shop blue-prints.

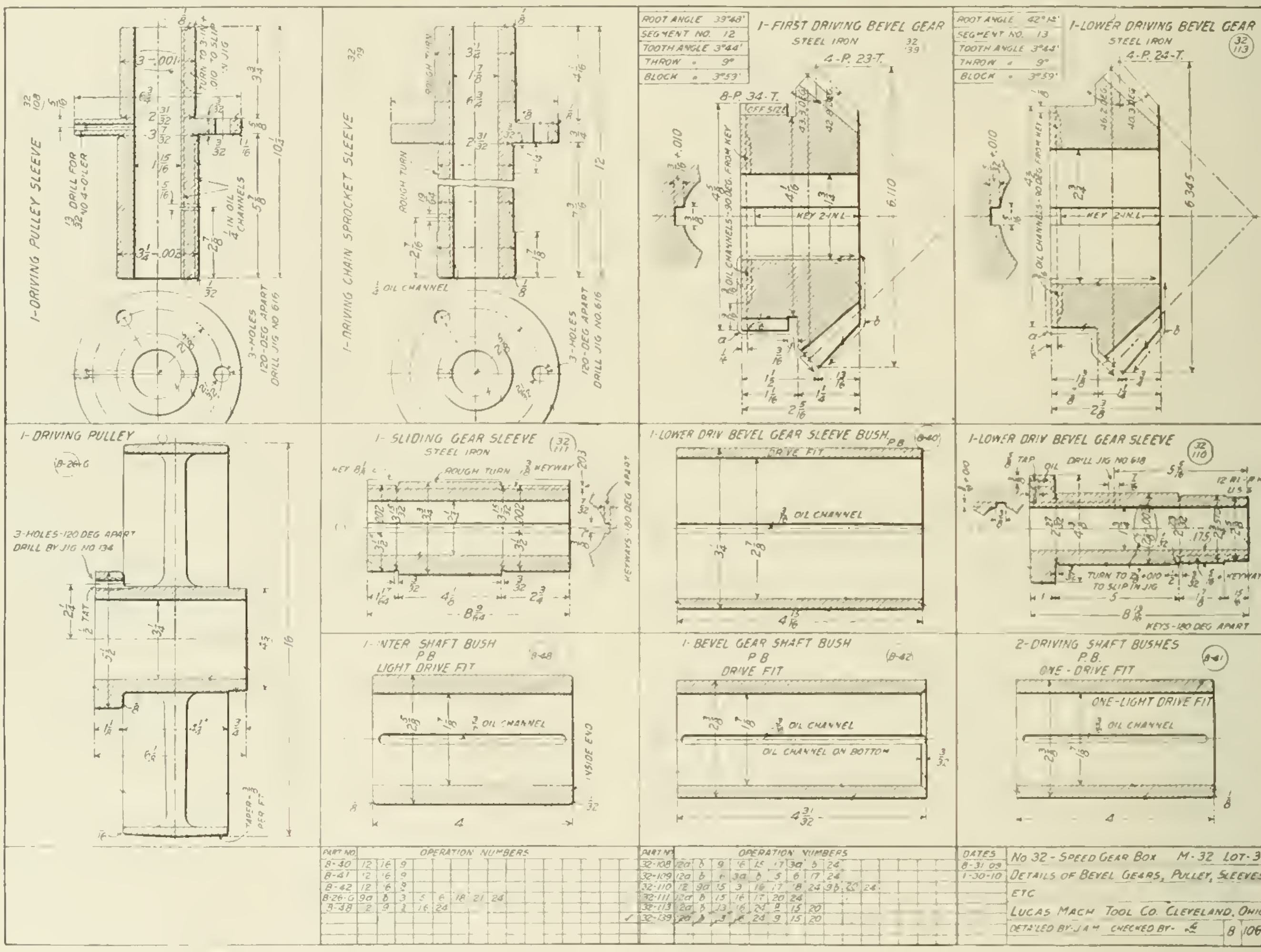


Fig. 1. Detail Drawing, Lucas Machine Tool Co., showing Operation Numbers and Record of Progress

OPERATION NUMBERS

1.—Planing
2.—Boring Machine
3.—Drilling Machine
4.—Helping
5.—Cleaning Castings
6.—Painting (including filling and rubbing)
7.—Cutting off
8.—Centering.
9.—Lathe
10.—Lo-swing Lathe
11.—Turret Bar
12.—Turret Chuck
13.—Gear Cutter
14.—Thread Milling Machine
15.—Milling Machine
16.—Keyseater
17.—Grinder
18.—Polishing
19.—Scraping
20.—Fitting
21.—Miscellaneous hand work
22.—Erecting
23.—Inspecting
24.—Store Room
25.—Graduating
26.—Spindle Boring Machine
27.—Auto. Turret Machine

The first operation on the bevel gear blank is chucking in the Gisholt turret lathe and performing operation a. This operation is boring, facing and turning the surfaces designated by the line *a* in the drawing, which starts in the bore

and terminates at the outer angle of the tooth section. This line is broken, the break being one short dash. One short dash indicates that it is the first operation. The second operation b is indicated on the drawing by another broken line b, the break consisting of two short dashes. Of course, the operator on the turret lathe does not change from one operation to the other on each piece. He does one operation on each piece first and then changes his chuck and tools to do the second operation, and so on.

When the lot of castings and the routing tag are delivered to the turret lathe, a check mark is made by the clerk on the shop office drawing, opposite the symbol. This mark shows

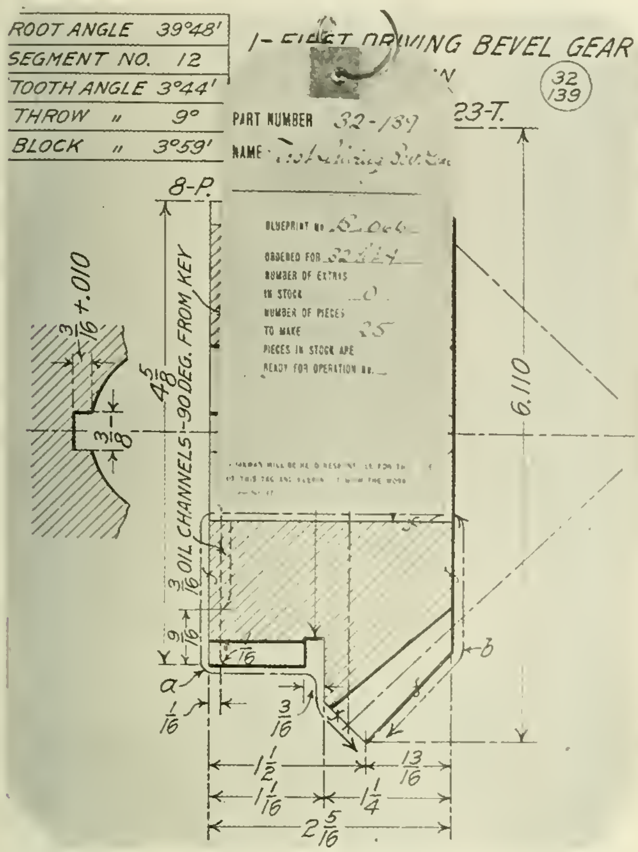


Fig. 2. Detached Detail Drawing with Routing Tag Attached

that work has been started on these parts. Further records are made from the cost cards, a sample of which is shown in Fig. 3. The cost cards are of the regular form supplied by the International Time Recorder Co., and are stamped in a time recording clock when the job is started and when completed. They are partly filled out by the shop office clerk, the order number, piece number, operation and number of pieces being the items entered. The cards then go to the foreman who keeps them in a card rack with index tab cards to designate the various operations. Thus there will be cards for practically all the operations enumerated on the schedule of operations.

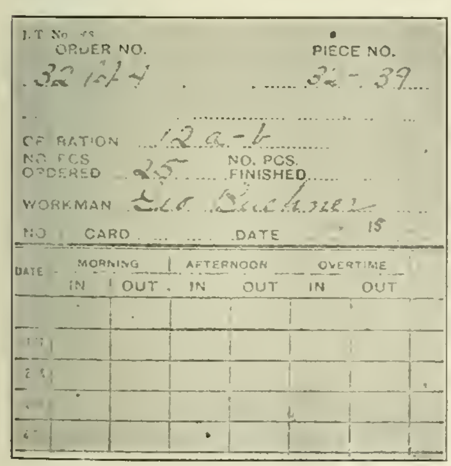
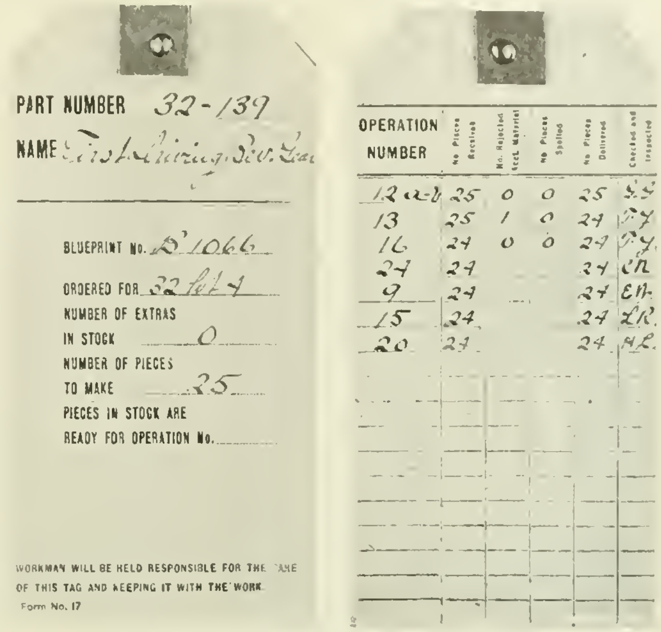


Fig. 3. Top Portion of a Cost Card

The turret lathe operator who machined the bevel gear blanks was charged with twenty-five pieces, an extra piece being supplied to replace any casting found defective or spoiled. When he finishes operation 12-a and 12-b, the time of completion is stamped in the time recorder, and the card is turned in to the foreman, who then gives the workman another job, and the cost card for the operation is stamped in the "In" column. The cards for completed operations are collected each morning, and the completed operations are marked off on the shop office blueprints as indicated in Fig. 1 for operations 12-a and 12-b. The same is being done for all the other parts on this sheet

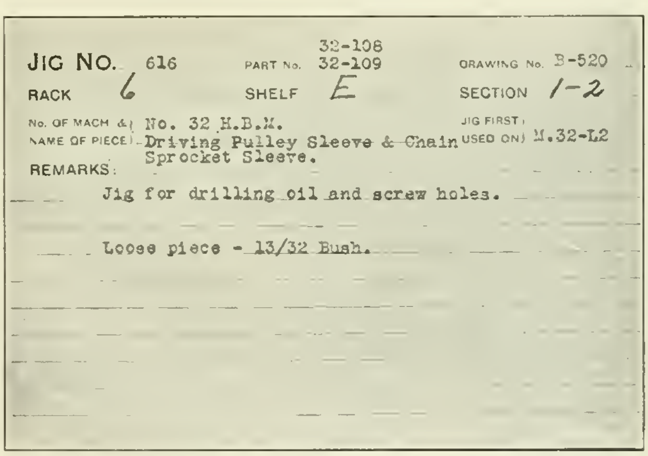


Figs. 4 and 5. Front and Back of Routing Tag

and on the other sheets for the lot of machines going through.

When the turret lathe man completes the lot of bevel gear blanks and so reports to his foreman, the report means to the shop office that the lot has been delivered to the machine for the next operation. An order is not considered complete until the delivery is made.

The next operation in this case is gear cutting. Twenty-five turned and bored blanks are delivered to the gear cutting de-


JIG NO. 616 PART No. 32-108 32-109 DRAWING No. B-520

RACK 6 SHELF E SECTION 1-2

No. OF MACH. & NAME OF PIECE No. 32 H.B.M. Driving Pulley Sleeve & Chain Sprocket Sleeve. JIG FIRST USED ON M.32-L2

REMARKS:

Jig for drilling oil and screw holes.

Loose piece - 13/32 Bush.

Fig. 6. Sample Index Card showing Location of a Jig in the Tool-room

partment together with the routing tag and blue-print, Fig. 2. The operator to whom they are turned over stamps the time of beginning in the "In" column of a cost card filled out for operation 13, and when the lot is completed the time is stamped in the "Out" column as before. In this case one blank was found defective when cut and twenty-four perfect gears were turned over to the keyseater for operation No. 16. The next morning the cost card went into the shop office and operation 13 was checked off on the shop office record blue-print.

The orders for castings also originate in the drawing office, and the prints are not issued to the shop office until the castings are delivered by the foundry. The drawings are made to convey all necessary instructions to the workmen. Thus when parts are to be drilled or bored in jigs, the jig number is given on the drawing. For example, the driving pulley sleeve and driving chain sprocket sleeve, symbols 32—108 and 32—109, are drilled in jig No. 616. This jig will be found in the

tool-room in rack 6, on shelf E, in section 1—2. The description of the jig and location are given on a card, Fig. 6, kept in a card index in the tool-room.

From this outline it will be understood that a constant record is available in the shop office which shows from day to day the progress of work on any lot of machines and the location of all parts. It also shows the number of parts spoiled and indicates on what operation they were spoiled. The costs can be calculated for a machine or lot of machines in any stage of construction. The system is much more quickly comprehended than described, and its simplicity is shown by the fact that one clerk attends to all its details after receiving the blue-prints from the drawing office. F. E. R.

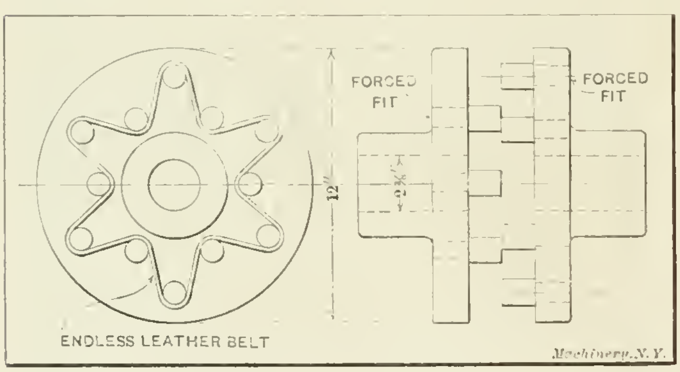
* * *

ELIMINATION OF LINESHAFT VIBRATION

By R. S. F.

The vibration coupling shown in the accompanying illustration has no doubt been known to the majority of practical men for a long time, and the writer does not lay any claim whatever to its invention. However, the success attending its use where an exceedingly heavy load had to be started by a direct-connected motor (due to the shaft vibration given by the device allowing the motor to get fairly started before the full load came upon it), suggested its use for the case to be described.

A new machine shop, 60 feet wide by 175 feet long, of an all-steel construction, with reinforced concrete gallery floors and roof, was equipped with two 40 horsepower motors. One of these was suspended from steel I-beams under the gallery and was direct-connected by cone vise couplings to a jack-shaft on which were located two pulleys, each driving a lineshaft, also suspended under the gallery in like manner as the motor, and extending the full length of the shop. The other motor was located directly above the gallery, suspended from the roof under exactly the same conditions. These motors when put in operation driving planers, slotters, shapers, etc., where the load is very intermittent, caused such a vibration on the



Coupling used to eliminate Vibration in a Lineshaft suspended from a Concrete Structure

gallery floor that it was impossible to work there with any degree of comfort. In addition, the concrete work developed large cracks in a very short time.

To remedy these troubles, the couplings shown in the engraving were installed in place of the cone vise couplings. This resulted in the total elimination of all vibration, much to the comfort of the workman, as well as materially reducing the wear and tear on the concrete work. In relating this incident, the writer does not condemn, of course, the cone vise or similar forms of couplings when used under ordinary circumstances, but strongly advises its elimination where conditions similar to the ones referred to above prevail.

It will be noticed that the two coupling sections are shown apart, for clearness, in the illustration. In operation, of course, the ends of the projecting pins are close to the opposite faces of the flanges.

* * *

It is mentioned in the *Times Engineering Supplement* that a steel chimney 56 feet high and 4 feet 3 inches in diameter was recently put together entirely by electric welding, and completed before erection. It was erected in about three hours. This is, so far as we know, a new use for electric welding.

MAKING "DIAMOND" AUTO TRUCK CHAIN

The first means for transmitting rotary motion from one wheel to another very likely was a cord, then a belt of leather, and then, for still greater power, a metal chain. The use of chain for power transmission dates back many years, the first forms being ordinary round iron link chain working on cast-iron sheaves made with smooth wedge-shaped grooves or with pockets for the chain links. The malleable detachable

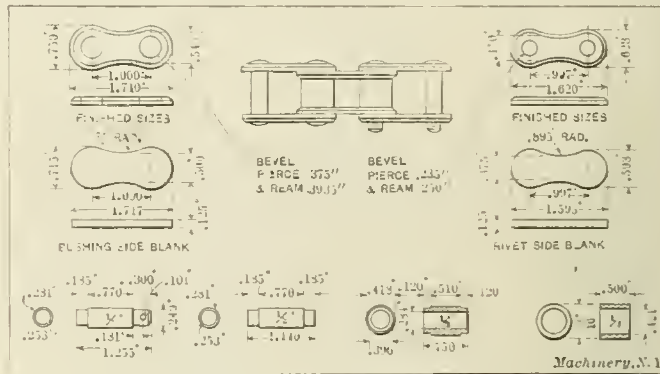


Fig. 1. Diamond Roller Chain No. 155 for Auto Trucks, etc.

link chain now so largely used on conveying and other rough machinery was a great improvement over the older form in point of efficiency and durability, but it was not until the advent of the bicycle that really high-grade transmission

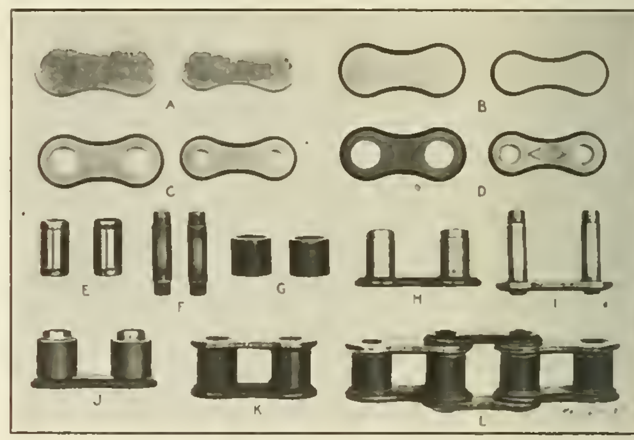


Fig. 2. Parts of Diamond Roller Chain No. 155

chain of uniform pitch, fitted to accurately-cut sprocket wheels, was put on the market as a regularly manufactured product. This light chain was used for many purposes other than the bicycle, and heavier sizes were manufactured to

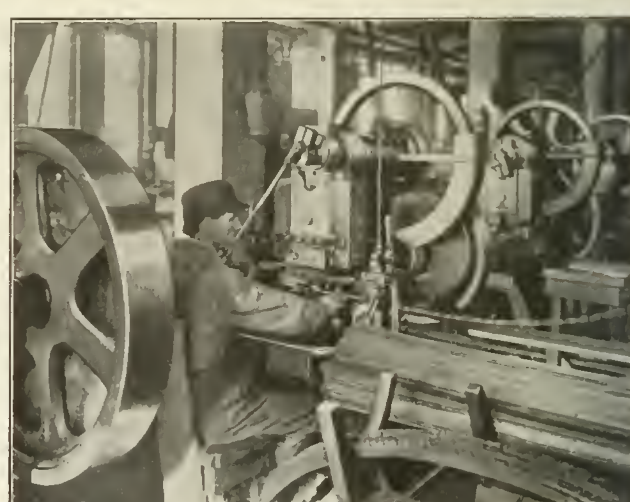


Fig. 3. Blanking Side Pieces from Cold Drawn Stock

meet the demand, but the development of the automobile and auto trucks made the market for heavy high-grade chain, most of which is now provided with rollers to reduce the friction of engagement and release of the chain links and sprocket teeth. The following article illustrates the main

features of the practice of the Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., in making heavy power transmission chain of the roller type.

The company was organized in 1890 when the bicycle was at the height of its popularity. For several years the product was bicycle chain exclusively, but with the development of the automobile, the auto truck and other machinery requiring heavier high-grade power transmission chain, the line has been extended, until now forty-eight distinct styles, sizes and weights are listed in its catalogue for all kinds of service. Highly developed special machinery for making bicycle chain is in use, the quantity of this chain produced every year being so great that a large investment in machinery for its manufacture is warranted. But for making auto truck chain comparatively little special machinery is employed, the quantity of any one size used being too small, perhaps, to pay returns on the cost of the heavy machinery that would be required if the bicycle chain equipment were duplicated. The present article, therefore, illustrates and describes more or less common machines and operations which derive interest chiefly from the product.

One size of chain, No. 155, has been taken to illustrate the steps of manufacture. This size is made in three widths, ⅜-, ½- and ⅝-inch, respectively. The working drawing, Fig. 1, shows the parts and dimensions of the bushing side piece, rivet side piece, rivet, bushing and roller of the ½-inch size; also the dimensions of the connecting rivets, one pair of which with spring cotters, must, of course, be furnished with every chain. Fig. 2 illustrates the parts in the following stages of manufacture: *A*, bushing and rivet sides blanked; *B*, bushing and rivet sides with edges beveled; *C*, bushing and rivet sides punched; *D*, bushing and rivet sides reamed and blued; *E*, finished bushings; *F*, finished rivets; *G*, finished rollers; *H*, assembled bushings; *I*, assembled rivets; *J*, assembled bushing and rollers; *K*, assembled roller link complete; *L*, section of completed chain.

The chain side blanks are punched from cold-drawn 20 to 40 point carbon steel strips, 0.125 by 0.875 inch for the bushing sides, and 0.125 by 0.750 inch for the rivet sides. By "bushing sides" and "rivet sides" are meant the parts in which the bushings and rivets are tightly fitted. Fig. 3 shows the style of press, and the roller feed which is typical of the feed used on all the heavy perforating presses.

Fig. 4. Beveling the Corners of Side Pieces in Coining Press

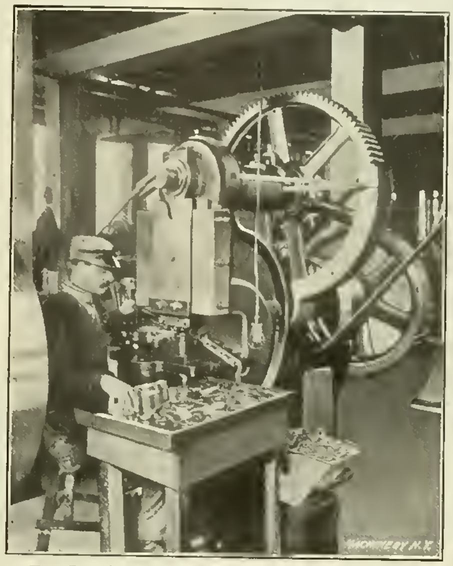


Fig. 5. Piercing the Rivet and Bushing Holes in Side Pieces

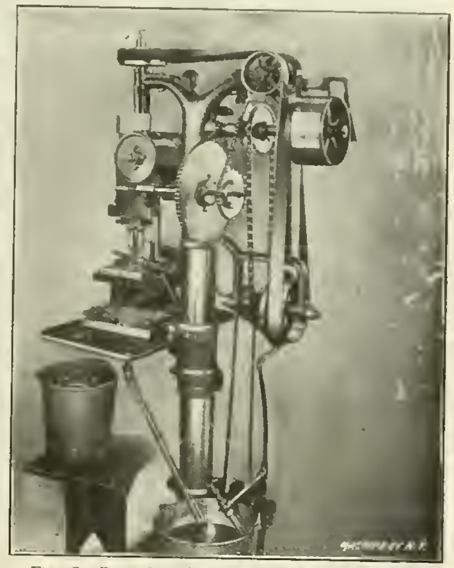


Fig. 6. Reaming the Rivet and Bushing Holes in Side Pieces

The second operation is beveling the sides of the blank, which is done on a Ferracute coining press, Fig. 4. The blanks are automatically fed to the dies by a slide which pushes the blanks from the bottom of the small magazine shown in front. The coining operation produces a smooth beveled surface with sharp corners and hardly perceptible flow of the metal, and is a rapid and satisfactory way to bevel the edges of the parts. In passing, it may be noted that this coining operation, while one of the oldest methods of forming designs, is strangely neglected as a method of producing many shapes that are now generally produced by profile milling. Where the number of pieces runs into thousands, there is little doubt that forming by heavy pressure could often be profitably substituted for the common method of removing stock by rotating or other cutting tools.

The holes are punched after the coining operation, as shown in Fig. 5, both holes, of course, being punched at once. Square-faced punches are used for blanking and punching in order to produce the parts with a minimum of twist. Punching the hard stock with the square-faced punches is heavy work, and heavy gap punching machines are employed. The

Fig. 7. Section of Screw Machine Department, 185 Screw Machines in Use

Fig. 8. Gaging Screw Machine Work

stock is fed by a roller feed operated by a ratchet, which automatically releases it at the moment when the punch descends.

The holes are reamed in jigs on semi-automatic machines, one of which is shown in Fig. 6. Reaming the holes is an important feature of the manufacture of high-grade machinery chain. It insures accuracy of size, which is necessary for snug and even bearing on the bushings and rivets, and accuracy of pitch—a very important consideration. Incidentally, the illustration Fig. 6 shows the advantageous use of chain transmission in machine tools, and is only one of many uses to which power transmission chain is applied in the factory. After reaming, the trade-mark and number are stamped on the rivet side pieces, this being the last machine operation before bluing.

Fig. 9. Assembling Bushings and Bushing Side Pieces

The rivets, bushings and rollers are made on automatic screw machines, mostly "Clevelands," a section of one battery of which is shown in Fig. 7. An idea of the number of these screw machine parts used is conveyed by the fact that 185 screw machines are in use. The rollers are casehardened, brightened by tumbling, and toughened by drawing to a straw color. The bushings are casehardened, and tumbled to remove the scale and left hard, without further finish. The rivets of chain No. 155 are nickel steel hardened and drawn to a blue on the ends only, which must be left soft for riveting over.

Fig. 10. Assembling the Chain

The limits of variation of the product are close, and to insure that the high standard is maintained, the parts, running into many thousands daily, are gaged by girls. A view of the gaging department is shown in Fig. 8. The gaging of the parts is regulated by the size of the chain and its grade. Every part of No. 155 is gaged, as is the case with other high grades. Smaller and cheaper chain is gaged by testing the parts regularly, thus maintaining a check on the general character of the product.

When the link parts are completed, they are assembled by hand, machines being used to force the rivets and bushings into the side plates. The order of operations is as follows: The rivets and rivet sides, and the bushings and bushing sides are first assembled in dial feed presses, as shown in Fig. 9. The operators supply the sides to small magazines and set the rivets or bushings in the dials as they revolve. When the revolution brings a pair under the press they are forced into the side piece that has been carried from the magazine around with the dial. The rivets and bushings are thus pressed into the sides, forming the "assembled bushings" and "assembled rivets," *G* and *H*, of Fig. 2. The rollers are assembled on the bushing assembly by girls, making the combination shown at *I*, Fig. 2, and then the complete chain assembly is made, as illustrated in Fig. 10. The sides are forced onto the bushings and rivets by the power press, as stated.

The final, but by no means the least interesting, operation is spinning the rivets on the automatic double-spindle machine shown in Fig. 11. Both ends of the rivets are spun simultaneously, the operation being one of the quickest and neatest in the making of the chain. After the final inspection and testing, the chain is ready for the market.

This chain, the making of which was described in the foregoing, is composed of about sixty parts per lineal foot. All the parts are accurately formed, beautifully finished, and part of them are hardened and tempered. The finished chain weighs about one-half as much as the raw stock required for its manufacture, yet the retail price is about $1 per foot. The possibility of manufacturing this product at the price, is due to automatic machinery, specialization of workmen and thorough organization of manufacture throughout. F. E. R.

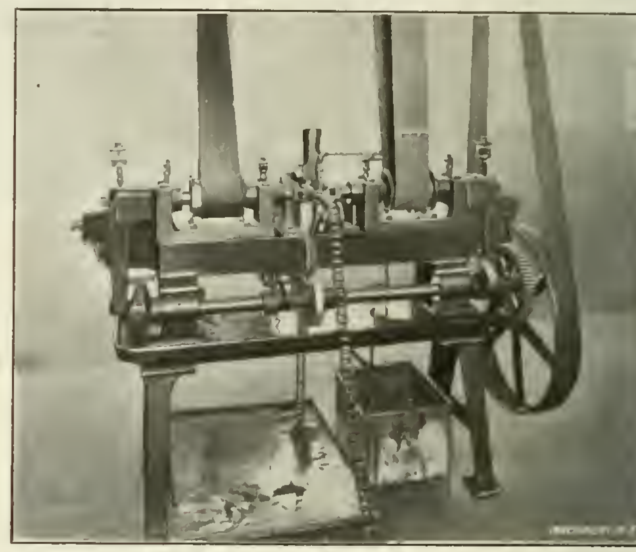


Fig. 11. Spinning the Rivet Ends and Completing the Chain

* * *

MAKING HAND-TAPS IN SETS

When hand-taps are made in sets of three, the first and second tap not cutting a full thread, but only partially completing the thread, which is finished by the third tap, it is of considerable importance that the relative diameters of the three taps are so proportioned that the two roughing taps each cut a fair amount of the thread, and that the finishing tap is required to do but comparatively little actual cutting, merely taking a shaving cut.

A simple rule used by one tap manufacturer for United States standard thread taps, and which has been found to give entire satisfaction, is to make the diameter of the first tap in a set equal to the diameter of the finishing tap less the depth of the thread, and to make the diameter of the second tap in a set equal to the diameter of the finishing tap less one-third of the depth of the thread. This makes the actual depth of the thread of the two roughing taps equal to one-half and five-sixths of the depth of the finished thread, respectively, and leaves but a small amount of metal to be removed by the finishing tap.

SHRINKAGE AND FORCED FITS—2

By WILLIAM LEDYARD CATHCART*†

The *total* allowance for shrinkage is the difference between the external diameter of the inner member (shaft) and the internal diameter of the outer (hub), before shrinkage. The *unit* shrinkage-allowance is the allowance per inch of nominal diameter, in either case, as above; and also, in either case, the *unit* deformation of a given circumference or diameter is the difference between its lengths before and after shrinkage, divided by its original length. The principle which is applied in the derivation of formulas for shrinkage-allowances, is that

TABLE III

Values of Ratio C for solid steel shafts of nominal diameter D_1, and hubs of steel or cast-iron of nominal external and internal diameters D_2 and D_1, respectively.

Ratio of Diameters $\frac{D_2}{D_1}$	C Steel Hub	$\frac{T_1}{T_2}$ Cast-iron Hub	Ratio of Diameters $\frac{D_2}{D_1}$	C Steel Hub	$\frac{T_1}{T_2}$ Cast-iron Hub
1.5	0.227	0.234	2.8	0.410	0.432
1.6	0.255	0.263	3.0	0.421	0.444
1.8	0.299	0.311	3.2	0.430	0.455
2.0	0.333	0.348	3.4	0.438	0.463
2.2	0.359	0.377	3.6	0.444	0.471
2.4	0.380	0.399	3.8	0.450	0.477
2.6	0.397	0.417	4.0	0.455	0.482

the unit-deformation at any point is the quotient of the unit stress at that point, divided by the modulus of elasticity. In a shrinkage fit, the unit-deformations considered are those at the fit, and the unit-stress to which these deformations correspond are manifestly the "true" or actual stresses, and not those which have been termed "apparent" since, as has been shown, the effect of lateral contraction is important.

The length of a given circumference varies directly as that of its diameter. Hence the unit-deformation will be the same for both, and this deformation, when due to the true tangential stress in the hub at the bore, will be the unit-deformation of the internal diameter of the hub. Similarly, for both solid and hollow shafts, the unit-deformations of the external diameters are those of the circumferences of their outer surfaces, produced by the true tangential stresses there, since that circumference and the external diameter decrease together. The unit-deformation of the external diameter of the inner face will serve only for a solid shaft, since in it, as shown in Fig. 4 (April issue) the tangential and radial stresses are equal at all points from the circumference to the center, while, in the hollow shaft, the intensity of the radial stress varies from P_1 at the outer surface to zero at the bore, and hence the deformation due to this stress at any given point is that corresponding only with the infinitely small element of radius in which that stress exists, and not with the average unit-deformation of the whole radius.

The formulas below have been deduced for calculating the allowances required for shrinkage fits with given stresses. Let

T_1 = true tangential compressive stress at outer surface, inner member.

T_2 = true tangential tensile stress at inner surface, outer member,

R_1 = radius of fit.

R = actual internal radius of outer member before expansion.

R' = actual external radius of inner member before compression,

$$S = \text{unit shrinkage-allowance} = \frac{R' - R}{R},$$

The values of C for various diametral ratios are given, for solid steel shafts with steel or cast-iron hubs in Table III; and, similarly, for hollow steel shafts, in Tables IV and V.

The modulus of elasticity for steel is assumed as 30,000,000, and for cast iron as 15,000,000. Then, for a cast-iron hub and a steel shaft:

$$S = \frac{T_2\,(2 + C)}{30{,}000{,}000} \qquad (22)$$

$$S = \frac{T_1(2 + C)}{C \times 30{,}000{,}000} \qquad (23)$$

and, for both hub and shaft of steel:

$$S = \frac{T_2\,(1 + C)}{30{,}000{,}000} \qquad (24)$$

$$S = \frac{T_1\,(1 + C)}{C \times 30{,}000{,}000} \qquad (25)$$

Calculating Shrinkage Fits

In designing shrinkage fits, there are but two main principles to remember. First, the stress in the hub at the bore, which is the most important consideration, depends chiefly on the shrinkage-allowances. If the latter be too large, the elastic limit will be exceeded and permanent set will occur; or, in extreme cases, the ultimate strength of the metal will be passed and the hub will burst. Second, the intensity of the grip of the fit, and hence the resistance of the latter to slip, depends mainly on the thickness of the hub. The greater this thickness, the stronger the grip, and *vice versa*. The information required in designing can be obtained as follows:

a. For a given allowance per inch of diameter, the true tensile stress T_2 in the hub at the bore can be found from Equations (22), or (24). These equations hold only up to the elastic limit. It will be seen that by increasing or de-

TABLE IV

Values of Ratio C for hollow steel shafts of external and internal diameters D_1 and D_0, respectively, and steel hubs of nominal external diameter D_2.

$\frac{D_2}{D_1}$	$\frac{D_1}{D_0}$	C	$\frac{D^2}{D_1}$	$\frac{D_1}{D_0}$	C
1.5	2.0	0.455	2.8	2.0	0.820
	2.5	0.357		2.5	0.645
	3.0	0.313		3.0	0.564
	3.5	0.288		3.5	0.519
1.6	2.0	0.509	3.0	2.0	0.842
	2.5	0.400		2.5	0.662
	3.0	0.350		3.0	0.580
	3.5	0.322		3.5	0.533
1.8	2.0	0.599	3.2	2.0	0.860
	2.5	0.471		2.5	0.676
	3.0	0.412		3.0	0.591
	3.5	0.379		3.5	0.544
2.0	2.0	0.667	3.4	2.0	0.876
	2.5	0.524		2.5	0.689
	3.0	0.459		3.0	0.602
	3.5	0.422		3.5	0.555
2.2	2.0	0.718	3.6	2.0	0.888
	2.5	0.565		2.5	0.698
	3.0	0.494		3.0	0.611
	3.5	0.455		3.5	0.562
2.4	2.0	0.760	3.8	2.0	0.900
	2.5	0.597		2.5	0.707
	3.0	0.523		3.0	0.619
	3.5	0.481		3.5	0.570
2.6	2.0	0.793	4.0	2.0	0.909
	2.5	0.624		2.5	0.715
	3.0	0.546		3.0	0.625
	3.5	0.502		3.5	0.576

* Address: Gwynedd Valley, Pa.

† William Ledyard Cathcart was born in Mystic, Conn., in 1855. He was educated in the the University of Pennsylvania and the U. S. Naval Academy. Following graduation from the Naval Academy he served sixteen years as an officer of the Engineering Corps of the U. S. Navy. During the Spanish-American War he volunteered for service, was appointed Chief Engineer, U. S. Navy and was ordered to special duty at the Navy Department, Washington, on the staff of Admiral Melville, then engineer-in-chief. He spent two years as professor of marine engineering at Webb's Academy of Naval Architecture and Marine Engineering, Fordham Heights, New York; four years as adjunct professor of mechanical engineering, Columbia University; seven years as treasurer of a textile manufacturing company; five years with the Babcock & Wilcox Co., New York, translating, collating and analyzing scientific data from French and German sources. Prof. Cathcart is the author of "Machine Design: Fastenings" and co-author with Prof. J. Irvin Chaffee of "The Elements of Graphic Statics."

creasing the allowances, any stress up to this limit can be produced at the bore, and this stress will be the maximum tensile stress in the hub.

b. Equation (3) and Table I show the relation between the true tensile stress in the hub at the bore and the radial pressure on the fit. There are several factors which govern the intensity of this radial pressure: the magnitude of the allowances, the compressibility of the inner member, and the expansibility of the outer. The two latter depend on the metals; the last is affected by the thickness of the hub.

c. When T_2 is known, the value of P_1 can be obtained from Table I.

d. The true tangential compressive stress T_1 at the outer surface of the inner member is usually of minor importance in design. The true radial compressive stress at the surface is equal to the radial pressure P_1 minus the product of ϕ_1 by the value of t_1, as given by (4) and (10).

e. At the bore of a hollow shaft, the radial pressure is zero. Equation (9) gives the true tangential compressive stress.

f. The intensity of the apparent stresses is, in general, of academic interest only.

Example 1.—A steel crank-web, 15 inches least outside diameter, is to be shrunk on a 10-inch solid steel shaft. Required the allowance per inch of shaft-diameter to produce a maximum tensile stress in the crank of 25,000 pounds per square inch, assuming the stresses in the crank to be equivalent to those in a ring of the diameter given.

$\frac{D_2}{D_1} = \frac{15}{10} = 1.5$; $T_2 = 25{,}000$. From Table III, $C = 0.227$.

Substituting in Equation (24), we find $S = 0.001$ inch.

TABLE V

Values of Ratio C for hollow steel shafts and cast-iron hubs. Notation as in Table IV.

$\frac{D_2}{D_1}$	$\frac{D_1}{D_0}$	C	$\frac{D_2}{D_1}$	$\frac{D_1}{D_0}$	C
1.5	2.0	0.468	2.8	2.0	0.864
	2.5	0.368		2.5	0.679
	3.0	0.322		3.0	0.594
	3.5	0.296		3.5	0.547
1.6	2.0	0.527	3.0	2.0	0.888
	2.5	0.414		2.5	0.698
	3.0	0.362		3.0	0.611
	3.5	0.333		3.5	0.562
1.8	2.0	0.621	3.2	2.0	0.909
	2.5	0.488		2.5	0.715
	3.0	0.427		3.0	0.625
	3.5	0.393		3.5	0.576
2.0	2.0	0.696	3.4	2.0	0.926
	2.5	0.547		2.5	0.728
	3.0	0.479		3.0	0.637
	3.5	0.441		3.5	0.587
2.2	2.0	0.753	3.6	2.0	0.911
	2.5	0.592		2.5	0.740
	3.0	0.518		3.0	0.617
	3.5	0.477		3.5	0.596
2.4	2.0	0.798	3.8	2.0	0.953
	2.5	0.628		2.5	0.749
	3.0	0.549		3.0	0.656
	3.5	0.506		3.5	0.603
2.6	2.0	0.834	4.0	2.0	0.964
	2.5	0.656		2.5	0.758
	3.0	0.574		3.0	0.663
	3.5	0.528		3.5	0.610

Example 2.—Let the shaft in Example 1 have a 5-inch axial hole bored through it, other conditions being the same. Find the unit-allowance.

$\frac{D_2}{D_1} = 1.5$, as before; $\frac{D_1}{D_0} = \frac{10}{5} = 2$; $T_2 = 25{,}000$. From Table IV we find $C = 0.455$.

Substituting in Equation (24), we find $S = 0.0012$ inch, the increase in the allowance being due to the fact that the hollow shaft is the more compressible of the two.

Example 3.—Let the crank-web in Example 1 be of cast iron and the maximum tensile stress in the hub be 4000 pounds per square inch. Find the unit-allowance.

$\frac{D_2}{D_1} = 1.5$; $T_2 = 4\,000$. From Table III, we find $C = 0.234$.

Substituting in (22) $S = 0.0003$ inch, which, owing to the lower tensile strength of cast iron, is about one-third of the shrinkage-allowance in Example 1, although the stress is two-thirds of the elastic limit. For a forced fit, good practice gives (see Table VI) a unit-allowance of 0.0013 inch, or one-third greater than that of Example 1. The stresses which such an allowance would produce are, however, uncertain, as will be further discussed in the following.

TABLE VI. ALLOWANCES FOR FORCED FITS

Steel Shaft and Pin to Cast-iron Cranks. Average pressure required = 12.5 tons (of 2000 pounds) per inch of diameter.		Steel Shaft to Cast-iron Wheel-hubs. Average pressure required = 10 tons (of 2000 pounds) per inch of diameter.	
Diameter of Shaft, Inches	Allowance per Inch of Diameter	Diameter of Shaft, Inches	Allowance per Inch of Diameter
4	0.0030	12	0.0010
5	0.0024	13	0.0009
6	0.0020	15	0.0008
7	0.0017	17	0.0007
8	0.0015	18	0.0006
9	0.00135	19	0.00055
10	0.0013	22	0.0004
11	0.0012	23	0.00035
12	0.0010	24	0.0003
13	0.0010	26	0.00025
14	0.0010	27	0.0002
15	0.0010	...	......
16	0.0009	....	.....
18	0.0008	....	.....
20	0.00075	....	......

Example 4.—What is the radial pressure P_1 in the above examples?

For Examples 1 and 2, we find from Table I that $\frac{P_1}{T_2} = 0.341$.

Hence,

$P_1 = 25{,}000 \times 0.341 = 8525$ pounds per square inch.

For Example 3, we find from Table I that $\frac{P_1}{T_2} = 0.351$. In this case $T_2 = 4000$, hence

$P_1 = 4000 \times 0.351 = 1404$ pounds per square inch.

Example 5.—What is the resistance to slip per inch of length of hub in Example 3?

In Equation (21), $D_1 = 10$, $L = 1$, and from Example 4 we have $P_1 = 1404$; f may be taken as 0.2. Then $Q = 8817$ pounds, which is the total resistance of a ring of the hub, one inch in length.

Example 6.—Let the crank in Example 3 be 20 inches least diameter, the other dimensions and the tensile stress remaining the same. Find the increase in the radial pressure P_1, and hence that in the resistance to slip.

In this case $\frac{D_2}{D_1} = 2$, Table I gives the ratio A, for this condition equal to 0.522, which is 49 per cent greater than the ratio $A = 0.351$ for $\frac{D_2}{D_1} = 1.5$. This percentage is the increase in radial pressure, and hence, that in the resistance to slip.

Example 7.—What is the true tangential stress (compressive) at the bore of the shaft in Example 2?

The radial pressure P_1 is, from Example 4, 8525 pounds. Substituting this value, and also $R_1 = 5$, and $R_0 = 2.5$ in Equation (9), the true stress $T_0 = 22{,}733$ pounds per square inch.

Example 8.—What is the intensity of the apparent tangential stresses in the crank and shaft, Example 1?

The radial pressure P_1 is, from Example 4, 8525 pounds. Substituting this value, and also $R_2 = 7.5$, and $R_1 = 5$ in Equation (1), the apparent tensile stress t_2 at the bore of the hub is 22,165 pounds per square inch. The similar compressive stress t_1 at the outer surface of the shaft is, from Equation (10), equal to P_1.

Shrinkage Temperatures

The temperature to which the outer member in a shrinkage fit should be heated for clearance in assembling the parts, depends on the total expansion required and on the coefficient a of linear expansion of the metal, *i. e.*, the increase in length of any section of the metal in any direction for an increase in temperature of 1 degree F. The total expansion in diameter which is required consists of the total allowance for shrinkage and an added amount for clearance.

The value of the coefficient a is, for nickel-steel, 0.000007; for steel in general, 0.0000065; for cast iron, 0.0000062. As an example, take an outer member of steel to be expanded 0.005 inch per inch of internal diameter, 0.001 being the shrinkage-allowance and the remainder for clearance. Then:

$$a \times t = 0.005$$

$$t = \frac{0.005}{0.0000065} = 769 \text{ degrees F.}$$

The value t is the number of degrees F. which the temperature of the member must be raised.

Cylindrical and Tapered Fits

The form of the shrinkage fit is usually truly cylindrical and of one diameter throughout; but both forced and shrinkage fits are, for some classes of work, either tapered or double-cylindrical, *i. e.*, with part of the fit of one diameter and part of another. The advantages of the tapered form in forced fits are: The possibility of abrasion of the fitted surfaces is reduced; less work is required to drive the inner member home; the drawings may be marked "Fit pin — inches from end of hole," which is the most trustworthy way of measuring the allowances; and the parts are more readily separated, if a renewal of the fit is desired. On the other hand, the difficulty of securing with accuracy the same form for both fitted surfaces, is somewhat greater; and the tapered fit is less reliable, since, if slip begins, the entire fit is virtually free with but little movement. These advantages and disadvantages apply also, but in less degree, to the double-cylinder form.

The practice of a prominent shipbuilding company, for both forced and shrinkage fits in either iron or steel, is: With large fits, both the inner and outer members have a taper of 1/16 inch to the foot; the allowances are 0.001 inch per inch of diameter with 0.001 inch added to the total. If the conditions are such that it is more convenient to ream the hole with standard parallel reamers, the inner member is tapered one half-thousandth inch (0.0005) per inch of length, unless the fit is so long that this taper would reduce the allowance at the small end to less than one-half that at the other extremity of the fit.

Differences between Forced and Shrinkage Fits

The formulas given in this article are based upon Lamé's formulas as modified for lateral contraction according to the principles established by Clavarino; these formulas are also the basis of the ordnance formulas employed by the United States Army and Navy. For economy in weight, the stresses in the metal of a gun, at the instant of explosion, approach closely to the elastic limit. It is evident, then, that the use of these formulas for such work makes their accuracy, for shrinkage fits in gun-steel, unquestionable. So far as is known, their fundamental principles are general, and they can be employed with equal accuracy for similar fits in cast iron. It has been customary to assume that they could be applied also for the determination of the stresses in the metals of forced fits. This assumption is, in the author's opinion, unwarranted, so far, at least, as cast-iron outer members with large forcing allowances are concerned. There seems to be considerable evidence in support of this contention.

The basic principle of shrinkage and forced fits is the same, but there is a radical difference between the methods by which this principle is applied in the two cases. In the shrinkage fit, the outer member, owing to its expansion, slips freely into place, giving, in cooling, clean, smooth and accurately fitted surfaces. In forced fits, on the contrary, there may be, in forcing, more or less abrasion, and, further, if the allowances be large, there may be an axial flow of the metal of the hub in advance of the entering shaft. It should be noted that, in forcing allowances, we are dealing with a layer of metal whose thickness is, in general, but 0.001 inch per inch of diameter, so that the total volume of the metal thus displaced would be very small, while its removal with that lost by abrasion, would reduce materially the amount of the effective allowances, and, in consequence, the stresses and "grip" of the fit. Taking the elastic limit in tension of cast iron as 6000 to 7000 pounds and that of steel as 50,000 pounds, and considering the corresponding values of E, the former will endure, without permanent set, less than one-fourth the deformation of the latter, yet the forcing allowances of the two metals are often made the same, and, further, with the same metals and dimensions, some builders make the allowances for forcing considerably greater than those for shrinkage fits. In such cases, there must be either permanent set in the cast-iron hub, or the effective allowances must be materially lessened by abrasion, displacement, or both.

In Professor Wilmore's tests, the average resistance of the shrinkage fit to slip was, for an axial pull, 3.66 times greater than that of the forced fit, and, in rotation or torsion, 3.2 times greater. In each comparative test, the dimensions and allowances were the same for both. These results imply either permanent set or considerable abrasion or displacement of the metal of the forced fit. While these experiments were made on a small scale, they agree with the general estimate of the comparative strength of forced fits.

Table VI represents the practice of one of the largest builders of engines and other machinery in the United States, in forcing cast-iron cranks and wheel-hubs on steel shafts. The allowance for a crank is greater than that for a wheel-hub, and, with both, the allowance per inch of diameter decreases with increasing diameter. Take the unit-allowance for a 12-inch wheel-hub which is 0.001 inch. Assume the ratio of the external diameter of the hub to that of the shaft (solid) as 1.8, which gives a hub-thickness of 4.8 inches. In Equation (22), $S = 0.001$, and, from Table III, $C = 0.311$, then the true tensile stress T_2 at the bore of the hub is about 13,000 pounds, or twice the elastic limit of cast iron. Again, we have here indications of permanent set, excessive abrasion, or very considerable displacement of the metal, so that the effective allowances cannot be those initially given.

Finally, the following formulas given by Mr. Stanley H. Moore may be cited. In these formulas, d denotes the total allowance, and D is the diameter of the shaft, in inches.

Shrinkage fit $$d = \frac{\frac{17}{16} D + 0.5}{1000}$$

Forced fit $$d = \frac{2D + 0.5}{1000}$$

These formulas show again a much greater allowance for forcing than for shrinkage.

Forced fits may be made by levers, screw-jacks, or hydraulic pressure, the latter being the most common. In the drive-fit, the pin is sent home by sledges; the allowances are usually about half that of a forced fit. With these various methods and the many purposes for which forced fits can be used, it is natural that the custom as to the amount of the allowances should differ, as it does, very widely, so that the practice cited here is not universal. The purpose of this discussion has been simply to point out that shrinkage formulas will not give with accuracy the stresses in a cast-iron hub, when the allowances are very large, or in any forced fit with undue allowances. Such a fit differs essentially from the shrinkage joint for which the formulas were constructed.

Cotterill says in his "Applied Mechanics," London, 1895, page 412: "When the limit of elasticity is overpassed, the formula (Lamé's) fails, and the distribution of stress becomes different. If the pressure be imagined gradually to increase until the innermost layer of the cylinder begins to stretch beyond the limit, more of the pressure is transmitted into the interior of the cylinder, so that the stress becomes partially equalized. If the pressure increases still further, the tension

of the innermost layer is little altered, and, in soft materials, longitudinal flow of the metal commences under the direct action of the fluid pressure. The internal diameter of the cylinder then increases perceptibly and permanently. This is known to happen in the cylinders employed in the manufacture of lead piping, which are exposed to the severe pressure necessary to produce flow in the lead. The cylinder is not weakened but strengthened, having adapted itself to sustain the pressure. Cast-iron hydraulic press cylinders are often worked at the great pressure of 3 tons per square inch, a fact which might be explained by a similar equalization."

TABLE VII. EXAMPLES OF TYPICAL FITS, FROM PRACTICE

Diameter of Pin or Shaft, Inches	Total Allowance, Inches		Metals
	Shrinkage	Forcing	
1.8798	....	0.0031	Shaft, steel. Hub, cast iron
4 2505	....	0.0103	Shaft, steel. Hub, cast iron
8.9	....	0.0152	Shaft, steel. Hub, cast iron
4 to 5	0 0045	0.0090	Cast iron crank
7.5 to 9	0.0027	0.0055	Cast iron crank
16 to 18	0.0015	0.0030	Cast iron crank
4	....	0.0120	Crank, cast iron. Shaft, steel
8	....	0.0120	Crank, cast iron. Shaft, steel
16	....	0.0144	Crank, cast iron. Shaft, steel
1 to 2	0.0090	0.0010	
4 to 6	0.0156	....	
5 to 7	....	0.0050	
9 to 12	0.0313	....	
10 to 12	....	0.0100	
5	....	0 0050	Shaft, steel. Crank, cast steel
5	....	0.0100	Shaft, steel. Crank, cast iron
11	0.0070		Cast iron counter-balance
13	0.0060		plates on steel crank-disks

Forcing Pressure

When the fit is cylindrical, the forcing pressure varies as the rate of advance of the inner member, reaching a maximum in continuous forcing when the pin or shaft is at the inner end of the hole. At this point, the pressure is theoretically equal to Q, the resistance to slip, as given in Equation (21), the coefficient of friction f being probably between 0.12 and 0.2, although it may vary widely. Tables VI and VIII give values of the forcing pressure, as found in practice. The assumption above, that the maximum forcing pressure is equal to the resistance to slip, is true only if that pressure is expended wholly in overcoming the obstruction to motion produced by the resistance of the outer member to expansion, and of the inner to compression. If there is abrasion of the surfaces, or axial displacement of the metal in advance of the entering member, the assumption is not fully justified.

Applications in Practice

Railway Work. In railway work, steel tires are shrunk on the cast-iron wheel-centers of driving wheels. The fit is cylindrical; a common, although not universal, shrinkage-allowance is 0.001 inch per inch of diameter of the finished wheel. Forced fits are used for securing wheels to axles and crank-pins to driving wheels. In wheel-fits, the joint is cylindrical; the pressure is usually 9 to 10 tons per inch of diameter of fit. In removing a wheel after long service, the total pressure may reach 150 tons.

Stationary Engines. Shrinkage and forced fits—the latter more frequently—are used for crank-pins, cranks, wheel-hubs, and minor parts. With different builders, the amount of the unit-allowance has a wide range, owing to differences in the thickness of hubs, the forcing pressure employed, etc. General practice seems to favor a smaller allowance for shrinkage than for forcing, and, with increasing diameter, a decreasing unit-allowance. The latter is usually greater for cast iron than for steel. Table VII, which gives the data for typical fits from different builders, shows the variation in practice. In Table VIII will be found complete data for forced fits from 2 to 9 inches in diameter.

Marine Engines. In marine work, built-up crank-shafts are assembled and the casings of propeller shafts are secured by shrinkage fits. Forced fits have been employed for crank-shafts and are frequently used for smaller parts. In building up a steel shaft, the allowance is usually 0.001 inch per inch of diameter; the cranks and crank-pins are keyed, in addition to the shrinking. The crank-webs are heated by gas in a sheet-iron furnace until the expansion is sufficient for a free fit; they are then removed, the pin is pushed home and keyed, and the webs and pin are cooled with water. The webs are then set with the bores for the shaft vertical, and one is heated as before until sufficiently expanded, when the section of the shaft is lowered into place and keyed; the same method is followed with the other section of the shaft.

Shaft casings are of bronze, usually from ⅝ inch to 1 inch thick at various sections of the shaft. In one case there were two such sections of casing, each 8 feet long and 20½ inches internal diameter. The shrinkage-allowance, total, was 0.013 inch, or 0.000634 inch per inch of diameter. Each section was set vertical and heated internally by gas. When expanded, it was slipped in place on the shaft, and the inner end was held firmly and cooled with water until it gripped the shaft.

Gun Construction. When a charge is exploded in the powder-chamber, the principal stress to which a gun is subjected is that due to the radial pressure of the gases which tends to burst it on an axial plane. This stress produces tangential (circumferential) tension in the tube, jacket, and hoops, and, in addition, there is a direct longitudinal stress in the layer of the tube in which the breech-plug houses. There also exists at all times, except during explosion, a radial compressive stress on the inner cylinders of the system, due to the shrinkage pressures of those outside of them. At the breech, there may be three or four of these superposed cylinders—the tube, the jacket, and one or two sets of concentric hoops. The radial pressure of the gases would produce in the tube, if the latter were unsupported, a circumferential tensile stress which would exceed the elastic limit of the metal. To counteract this, the jacket and hoops are shrunk on, each of these cylinders putting the one which it encases under compression, and the aggregate of these radial pressures being transmitted to the tube. The actual tensile stress in the latter, during the burning of the powder, is then the difference between the tensile stress developed by the gases and the compressive stress due to the jacket and hoops—a remainder which is less than, but usually fairly close to, the elastic limit of the metal.

TABLE VIII DATA FOR FORCED FITS, FROM PRACTICE

Mean Diameter of Pin, Inches	Length of Fit, Inches	Mean Diameter of Hole, Inches	Total Allowance	Allowance per Inch of Diameter	Area of Fitted Surface, Square Inches	Volume within Fitted Surface, Cubic Inches	Pressure to Enter Pin, Tons	Pressure at Mid-Position, Tons	Maximum Pressure, Tons
1.8798	6.125	1.8767	0 0031	00.0170	36.0	16.7	2	10	20
1.8819	6.125	1.8770	0.0042	0.00220	36.0	16.7	2	15	23
1.8774	4.375	1.8764	0.0010	0.00052	24.4	13.7	0.5	1	1
2.7455	4.500	2.7387	0.0068	0.00247	38.7	26.5	3	12	25
2.7465	4.500	2.7437	0.0028	0.00100	38.7	26.5	5	12	23
3.2610	5.000	3.2542	0.0068	0.00210	51.0	41.5	5	20	45
3.2625	5 000	3.2555	0.0070	0.00200	51.0	41.5	5	15	30
3.2670	5.000	3.2610	0.0060	0.00180	51.0	41.5	5	15	20
4.2505	6.000	4.2402	0.0103	0.00240	79 8	85.1	5	22	44
4.2388	6.625	4.2478	0.0091	0.00210	78 1	93.4	12	30	60
4.2303	6.500	4.2224	0.0079	0.00190	95.8	91.0	10	60	125
5.9343	4.062	5.9216	0.0127	0.00220	75.7	112.2	6	16	25
5.9381	4.000	5 9252	0 0129	0.00220	74.4	110.4	3	18	35
5.9294	4.125	5.9194	0.0100	0.00170	76.7	113.8	5	15	25
6.8829	5.125	6.8697	0.0132	0.00200	110.7	190.1	8	20	42
6.8890	5.000	6 8785	0.0105	0.00150	108.0	185.9	5	22	45
6.8692	4.875	6 8550	0.0142	0.00210	104.8	180.4	5	35	65
7.8884	5.500	7.8730	0.0154	0.00200	135.9	267.3	5	32	64
7.8715	6.500	7 8575	0.0140	0 00180	160.5	315.9	5	25	50
7.8620	5.625	7.8460	0 0160	0.00200	138.2	272 8	8	40	80
8.9240	6.125	8.9050	0 0190	0.00210	170.8	378.9	20	45	68
8.9000	6.750	8.8848	0.0152	0.00170	188.4	419 9	5	47	96
8.8780	6.500	8.8669	0.0112	0.00130	180.7	401.0	10	45	92

For maximum economy of material, the relations of the

thicknesses and shrinkage-allowances should be such that the stresses at all points in the walls of the built-up gun will be, during explosion, not only approximately equal but also the greatest permissible, with due regard to the elastic limit and the factor of safety. The outer layers of the metal are, therefore, in a state of initial tension, the inner under initial compression, and during explosion all are in tension. The principles involved are those which have been treated herein for shrinkage fits, with the added requirement that the superposed cylinders, during explosion and the subsequent release from pressure, must expand and contract together, so that each cylinder must have a definite shrinkage-allowance with regard to all the others of the system.

* * *

RULES FOR THREADING SQUARE THREAD TAPS

One of the New England tap makers, in cutting the threads in square-threaded taps, makes them according to the rules below: The width of the groove between two threads is made equal to one-half of the pitch of the thread less 0.004 inch. The width of the thread itself is made equal to one-half of the pitch plus 0.004 inch. The depth of the thread is made equal to 0.45 times the pitch plus 0.0025 inch. This latter rule provides for a thread which for all the ordinarily used pitches for square-threaded taps has a depth less than the generally accepted standard depth, this latter depth being equal to one-half the pitch. The object of this "shallow" thread is to insure that if the hole to be threaded by the tap is not bored out so as to provide clearance at the bottom of the thread —something that ought to be provided, but which is not always done—the tap will cut its own clearance. This method of obtaining the clearance is not, perhaps, a very desirable one, as it is much simpler and better to drill the hole to be tapped the required amount over-size. It is of course assumed that this is done in the majority of cases, but when neglected, the dimensions here given for the depth of the thread in the tap insure that a reasonable amount of clearance will always be provided.

* * *

An indication of the advance of China in engineering matters is afforded by the establishment in Pekin of a school for training railway officials and engineers. The equipment provides for 600 students, the present number being 350. The full course is three years, the students varying in age between 18 and 25. Among the instructors are one American, one Englishman, two Frenchmen and two Germans, the remaining twenty-four being Chinese who have been educated abroad.

DIE-CASTING AND DIE-CASTING MACHINES*

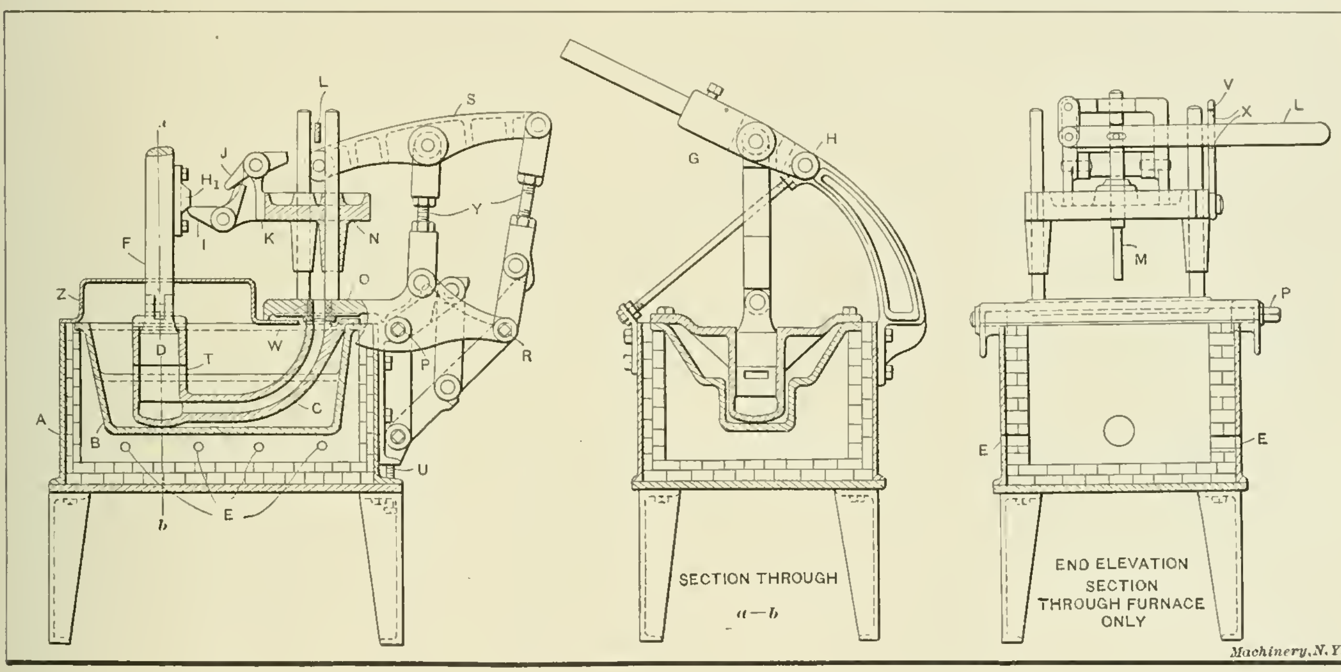
By A. W. CHRISTIANSON†

A. W. Christianson‡

The subject of die-casting is one about which comparatively little is known by the majority of mechanics. In the following article a simple method for making die-castings is explained, and one of the best machines for casting white metal, or for making "pressure castings," as they are often called, is described. The accompanying illustration shows cross-sectional elevations of the machine, which so far as the writer knows is the latest design of die-casting machine in practical use. No skill is required to operate it; an ordinary laborer can learn how to do it in a very satisfactory way in a short time. When the dies are small and there are only two or three levers to be handled, one man can operate the machine advantageously. But when larger dies are used and a number of levers must be handled, it is more economical to employ two men at the machine.

It is important, however, that only one man control the injection of the metal into the dies. This is a very essential point, because two men cannot produce exactly the same results for every pouring. Uniformity in the control of the injection of the metal is one of the basic points in white metal die-casting.

In designing a die-casting machine, it is necessary to so arrange it that the metal will be handled as little as possible, as otherwise part of the metal would oxidize and be wasted. The molten metal should be covered so that the air will not strike it more than is absolutely necessary. In the machine



Die-casting Machine of the Latest Design

* See MACHINERY, January and February, 1911: "Die-casting."

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shown in the accompanying illustration, the metal comes into contact with the air only at the nozzle, where it is injected into the die. It may be argued that this would have a detrimental effect on the casting, but experience has shown that it does not; the reason for this is that the surface which comes in contact with the air is so small in comparison to the amount of metal that is pressed out each time, that the few seconds during which the air comes into contact with the surface is not enough to have any serious effect. This is particularly true in the case of large castings. In the case of small castings the metal is poured so much oftener that the surface of the metal at the nozzle is not in contact with the air long enough to injure the casting.

The design of the die-casting machine is, briefly, as follows: In the accompanying illustration *A* is a gas furnace made by the American Gas Furnace Co., 24 John St., New York, this furnace being one of the standard sizes. At *E* are shown the gas burners, four being placed on each side of the furnace. The metal is melted in the pot *B*, and the gas burners can be so controlled that the heat can be directed toward any part of the melting pot. This pot is made of cast iron, and it can be replaced by one of the standard sizes made by the American Gas Furnace Co., at very little cost, when burnt out. The life of the pot depends upon the metal used for making the die-castings. If the metal requires a high degree of heat for melting, the receptacle naturally will not last so long as when less heat is required for melting.

At *C* is shown the part forming the nozzle which is connected to a cylinder in which the metal is compressed by means of the plunger *D*. When the plunger descends, the metal is pressed or pushed out through the nozzle *C*, which is tube-shaped as shown in the illustration. At *F* is shown a connecting-rod which is operated by means of the handle *G* having its fulcrum at *H*. A dog or trip H_1, fastened to the connecting-rod *F*, operates the lever *I* which, in turn, moves the lever *J*, both of these levers being mounted on bracket *K*. The lever *J*, in turn, operates the handle *L*. To the handle *L* is attached a rod *M*, called a "sprue cutter." The part *V* acts as a stop for the motion of lever *L*, this motion being limited between the points *X*. The stop *V* swings out of the way for lever *L*, when the core is being pushed out of the casting.

The dies are fastened between the plates *N* and *O*. The plate *O* is hinged at *P*, and the shaft passing through the lever at *P* is squared on the end as shown, so that a handle may be put on the shaft. In this way plate *O* can be swung away from the nozzle, thus allowing the die to swing away from the furnace through an angle of about 45 degrees. This uncovers nozzle *C*, permitting the pushing out of the so-called "core," which is formed at every pouring. It is advisable to have the core as small as possible, but, of course, the size of the core depends very largely on the size of the casting. When the die-plates are swung away from the nozzle, the operator chills the core by means of compressed air blown through a rubber tube, and when this is done the core is forced out by a forward push of the handle *L*, which at that moment operates the sprue cutter *M*. This action releases the core which is slightly tapered in order that it may be easily removed.

The next operation is to separate the two plates *O* and *N*, thus opening the die, one-half of which is held on the plate *N* and the other on the plate *O*. The die-plates *N* and *O* are separated by operating a handle placed on shaft *R*, which through a set of connecting links and the arm *S* separates the two plates. At *Y* adjustment is provided for setting the two plates properly for any size of die. The top of the furnace is covered by a sheet-iron lid *Z*, lined with asbestos. This cover is left on all the time when the heat is on or when the metal is melted, so as to prevent the latter from coming into contact with the air.

At *T* is a slot in the pressure cylinder through which the molten metal runs into the cylinder before being pressed into the die. The screw *U* serves the purpose of adjusting the nozzle, so as to get it perfectly tight. This is an important factor, as is also the cleaning of the nozzle, which should be done after every pouring, by the operator. This takes but a moment's time and makes it possible to obtain good results. Many times the neglect of this precaution has made it difficult to obtain good castings.

When the die is open ready to eject the casting, the operator takes the air hose and chills off the casting for a moment. Then he grasps the handle connected to the ejecting pins in the die, and puts one hand under the edge of the die, when a push of the handle makes the piece or pieces fall into the hand of the operator. The air hose is again used for cleaning the die. The reason for this is that after every pouring there is, due to the pressure, a small fin formed on the face of the die, and this must be removed before casting another piece. Blowing the air over the face of the die removes it easily. After the die is cleaned and again closed, plate *O* is closed down over the nozzle and everything is ready for the next pouring. All the operations described require but a part of a minute, especially when the machine and dies are small and light. When a larger machine and larger dies are used, the work cannot be done so rapidly, but will be in proportion to the size and design of the pieces to be cast.

Many experiments have been made to obtain a strong and durable metal for die-castings. When making small parts for machines which require high tensile strength, great care must be exercised to obtain a strong metal and one that flows easily, because when the metal flows easily it is possible to obtain a solid casting. The mixing of the metal must be done in a careful manner, because white metal is very treacherous, and carelessness at this time makes it difficult to obtain good castings. The metal must be carefully handled, and care taken to see that it is not too hot when casting. If it is too hot, the operator will have difficulty in obtaining good sound castings.

The dies should be heated slightly before beginning the casting. This is done by closing the die and also closing the plate *O* lightly against the nozzle while the metal is melting. The die will then be of the right temperature for starting the work when the metal is melted. Care should also be taken to keep an even heat in the furnace, so that the temperature of the metal is the proper one for obtaining solid castings. This can be done only by a man experienced in white-metal casting. The metal should not be put into the pot in "pigs," as this chills the melted metal in the pot and causes difficulties. Instead a small furnace should be used alongside of the machine for melting the metal. This melting can be done at a slow heat which is, in itself, a good thing for white metal. When more than one man works the machine it is difficult to obtain castings without blow-holes. A casting may look good on the outside, and when broken may show such defects as to make it useless for the purposes for which it is intended.

* * *

CONSTANT ATTENTION REQUIRED FOR AUTOMATIC MACHINES

Constant attention is required by most automatic machinery to supply stock, correct defects of feed, flow of lubricant, clogging of parts, etc. Some time ago a concern having a department equipped with automatic machines which was kept tuned up to a high efficiency, determined to make a test to find out to what extent the machines were actually automatic. The operators were instructed to leave their machines running during the noon hour with the hoppers supplied with blanks, and were promised full pay for the extra production. One attendant was left in charge of the running machines with instructions to do absolutely nothing except to shut down machines that clogged or went wrong in any particular. He did as told, keeping close watch and throwing the shifters of the machines as soon as they balked. The result of the test, which continued for several consecutive noon hours, was that practically every machine was stopped before 1 o'clock. The operators had the entire forenoon to get their machines in good working condition, but nevertheless automatic performance for one full hour was beyond their capability.

* * *

Some people have too much wish-bone and not enough backbone to get far in the world.

MILLING CUTTERS AND THEIR EFFICIENCY*

The amount of metal which a machine tool can remove in a given time is limited by the strains caused by the cut, and while it is possible to increase the driving power indefinitely, and almost any amount of metal can be put into machine elements to give them rigidity, there are certain classes of machines where practical considerations limit such increase of power and strength. This is especially true in machines where the main elements must be adjusted frequently; the knee-and-column type of milling machine owes its success in a large measure to the ease and rapidity with which it can be manipulated. In order to increase the capacity of this type of milling machine, it becomes necessary to reduce the strains set up by the cut. To accomplish this result, there are only two elements which can be modified; these are the hardness of the metal to be cut and the cutting qualities of the milling cutter. The latter is the only controllable avenue for improvement.

This article is the outcome of an extended series of tests, carried on at the works of the Cincinnati Milling Machine Co.,

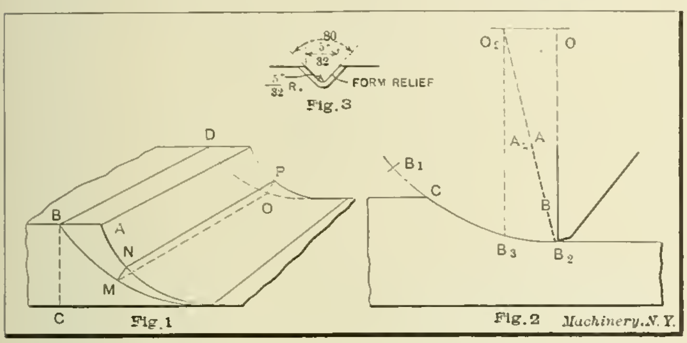


Fig. 1. Metal Chip assumed to be produced by Milling Cutter without Distortion. Fig. 2. Diagram to illustrate Action of Milling Cutter. Fig. 3. Detail View of Chip Breaker

on spiral mills, end mills, side mills, slitting saws, face mills, and a new type of mill which, for lack of a better name, will be called a "helical mill."

The ordinary milling cutter does not give a true cutting action, for by this term is meant the driving of a wedge-shaped tool between the work and the chip. In a milling cutter the tooth compresses the metal until it produces a strain great enough to cause a plane of cleavage at some angle with the direction of the cutter; it then begins to compress a new piece, push it off, and so on. This at least seems to be the action of the cutter, judging from the form of the chips. If no compression occurred, the milling chip would appear as in Fig. 1, which is very much exaggerated for illus-

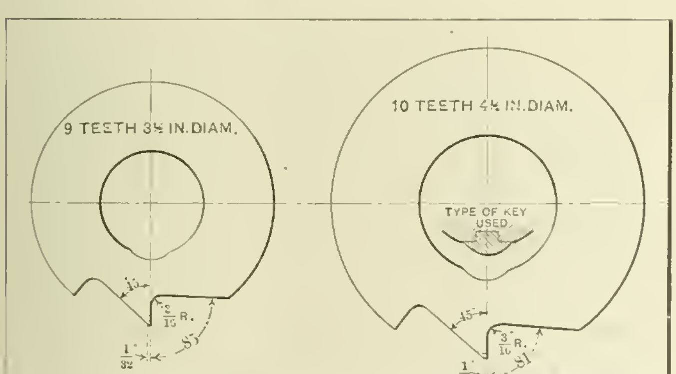


Fig. 4. Form of Spiral Milling Cutters now used by the Cincinnati Milling Machine Co., showing Wide Spacing, Large Arbor, and Form of Key Recommended

trative purposes. AB is the feed per tooth, BC depth of cut, and BD the width of cut. The normal section $MNOP$ is a measure of the amount of work done by the cutter when passing the point M.

Fig. 2 shows the action of a milling cutter with center O, when the cutter is rotating and the work is being fed simultaneously. The tooth AB sweeps the path BC; when the point B has reached the position B_1 a new tooth begins to cut, but by this time O has advanced to position O_2 and the new tooth A_2B_2 is not yet in a vertical position when the point B_2 touches the work. When the cutter revolves, this point B_2 must penetrate into the work and compress the metal, result-

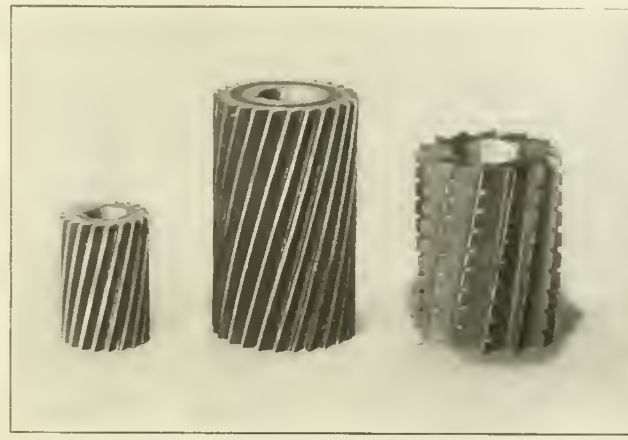


Fig. 5. Comparison of Old- and New-style Spiral Mills

ing in the springing of the arbor. When this spring has assumed certain proportions, the tooth begins to remove a chip; this may be assumed to be at position B_3, the tooth simply gliding over the work from B_2 to B_3. It is believed that this, perhaps more than any other action of the cutter,

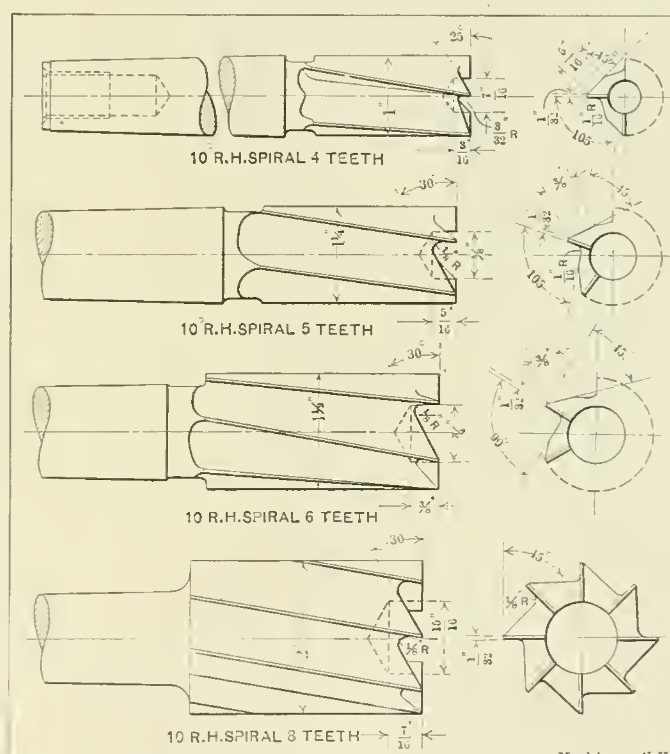


Fig. 6. New Type of Taper-shank End Mills

causes its dulling; this peculiar action of the milling cutter is inherent in its construction and cannot be avoided.

Another feature tending to limit the ability of a milling cutter to remove metal is the proportion between the chip to be removed and the amount of space between two adjoining teeth. This was emphasized to the writer when a very powerful machine stalled on a comparatively light cut; upon examination it was found that the amount of metal removed per tooth was sufficient to fill the chip space completely, and from that moment the action was like trying to push a solid bar of steel through a piece of cast iron.

These conditions have led to the gradual evolution of spiral milling cutters. In Fig. 4 are shown the spacings adopted for the new style of wide space milling cutters, now used by the Cincinnati Milling Machine Co., while Fig. 5 gives a graphic comparison between the two. Experiments made with cutters of this type show that the amount of metal

* Abstract of paper presented before the Spring meeting of the American Society of Mechanical Engineers, by Mr. A. L. DeLeeuw, Mechanical Engineer, Cincinnati Milling Machine Co., Cincinnati, O.

capable of being removed for the same expenditure of power and on the same machines, is very materially increased. In connection with these cutters, attention should be drawn to the fact that present practice calls for arbors too small; in the cutters shown, the 3½-inch is made with 1½- and 1¾-inch arbors, and the 4½-inch with 1¾- and 2-inch arbors.

Another important feature determined from experiment was that, for roughing on ordinary work in the shop, a cutter

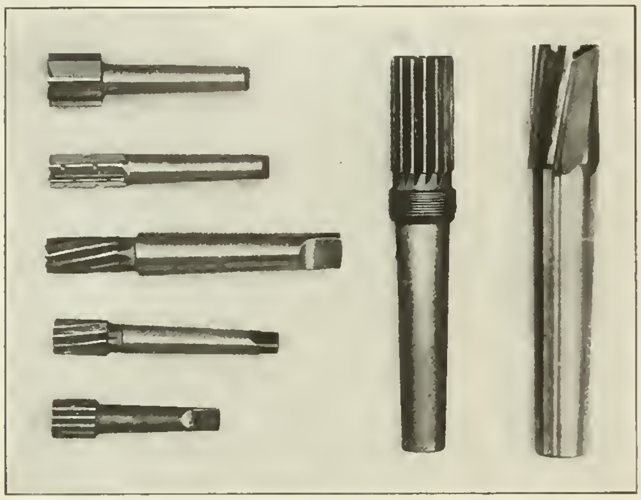


Fig. 7. Comparison of Old- and New-style End Mills

with the wider-spaced teeth would remain sharp for a longer period, notwithstanding increased feeds. A further advantage is that only about one-half the time required for sharpening what is now considered a standard cutter, is required owing to the number of teeth being about half. This same feature

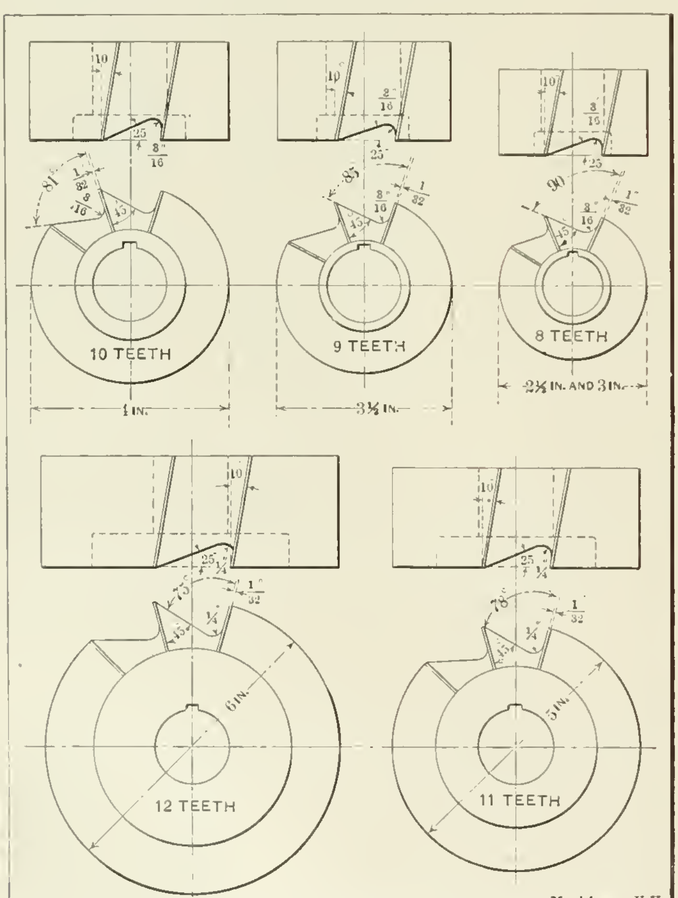


Fig. 8. New Type of Spiral Shell Cutters

makes it possible to sharpen the cutter more frequently owing to the body of the tooth.

These wide-spaced cutters were originally intended for roughing-out operations only, but the very satisfactory finish obtained when roughing led to their adoption for finishing purposes as well. In this connection it might be mentioned that for finishing alone it is generally believed that a milling cutter should be used without chip breakers, as the latter tend to scratch the surface. To overcome this trouble, chip breakers were made, as shown in Figs. 3 and 5, with clearance at both corners; this prevents the tearing up of metal, with the result that a cutter with these breakers produces as good a finish as one without them. One of the great advantages of this form of chip breaker is that one gang can be used for both roughing and finishing.

It is a common belief that a better finish is obtainable with teeth closely spaced, but experience with the wide-spaced cutter shows that there is no ground for this assumption, for the marks on the work are not due to the indentation left by the successive teeth, but are revolution marks which it is practically impossible to eliminate. These are due to the cutter not being concentric, the arbor being slightly out of

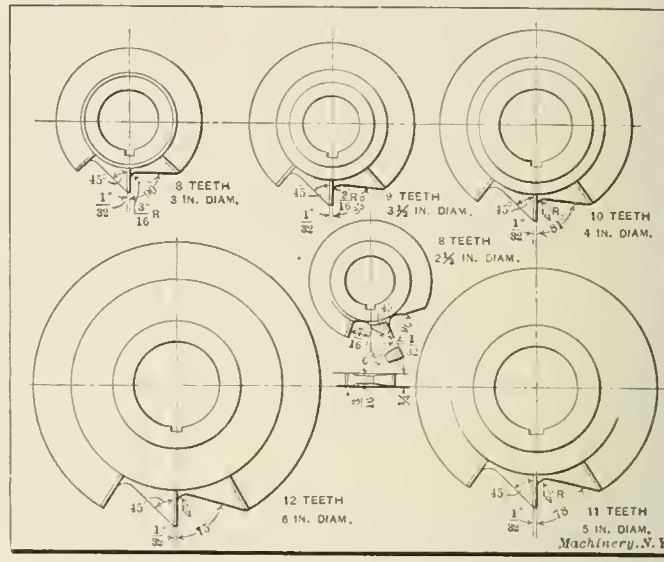


Fig. 9. New Type of Side Mills with Detail of Tooth Construction

true, or one of many trifling errors which, accumulated, make the shallow groove noticeable. This was proved by putting cutters of each type on the same arbor and taking cuts, when it was found that the marks corresponded. Following this, on each of the cutters all but one tooth were ground away so as not to cut, and the surface produced by these one-tooth cutters presented the same appearance as those just previously obtained.

Fig. 6 shows the end mills now considered standard by the company, and Fig. 7 shows them in comparison with the old style. Similarly, Fig. 8 shows the new type of spiral shell cutters, and Fig. 9 the new type of side mills, the center cutter of this group showing the general characteristics of the tooth.

Face mills have undergone a gradual evolution, for while

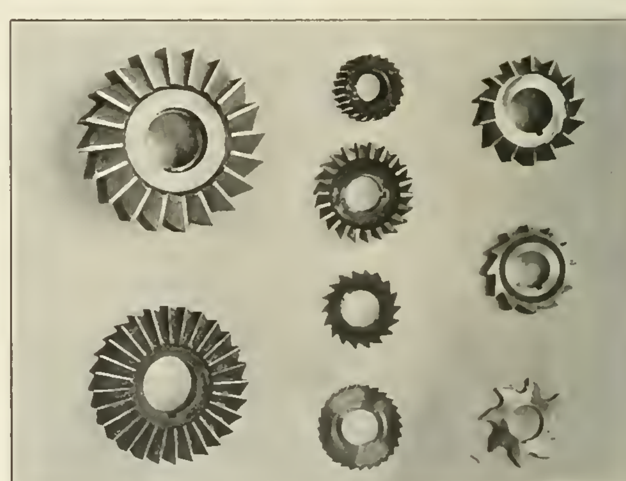


Fig. 10. Comparison of Side Mills and Slotting Mills

in the old style the blades were spaced about 1 inch apart and set radially, they now have a 2-inch spacing and are set at an angle of about 15 degrees with a radial line, and are backed by a backing-ring with a set-screw for each blade.

Fig. 11 shows the previously-mentioned new type of helical

cutter; these cutters consist of a cylindrical body with two or three screw threads wound around them, the threads being of the section indicated in the engraving. The helix is wound around the body at an angle of 69 degrees with the axis, the other details being shown in the illustration. Their most distinguishing feature is that they push the chip off in the direction of the axis of the cutter, at right angles to the feed. The power consumption is extremely low, but does not show up so favorably for cast iron. For a roughing cut in steel, only about one-third the power of the old-style spiral mill is required. In addition, the cutter does not make revolution marks, but instead makes tooth marks permitting of a coarser feed. Still another feature of this cutter is the entire absence of spring in the arbor when cutting steel; it is possible to take a finishing cut over a piece of steel, and return the work under the revolving cutter without producing a mark.

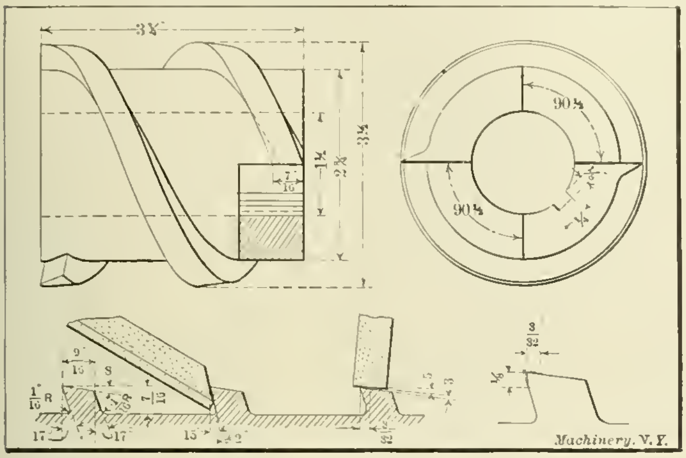


Fig. 11. Details of New Type of Helical Cutter

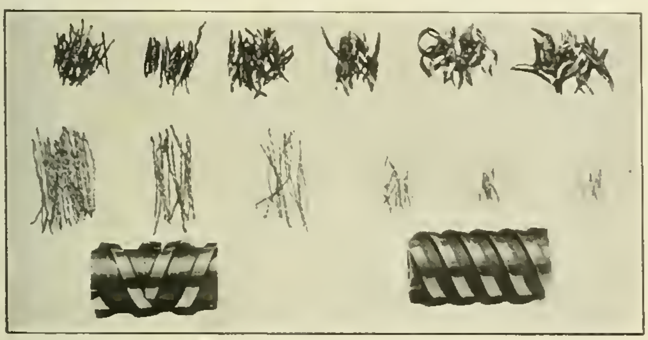


Fig. 12. Helical Cutters, Single and Interlocked, and Chips produced by them

For roughing purposes on account of the excessive end pressure on the spindle, the interlocking cutter shown in Fig. 12 was produced. However, it was found that this end pressure, though perceptible, was not a disturbing element. The same illustration shows the kind of chips produced by this type of cutter. While it was first believed that these cutters would work more advantageously at high speed, it has been found that the best results are produced when they are operated at the same speed as the ordinary spiral mill.

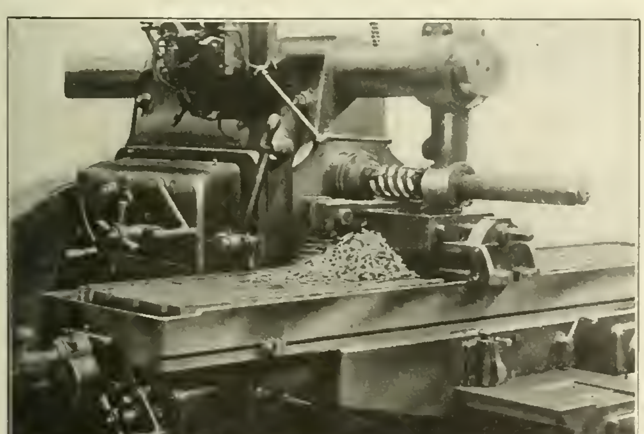


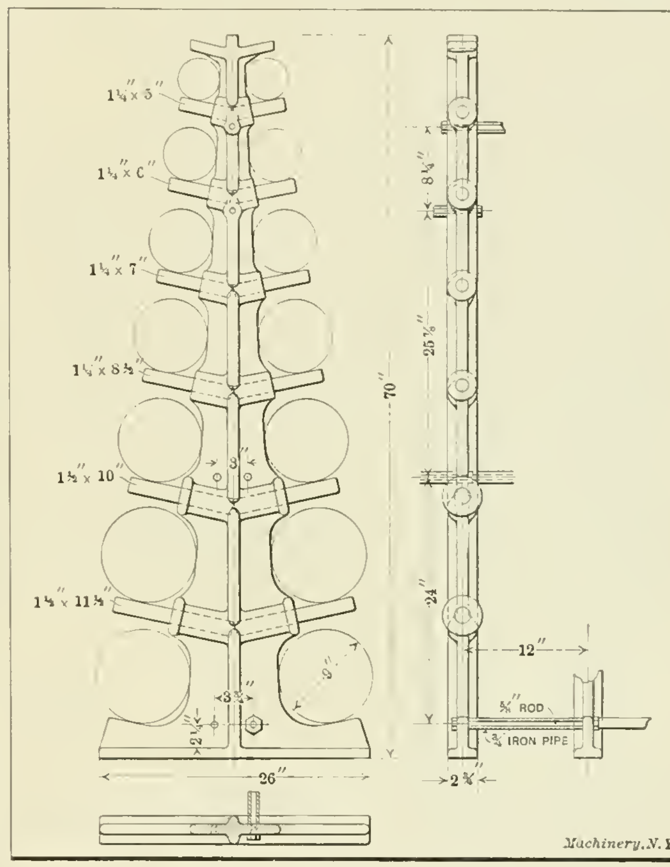
Fig. 13. Helical Cutter at Work on Steel Test Pieces

The writer believes that the remarkably low power consumption is due to what might be called "virtual rake" which is an angle depending upon the angle of rake and on the angle the thread or tooth makes with the axis. This virtual rake becomes a small angle when the actual rake is small. This may explain why the saving in power consumption is not so pronounced when cutting cast iron. It is believed that this saving in power would be equally as great as with steel if the same virtual rake could be obtained, and this supposition was proved by a few tests made on cast iron with a helical cutter ground for steel.

* * *

STOCK RACK FOR HEAVY BAR STOCK

The storing of heavy bar stock of from four inches in diameter upward is a rather difficult problem. Ordinarily, heavy bars of this kind are put on the floor in the stock-room, thus occupying a considerable floor space and, as a rule, being difficult to get at when required. The accompanying illustration shows a stock rack for heavy bar stock used at the plant of the Union Twist Drill Co. of Athol, Mass., which presents a satisfactory solution to this problem.



Stock Rack for Large Diameter Bar Stock

As shown, the rack consists of very heavy cast-iron stands or uprights, having machine steel pins or plugs cast in place, these pins being 1½ inch in diameter for the lower spaces and 1¼ inch in diameter for the higher spaces, where the smaller bars are kept. These uprights are placed at a distance of one foot apart, as shown to the right in the illustration, the whole length of the rack being 18 feet. The stands are held together longitudinally by means of ⅝-inch rods, over which are placed ¾-inch iron pipes acting as spacers. It will be seen that every other hole provided in the stands has a bolt connecting with the stand to the left, while every other hole has a bolt connecting with the stand to the right, so as to firmly connect the whole system of uprights. Over this arrangement of stock racks a traveling crane is used, so that any bar can be easily and conveniently removed from its location in the stock rack and be brought to the cutting-off machines. By casting the machine steel supports in place, it was possible to make these racks with practically no machine work, except that of drilling the holes for the connecting rods between the stand. The largest bar provided for by the stock rack shown is 9 inches in diameter. This is a trifle larger than the largest regular diameter bar manufactured.

THE AIR-LIFT PUMP

By HARRY L. GLAZE*

The air-lift is in general use in pumping and metallurgical plants, but is little known to those engaged in other mechanical pursuits. A better knowledge of the air-lift among mechanics and mechanical engineers would result in the development of many more uses for this valuable principle.

The action of the air-lift is simple and easily understood, but many theories have been advanced by various authorities to explain the phenomenon; the explanation following is perhaps the one most widely accepted. In order to consider the principles involved it will be necessary to refer to Fig. 1, which shows the air-lift as ordinarily applied to pumping from wells. Here *A* shows a pipe which serves as the discharge pipe to carry the water out of the well *B*, *C* is an air pipe which carries the air from the compressor and introduces it into the open end of the discharge pipe, which is usually made with a slight bell at the bottom; this air pipe is bent up so as to pass a short distance into the discharge pipe. It will be noticed that the discharge pipe is submerged in the water, and upon the amount of this submergence depends the efficiency of the pump.

The action is as follows: Air is introduced into the air pipe *C* under pressure sufficient to overcome the static head of the water from the end of the pipe to the surface of the water; this head is called the "submergence." The distance from the surface of the water to the highest point that the water is lifted is called the "lift." When the air issues into the water contained in the discharge pipe it breaks up into small bubbles which form, by virtue of the violent action, what is virtually an emulsion of air and water. This emulsion is lighter than water and of course it is forced up into the discharge pipe by the weight of the water outside and will be made to issue from the top of the discharge pipe with considerable violence.

The results obtained are improved but very little by the various fancy and expensive devices on the market which are made for attaching to the lower end of the discharge pipe. The best results are of course obtained when the submergence exceeds the lift; in fact, the efficiency of the system varies

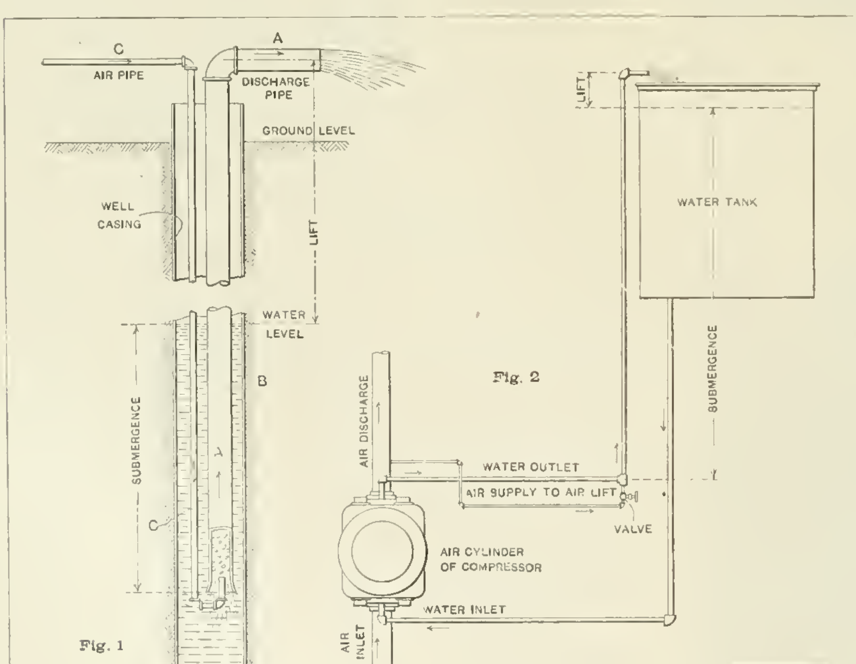


Fig. 1. The Air-lift Pump. Fig. 2. Application of the Air-lift Pump to Circulating Air Compressor Jacket Water

directly as the ratio of lift to submergence. In deep-well pumping, the conditions are seldom ideal for a high efficiency, but when the simplicity of the whole arrangement is taken into consideration one can readily appreciate its advantages. Although but few wells are drilled deep enough below the water level to give a greater ratio than 1 to 1, there are a great many large air-lift pumping plants in California working on both water and oil. An efficiency of 35 per cent may be considered about the average of the results ordinarily obtained.

* Address: Young Construction Co., Los Angeles, Cal.

The air-lift has as many faults as virtues, but when it is

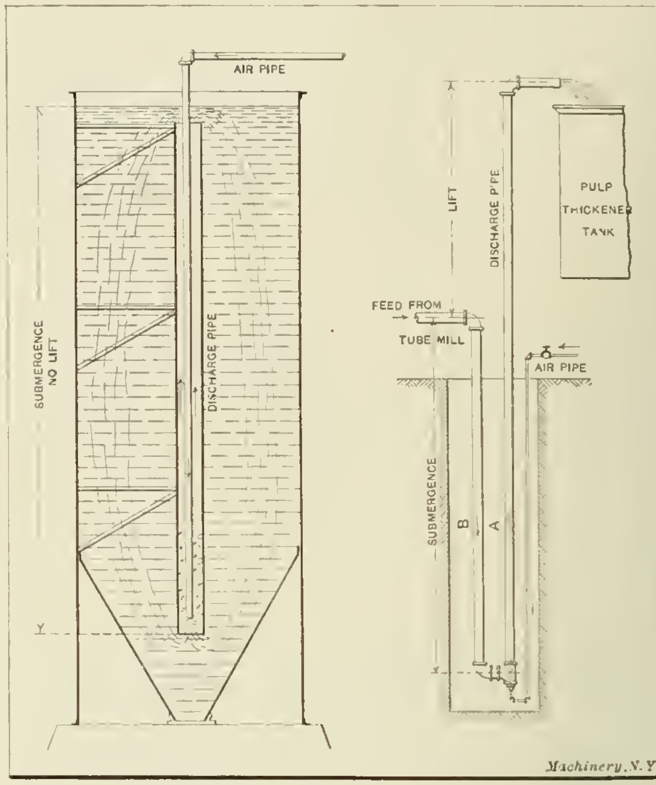


Fig. 3. The Pachuca Tank for Stirring up Ores in Cyanide Solution. Fig. 4. Elevator for Lifting Tailings

possible to rig up some old junk-heap of a compressor and a few pieces of rusty pipe, and produce a good, steady and dependable pump, it is worthy of consideration. Even the absence of valves would enhance the value of it to any one who has ever pulled about a mile of casing and pump rods out of the ground to get at the worn-out valves and leathers of an old deep-well pump.

So much for the water pumping air-lift. Consideration will now be given to the possibilities of applying the principle to the mechanical arts. Fig. 2 shows a novel method of circulating the cooling water in an air compressor. The engraving is self-explanatory, and the working of the system shows the same simplicity as does that of the other members of the air-lift family. A slight opening of the air valve will serve to create a brisk motion of the water in the pipes and cooling jacket. A cooling tower might be provided if the water showed a tendency to become quite hot. This cooling tower could be placed upon the tank and the air-lift pipe raised so that the water would flow over the slats of the tower and into the tank. This scheme may be applied to the cooling of ice machines, ammonia condensers, gas engines and transformers.

Fig. 3 shows what is called the Pachuca or Brown agitator, which is used very extensively in cyanide plants for mixing and agitating the finely-ground ore or "pulp" with the cyanide solution. The Pachuca tank consists of a tall cone-bottomed steel tank which has an air-lift pipe in the center and a small pipe for introducing air. The use of the air-lift is, in this case, simply to agitate the pulp and bring it intimately into contact with the cyanide, although the air has a beneficial effect in supplying the oxygen necessary to bring about the dissolv-

ing of the gold and silver. The time of agitation is usually sixteen hours, but the tendency is toward continuous agitation in several Pachuca tanks operated in series, the pulp running slowly from one tank into the other through the series, the rate of flow being regulated to conform to the time it takes to dissolve the precious metals.

In the case of the Pachuca tanks, the air-lift works under ideal efficiency conditions for the submergence exceeds the lift. No system of mechanical agitation can compete with the Pachuca tank, and it will be seen that wherever agitation is to be carried on, the Pachuca tank can be used, provided that the action of air is not harmful to the substance being handled. The air-lift will handle almost any amount of solids, slimes, or sands in the solution and this would recommend it for pumping such things as pulp, mud or any liquid containing solids which are hard on plunger pumps.

Fig. 4 shows an application of the air-lift, in which it is used to raise the tube-mill tailings into pulp thickeners or classifiers in ore milling plants. The vertical pipes shown are placed in a pit so as to give at least a 1 to 1 submergence. Air is admitted at the bottom of the pipe *A* and the pulp comes in at the top of the pipe *B* down which it flows, and is elevated in pipe *A* by the action of the air.

Many other applications of the air-lift are at present in use, but they all work upon the same principle. These four examples will suffice to give some suggestions which it may be possible to turn to good advantage.

* * *

INEFFICIENCY IN THE BUILDING TRADES

The waste of material and labor in house building is appalling to one accustomed to the economies and precise methods of manufacturing. A contractor seldom makes use of labor-saving devices for reducing cost and improving the quality of the work. Think what the wood trimmer used by almost every pattern-maker would save of the time of a carpenter putting in the trim of a house. Not only would its use save time, but it would insure making joints of mathematical accuracy, if used with intelligence. But this is not the least of the indictments.

The average run of contractors leaves on the premises horses, temporary benches, makeshift miter boxes and many other things that have consumed time and lumber in the making and which have to be made for the next job if not saved. Another indictment is the lack of system in getting material on hand to keep the workmen employed. Time is lost by failing to order lumber, doors, sash and trim promptly. The aggregate loss in the country each year because of these wasteful methods is enormous, and we all feel it in increased first costs, higher rents and dissatisfaction with slovenly jobs that have cost more than first-class work should.

* * *

When you start in to fix a machine, first be positive that something ails it, and then try to make sure of just what ails it.

BENDING SHEET-STEEL FOR METAL FURNITURE

By K. GEORGE SELANDER*

In view of the fact that but little information has ever been published concerning the bending of the sheet metal used for ornamental purposes, the writer trusts that the data embodied in this article will prove useful. The work for which this data has been developed refers more particularly to the bending of sheet metal for counters, bank fittings and general office fixtures, for which purpose it is not absolutely essential to have the legs of the bends within very close limits. Absolutely accurate data for this work cannot be deduced, as the stock varies to a great degree as regards material, hardness, etc., though experience has shown that the figures given may be safely employed for sheet steel, aluminum, brass and bronze. In the use of the table, caution should be exercised in the choice of the proper gage, for on account of the differences in the gage systems the results might be erroneous. It is therefore advisable to use the decimal equivalent.

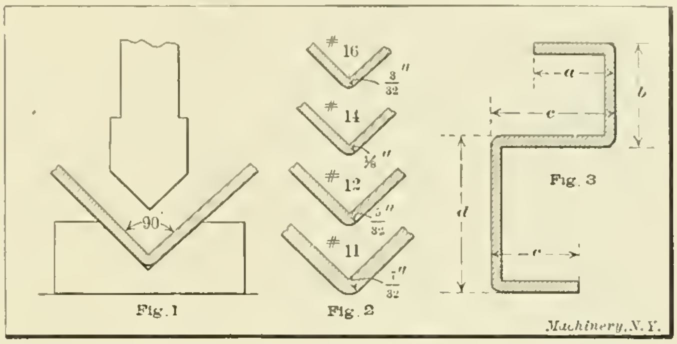


Fig. 1. V-die for Bending Sheet Metal. Fig. 2. Radii to which Corners are bent. Fig. 3. Illustrating the Meaning of the Sum of the Outside Bend Dimensions

The bends made in a V-die will be the first considered. The manner of forming and the radii to which the outside corners are bent are shown in Figs. 1 and 2. From experience it has been found that for the semi-square corners, such as are formed in the V-die, the amount to be deducted from the sum of the outside bend dimensions represented in Fig. 3 by the sum of the letters from *a* to *e*, is as follows:

$$X = 1.67\,B\,G$$

where X is the amount to be deducted; B, the number of bends; and G, the decimal equivalent of the gage. The values of X for different gages and numbers of bends are given in the accompanying table. Its application may be illustrated by an example: A strip having two bends is to have outside dimensions of 2, $1\frac{1}{2}$ and 2 inches, and is made of stock 0.125 inch thick. The sum of the outside dimensions is thus $5\frac{1}{2}$ inches, and from the table the amount to be deducted is found to be 0.4167; hence the blank will be $5.5 - 0.4167 = 5.0833$ inches long.

ALLOWANCES FOR BENDS IN SHEET METAL

Square Bends	Weight per Square Foot: Ounces	Weight per Square Foot: Pounds	Gage	Thickness, Inches	Amount to be Deducted from the Sum of the Outside Bend Dimensions, Inches: 1 Bend	2 Bends	3 Bends	4 Bends	5 Bends	6 Bends	7 Bends
Formed in a Press by a V-die	32	2.000	18	0.05000	0.0833	0.1667	0.2500	0.3333	0.4167	0.5000	0.5833
	40	2.500	16	0.06250	0.1042	0.2083	0.3125	0.4166	0.5208	0.6250	0.7292
	50	3.125	14	0.07813	0.1302	0.2604	0.3906	0.5208	0.6510	0.7813	0.9118
	60	3.750	13	0.09375	0.1563	0.3125	0 4688	0.6250	0.7812	0.9375	1.0937
	70	4.375	12	0.10938	0.1823	0.3646	0.5469	0.7292	0.9115	1.0937	1.2760
	80	5.000	11	0.12500	0.2083	0.4167	0.6250	0 8333	1.0417	1.2500	1.4583
	90	5.625	10	0.14063	0.2344	0.4687	0.7031	0.9375	1.1719	1.4063	1.6436
Rolled or Drawn in a Draw-bench	32	2.000	18	0.05000	0.0667	0.1333	0.2000	0.2666	0.3333	0.4000	0.4666
	40	2.500	16	0.06250	0.0833	0.1666	0.2500	0.3333	0.4166	0.5000	0.5833
	50	3.125	14	0.07813	0.1042	0.2085	0.3127	0.4169	0.5212	0.6254	0.7296
	60	3.750	13	0.09375	0.1250	0.2500	0.3750	0.5000	0 6250	0.7500	0.8750
	70	4.375	12	0.10938	0.1458	0.2917	0.4375	0.5833	0.7292	0.8750	1.0208
	80	5.000	11	0.12500	0.1667	0.3333	0.5000	0.6666	0.8333	1.0000	1.1666
	90	5.625	10	0.14063	0.1875	0.3750	0.5625	0.7500	0.9375	1.1250	1.3125

The latter part of the table has been developed for square bends which are either drawn through a block of steel made to the required shape, or else drawn through rollers in a draw-bench. The pressure applied not only gives a much sharper corner, but it also elongates the material more than in the V-die process. In this case the deduction is

$$X = 1.33\,B\,G$$

* * *

In making aluminum castings of complicated shapes, the sand should be rammed as soft as possible in order to allow the shrinkage of the metal in cooling to take place without rupture of the casting.

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ECCENTRICALLY LOADED RIVETS

By JESSE LONG

Mr. M. Terry in his article on "Eccentrically Loaded Bolt and Rivet Groups" in the August, 1910, issue of MACHINERY, engineering edition, states that in the case of the cantilever shown in Fig. 1, the moment of resistance of the four rivets on the circle of 3-inch radius equals that of the rivets on the circle of 4¼-inch radius. To prove this, he assumes that the pressure on each rivet varies inversely as its distance from the center; this assumption is correct only when the rivets are at equal distances from the center, as in Fig. 2. In this case

$$Wl = 4\,rp;\ \text{or}\ P = \frac{Wl}{4\,r};$$

that is, when r increases P decreases r being the radius and P the load on each rivet.

But is it true when the rivets are not at equal distances from the center, which is the case in Fig. 1? Consider Fig. 3;

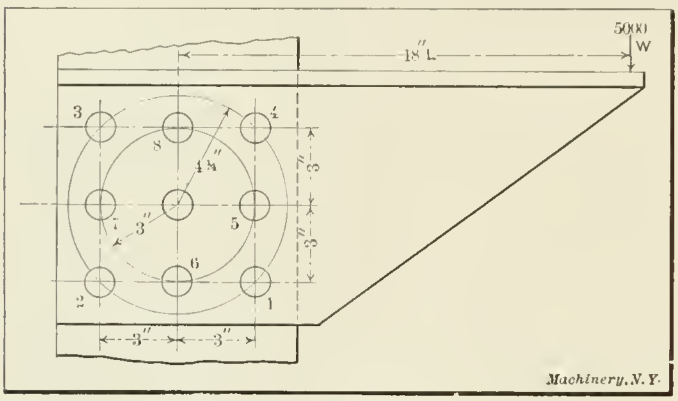


Fig. 1. Eccentrically Loaded Rivet Group

here is a cantilever pivoted at A, and held by rivets 1 and 2. The dotted lines show strain caused by load, exaggerated for the sake of clearness. It is evident that the strain is proportional to the distance of the rivets from the center; but stress is proportional to strain, within elastic limit; therefore

$$\frac{f_1}{y_1} = \frac{f_2}{y_2};\ \text{or}\ f_2 = \frac{f_1\,y_2}{y_1}$$

where f_1 and f_2 are the stresses per square inch, and y_1 and y_2, the distances from the center, for rivets 1 and 2, respectively. Referring now to Fig. 1,

$$W\,L = 4\,f_1\,ay_1 + 4\,f_2\,ay_2$$

where f_1 and f_2 are stresses per square inch; y_1 and y_2, radii for outer and inner circles of rivets, respectively; and a, the

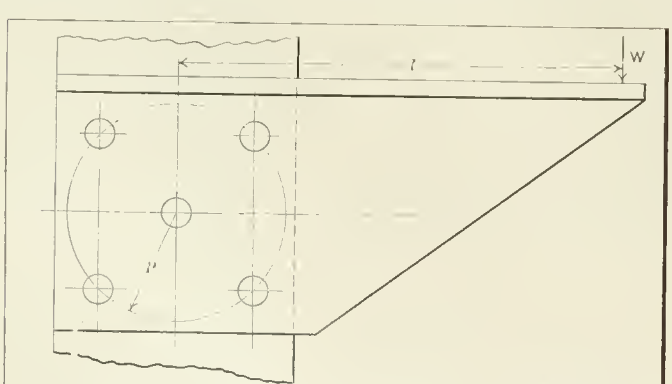


Fig. 2. Eccentrically Loaded Rivet Group—Rivets all at Same Radius

area of each rivet. Substituting the value found for f_2 the equation becomes

$$W\,L = 4\,f_1\,a\,y_1 + \frac{4\,f_1\,a\,y_2^2}{y_1}$$

This may be expressed as

$$W\,L = \frac{4\,f_1\,a}{y_1}\,(y_1^2 + y_2^2);$$

That is, the moment of resistance of each rivet varies with the square of its distance from the center. The last equation gives

$$f_1\,a = \frac{W\,L\,y_1}{4\,(y_1^2 + y_2^2)}$$

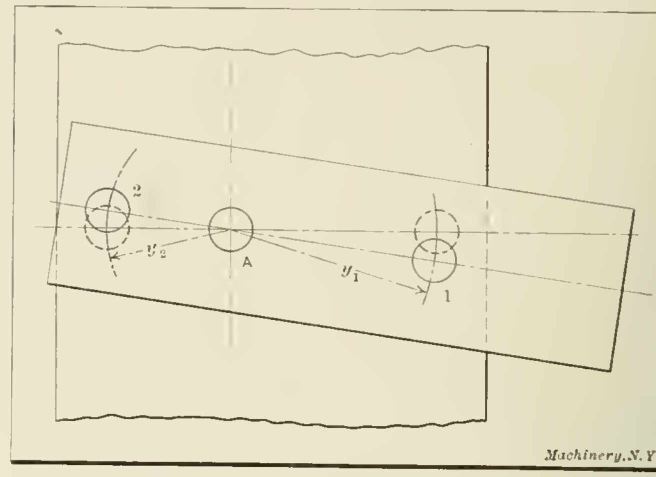


Fig. 3. Cantilever with Rivets at Unequal Distances to represent Intensity of Stress

Using the figures given in Fig. 1 in the above equation

$$f_1\,a = \frac{5000 \times 18 \times 4.25}{4\,(18.06 + 9)}$$
$$= 3536\ \text{pounds.}$$

This is the shearing load on each rivet in the outer circle,

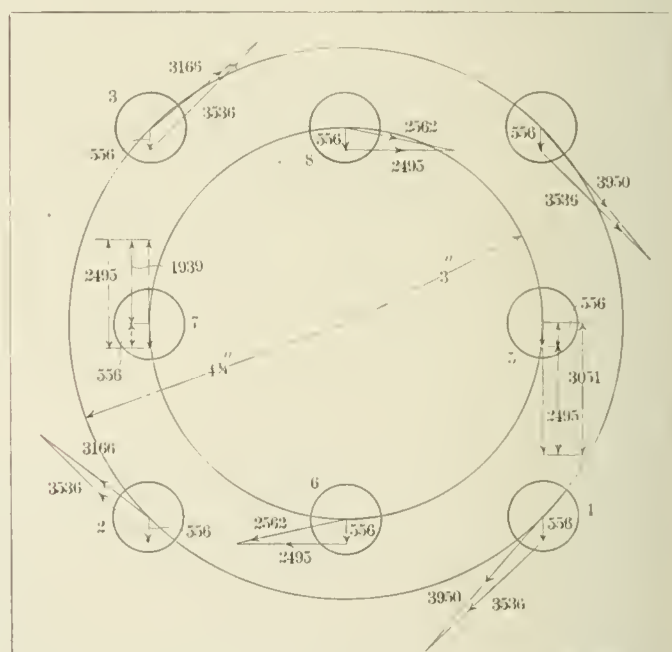


Fig. 4. Rivet Group with Vector Diagrams showing Load on Each Rivet

due to moment of W. The shearing load on each inner rivet, due to moment of W is

$$f_2\,a = \frac{f_1\,a\,y_2}{y_1} = \frac{3536 \times 3}{4.25}$$
$$= 2495\ \text{pounds.}$$

The direct and tangential shearing loads on each rivet are shown in Fig. 4, and also the geometrical sum of the loads on each rivet. The greatest load is on rivets 1 and 4 and amounts to 3950 pounds, or slightly less than the 4400 pounds allowed as the safe load for a ¾-inch rivet.

* * *

The Boston & Maine Railroad is gradually substituting the telephone for the telegraph for train dispatching. It now uses the telephone on lines over 230 miles in length. The New York, New Haven & Hartford Railroad has also equipped about 100 miles with a telephone system.

THE CUSTER PROCESS OF CASTING IN PERMANENT MOLDS

ITS HISTORY, THE METHODS EMPLOYED, AND ITS EFFECT UPON THE METAL CAST

By ERIK OBERG*

From time to time articles have appeared in the engineering press describing different phases of the Custer process of producing castings in permanent molds—that is, molds made of metal, and hence of a permanent nature, as distinct from the sand mold which disintegrates for each casting made. This process has been developed by Edgar A. Custer, president of the Tacony Iron Co., Philadelphia, Pa., and the articles so far published have mostly been in the nature of abstracts of papers read by Mr. Custer before various societies. Many of these papers were prepared and published while the process was still—to some extent—in its experimental stage, and while many isolated examples illustrating the application of the process were given, it is only recently that data indicating the full scope of its possibilities, and the effect upon the metal thus cast, have been available for publication. The development of this process may be considered as one of the great epochs in the history of the iron industry—this development opening the way for unheard of possibilities in the future methods of foundry, as well as machine shop practice, the extent of which it is at this stage impossible to fully appreciate or foresee. For this reason it has been deemed advisable to present in MACHINERY a complete account of the present state of this process—revolutionary alike from the molder's and the machinist's point of view. In order to make the following article authoritative, the writer was sent to obtain, from the inventor personally, the information contained in the following; at the same time an opportunity presented itself for the writer to personally see the process in use, for demonstration purposes, at the plant of the Best Mfg. Co., of Verona, near Pittsburg, Pa., where the half-tone illustrations of the machines exhibited, which accompany this article, were obtained.

History of the Process

It cannot be said that the permanent mold, or the process of casting in permanent molds, is new. For many years small iron castings have been produced in metal molds with comparatively good success. It must be remembered, however, that the castings produced were chilled to an extreme hardness, and that they were invariably very small. On account of the hardness of the chilled metal it was not possible to machine the castings, and hence the process had only a very limited application.

In 1902, Mr. Edgar A. Custer began to undertake extensive experiments at the Tacony Iron Works, in order to ascertain if it were not possible to produce a soft iron casting in a permanent mold. As the main product of the company is sewer pipe, the experiments were conducted with castings of this type. At first various coatings were used in the molds, such as a mixture of oil and graphite, for example, but without success. The castings produced were too hard to permit of machining. As a result of the continued experiments it was finally found, in 1906, that a soft "machinable" casting could be produced in a simple cast-iron mold, if no coating at all were used in the mold, and if the casting were removed from the mold as soon as it had set and while it was still at a high red heat. As a result of the successful method thus developed, a machine for casting pipes in permanent molds was designed in which 240 pipes an hour could be cast. This machine, together with the method for operating it, was described in MACHINERY, September, 1908, engineering edition, and it is, therefore, not necessary to again describe it in detail. It may be mentioned, however, that the machine consisted of 30 molds; each mold was poured every 7½ minutes. A core consisting of a cast-iron hollow arbor covered with sand was used. The process proved successful for the casting of pipes and suggested the casting of fittings in permanent molds as well.

* Associate Editor of MACHINERY.

The problems met with in the casting of pipe fittings were of a somewhat different nature from those met with in the casting of pipe. The fittings, in general, were of a more complicated shape, and the coring of them presented difficulties. It was found impossible to use sand cores successfully in the casting of fittings, owing to the irregularity in the form of the cores. It was practically decided to discontinue the experiments for producing cast-iron fittings in permanent molds, when, as a last resort, plain cast-iron cores were suggested and tried. The very first experiment with cast-iron cores proved successful, and the way was now open for a practically limitless development and application of the process. With a cast-iron mold, requiring no coating, and a cast-iron core, practically any casting of not too complicated a shape could be successfully made in a permanent mold, both from an engineering and a commercial point of view. Since that time, when the governing principles of casting by this process were thoroughly established, the process has been gradually developed so that now castings of a variety of shapes—fittings, flanges, brake shoes, cast gear wheels, both of the spur and bevel type, truck wheels, mining car wheels, etc.—are produced successfully by this method.

The Mold and the Cores

The molds and cores are made from ordinary gray cast iron, of the same kind and quality as that ordinarily used for sewer pipes and fittings. One of the most important considerations with relation to the mold is, of course, its life. As yet, no definite answer can be given to the question of the life of a permanent mold of the type described, because no molds have as yet been in use long enough to have outlived their usefulness. Some have been used continuously for five years and are still in good condition. The only points where the molds will disintegrate are in the runners and the gates. After from 7000 to 10,000 castings have been made in a mold, the gates are generally renewed by inserting new blocks containing the gates. In doing this work, it is of especial importance to see that no joints are made at any point where the molten metal strikes when in its most liquid state, as this quickly causes disintegration of the mold. In general, the molds should have as few joints as possible; that is, they should not consist of any more parts than is absolutely necessary. Usually, the mold is simply made out of two solid blocks of cast iron, each containing about one-half of the mold. One reason for avoiding joints is to prevent deterioration, and another important reason is that the heat conduction is retarded by a joint a great deal more than by solid metal. The necessity for a rapid distribution of the heat into the mold itself, and for radiation of the heat, is self-evident.

It might be suggested that some system of water cooling would aid in rapidly cooling the molds. This has been tried, but found unsuccessful. The effect of water cooling was to produce a tendency of the molds to crack toward the water chamber. A uniform cooling of the mold could not be effected, and strains were set up in the mold itself.

The cost of the repairs necessary with relation to the gates amounts to about 10 per cent of the original cost of the mold. The matrix of the mold has not as yet, in any case, shown signs of wear or disintegration. In one mold 21,000 castings have been made, these castings weighing 10 pounds each, and the original tool-marks are still visible in the matrix. One very interesting and important feature in this connection is the fact that the life of the mold does not depend so much upon the number of castings made in it as upon the number of times that it is permitted to become cold after having been heated by pouring the molten metal into it. A mold which is worked continuously will last for about four times the number of castings before repairs are required, as compared with one that is used at intervals only.

In making the molds, several points must be considered. Loose parts, if inserted in the mold, must be held as lightly as possible, as otherwise the mold will be destroyed by the effect of the expansion due to heat. All joints directly acted

upon by the hot metal, or influenced by the expansion due to the heat, must be of the expansion type. The molds themselves are made of large bulk so that they will have a great heat capacity. Another object of making the molds of large bulk is to prevent distortion from the heat. A small vent is provided in the top of the mold to permit the air to escape. The general construction of the molds, as shown in the accompanying illustrations, also aids the air in escaping easily.

Operating the Molds

The operation of the molds was described by Mr. Custer in a paper read before the February meeting of the New England Foundrymen's Association. The operation is very simple, and requires little or no training or skill.

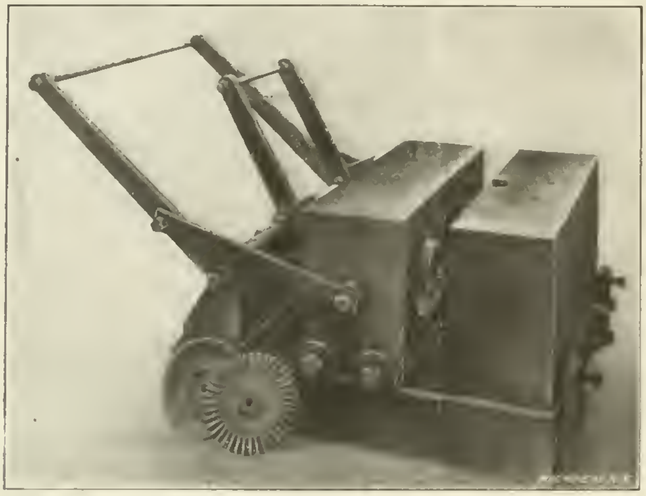


Fig. 1. Permanent Mold for Casting Bevel Gears

In practice, the molds are placed in batteries. Eight and ten molds constitute a battery, and at each of these batteries a gang of men, generally four or five laborers, is placed. A large ladle, holding 150 to 200 pounds, usually sufficient to pour all the castings in one battery, is pulled on a trolley, and the ten molds poured as fast as the pourer can fill each mold and move to the next one. The other men follow up this operation and take out the castings from the molds, seeing that the latter are thoroughly cleaned and closed, ready for the next operation. By this method ten castings are generally poured, in from two to four minutes, and the time necessary to make one casting is the time that is necessary to pour this one casting and move to the next mold. If iron be continuously supplied to the batteries the work can go on all day without interruption.

In the earlier experiments, the molds as well as the cores were occasionally coated with a thin mixture of oil and graphite, but at the present time no coatings are used, as they tend to prevent the rapid conduction of the heat from the surface of the poured casting, which is one of the most important of the principles involved. No special care need be exercised to prevent the castings sticking to the mold. They are very easily removed, and the only portion that may stick to some extent is the sprue in the gate, but even this is removed in an instant by a suitable tool.

The rapidity with which castings can be produced by this method is remarkable. Very small castings can be cast at the rate of four a minute. Small pipe fittings can be cast one every two minutes, but for medium-sized castings, weighing from 10 pounds up, it is not recommended to pour oftener than every four minutes into the same mold. With a battery of ten molds, however, 150 castings can be produced per hour. In the case of large pipes, one casting out of every mold for every eight minutes is considered a practical average. The molds are, in general, designed to produce 1000 pounds of castings per day, in the case of comparatively small castings. In the case of large castings, much better results can be obtained. As an example, it may be mentioned that in one case 18 tons of castings were produced in 37 molds in 10 hours in a floor space of 60 by 26 feet. To produce the same tonnage of the same castings in sand, a floor space of 400 by 105 feet would have been required, or an area about 27 times as large.

When a casting is made in a permanent mold, the cores must be withdrawn quickly as soon as the metal has set, as otherwise the iron will shrink and grip the core so that it cannot be withdrawn. This condition, however, is not as serious as might be at first assumed, because if the cores should be gripped by the casting, all that is necessary to do is to open the mold and break the casting with a hammer. This releases the core without injury to either the mold or core, and the only loss is that of the labor required to produce the casting, which is of little account. In this connection it may be of interest to point out the difference between the loss of a casting made in a permanent mold and one made in sand. In the former case, the mold remains intact, and all the loss involved is that of the labor required for pouring and making the casting lost, which is a question of a minute's time, perhaps, at most. In the case of the loss of a sand-molded casting, the mold itself is lost and the labor expended in making it, which is a very considerable item. To further emphasize the difference, it may be mentioned that the amount of bad castings when made in permanent molds is only 1 to 2 per cent, while with a similar class of castings made in sand molds, the loss in bad castings is from 5 to 15 per cent. The loss from bad castings in the permanent mold process may, therefore, be considered as of hardly any account.

Principle of the Process

The reason that it is possible to produce soft castings in a permanent metal mold is due to the fact that a certain time elapses between the point at which the molten metal will set and the temperature at which it will begin to chill. This interval is long enough to give the operator of the mold time to remove the casting from the mold before chilling begins. At this time the casting is still at a bright red heat, but the sudden contact with the cooler surfaces of the mold has made the surface of the casting sufficiently hard so that it can be handled without fear of distortion or breakage. It has been definitely determined that the iron does not chill until some time after it has set, and the main point in the design of the molds is to have them so arranged that, in the first place, the iron will set quickly, and in the second place, the operator can then quickly remove the casting from the mold before chilling begins. In general, the castings are removed from the molds about five or six seconds after the pouring has been completed. When castings are of such a nature that permanent cores are used, the cores are withdrawn immediately after the completion of the pouring, and then the casting is removed from the mold after six to ten seconds.

Fig. 2. Mold for Casting a 6- by 4-inch Reducer

When the molten metal is first poured into the mold it swells until that point has been reached at which it begins to set. The bulk of the metal remains at this volume for

a short period of time, and then begins to shrink. In the permanent mold, however, the metal on the surface sets firmly at the moment it has reached its largest volume, and remains in the shape and volume thus assumed, because the interior metal is now so much softer that it adjusts itself to the condition and form of the outside. As will be later referred to, it is a remarkable condition that castings made by this process have apparently no shrinkage strains set up in them. As the metal sets when it has assumed its largest volume and completely filled the mold, the casting becomes an exact duplicate of the mold, and even the toolmarks in the mold are frequently visible on the casting.

Characteristics of Metal in Castings made by this Process

We now come to one of the most remarkable facts in connection with the process described. The characteristics of the iron in the castings made in permanent molds are entirely different from those of sand castings. Although the same pig iron is used in producing castings by the two processes, the qualities of the iron in the castings are entirely different, and no direct comparison can be made between the quality of the products. The casting produced in a permanent mold is a different metal, so to speak, from the casting made in a sand mold, although both may be poured from the same ladle. The difference, however, is not chemical, but of a purely physical nature. Mr. Custer himself refers to the properties of the permanent mold casting as follows:

The permanent mold castings differ from the sand castings not only in their physical structure, but also in their characteristics. A soft, open pig iron, high in graphitic carbon, becomes a close-grained iron, showing no traces of the graphitic flakes, but having the same amount of carbon as existed in the original pig iron. This close-grained iron is capable of being magnetized, permanently retaining the magnetism; it can be tempered and hardened precisely the same as a bar of tool steel, and, when tempered, will make a cutting tool equal to the best non-alloy carbon steel. This latter fact is true, irrespective of whether the original pig iron is high or low in silicon. There are no spongy spots, and the castings are free from shrinkage strains. The castings can be

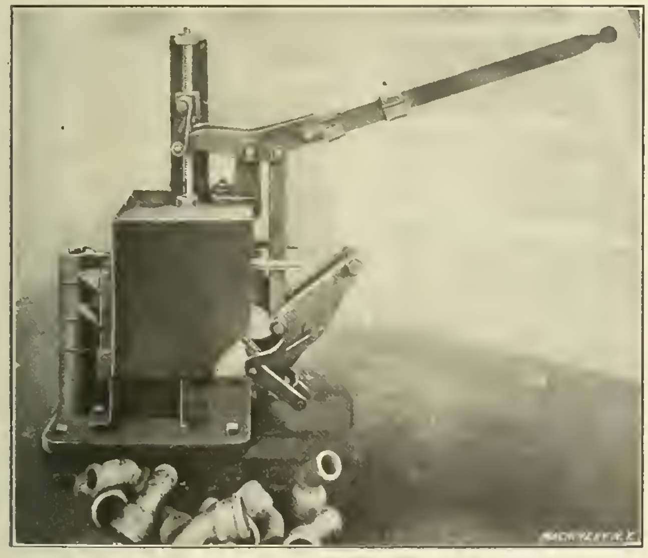


Fig. 3. Mold for Pipe Bends—Mold closed ready to pour

taken from the mold at a bright red heat and plunged in water until cold without showing a sign of cracks. High shrinkage does not begin in a permanent mold until a very low heat is reached, 1200 degrees to 1400 degrees F. being the point at which the casting must be removed to prevent cracking the undercut parts. Again, when a permanent mold casting is hardened until it is "unmachinable," it only requires heating once to a red heat to restore it to a soft, strong metal. None of these characteristics is shown in sand-made castings, and it must be borne in mind that these characteristics are invariably present in a permanent mold casting.

It might be inferred from the foregoing paragraph that the process of casting iron in permanent molds may entirely revolutionize the present method of making cutting tools from carbon steel. It would seem that lathe tools, planer tools, milling cutters, etc., could be cast in permanent molds and give as good service as those made from ordinary carbon tool steel. This is, however, not possible, at least not at the present stage of the development of the process. While the iron cast in permanent molds possesses hardening qualities equal to tool steel, the cast metal still retains the brittleness of cast iron, it has not the tenacity or ductility of steel, it cannot be forged, and if used as a cutting tool, it is liable to chip and break if subjected to shocks. Nevertheless, milling cutters have been made from

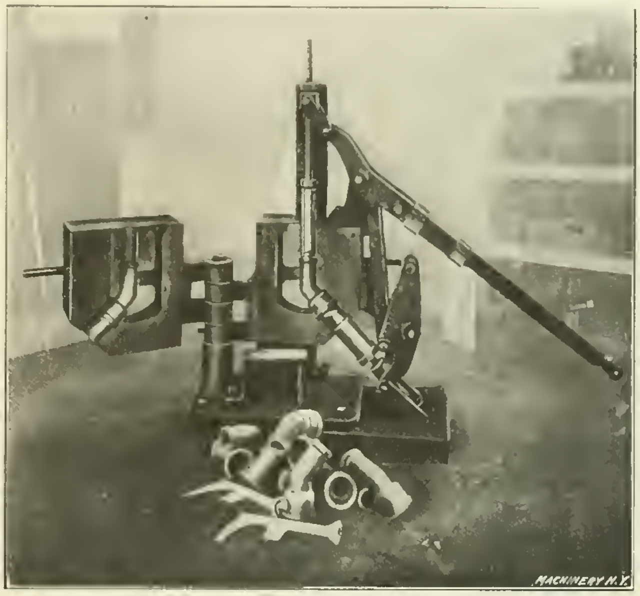


Fig. 4. Mold opened, Cores withdrawn and Casting removed

the metal for demonstration and experimental purposes, that have given proofs of possessing the required cutting qualities.

In case milling cutters were to be made by this process, it might also be inferred that the teeth could be cast right in the mold, and merely ground after hardening. This, however, would be impracticable, because the thin edges of the teeth would cool so rapidly as to be chilled in the mold, after which all the properties referred to as present in the metal would be lost. If it ever should prove practical to make cutters of this metal, it would be likely that only the blanks would be cast, and then the teeth cut as usual. It must be remembered that even in this case a material saving would result. The material in the blank would be as cheap as ordinary cast iron, and the teeth could be cut at a rate, perhaps four times as fast as the teeth in a tool steel blank, because the metal is very soft before hardening. It is not possible to go further into this phase of the subject at the present time, however, because further investigations will have to be made before any practical commercial results with this metal used as a cutting tool can be expected.

The hardening qualities of the permanent mold cast iron are, however, of great importance, even though the metal may not be suited for cutting tools. When hardened it is an excellent substitute for hardened tool steel in cases where it is required to stand steady wear. It presents the same hard surface, and if not subjected to severe shocks, will give satisfaction. The hardness of the metal depends upon the temperature to which it is heated before quenching. It will not harden at all if heated only to a dull red heat. If heated to a bright cherry red heat, it will become as hard as hardened and tempered tool steel. If heated to a yellow heat, it will become glass hard; in fact, it is possible to obtain a sufficient hardness to make it capable of scratching glass. The temper is not drawn, as the desired degree of hardness is governed by the hardening temperature.

When hardening permanent mold cast iron, it must be quenched in ice-cold water. If quenched in boiling water, it

will crack almost invariably, and dipping it in oil has no hardening effect whatever. To anneal the piece, after it has been hardened, all that is necessary is to heat it to at least the hardening heat, or to a slightly higher temperature, and permit it to cool in the air. The effect of the hardening is to slightly lighten the color of the section, but there is apparently no change in the grain or physical structure of the metal.

Effect of Impurities

As to the effect of impurities in the pig iron, Mr. Custer said before the New England Foundrymen's Association that the hardening elements which make it difficult to produce a "machinable" casting in permanent molds are sulphur and manganese. Phosphorus has little or no effect; it produces no weakening of the metal even when used in quantities as high as one per cent. The function of silicon is simply that it lengthens or shortens the interval between the setting point and the chilling point, according to whether the silicon content is low or high. Manganese, in excess of 0.60 per cent, is a detriment. It does not increase the strength of the casting, but it renders it brittle and weak. It is to the permanent mold process what sulphur is to the modern foundry.

Absence of Shrinkage Strains

Castings produced in permanent molds have no shrinkage strains. Molten iron is homogeneous and if this iron were instantly chilled beyond the setting point it would still be homogeneous; there would be no chance for segregation. The sulphur, phosphorus and carbon would remain in the same relative positions that they occupied when in the molten state, but since the mass was all cooled at precisely the same rate, it becomes evident that no shrinkage strains could be possible. It is obviously impossible to cool iron instantly, but approximately the same result can be obtained if it can be chilled fast enough to prevent segregation. If a casting, say one square inch in section, be made in sand, it would require at least a minute before it could be removed from the sand without breaking or distorting. In this time the different elements segregate and different portions of the bar are cooled at different rates. Consequently, shrinkage strains are set up that become more marked when a portion of the casting is much thinner than the other, or when a thin section is joined to a heavy section at right angles. A permanent mold casting of this thickness, however, can be removed from the mold within two seconds after it is poured and the time in which segregation is possible is reduced from 60 seconds to 2 seconds. Hence, all the ingenuity of the designer is bent toward the construction of a mold for introducing the metal and removing the casting in the least possible time.

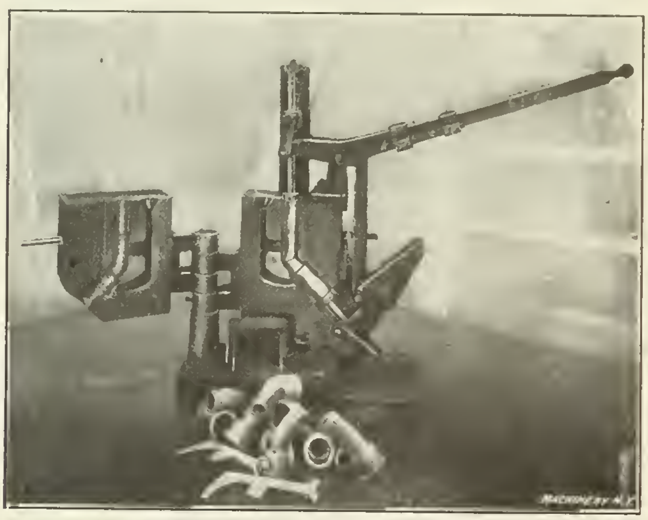


Fig. 5. Cores in Position, Mold open

As an example of absence of shrinkage strains, the following case may be cited. A piece 2½ inches in diameter and ½ inch long was cut off from a cast-iron fitting, cast in a permanent mold. This piece was bored out with an eccentric hole, so that the thickness of the wall was ⅜ inch on one side, and ⅛ inch on the opposite side. Then a thread was cut on the inside, and the dimensions of the piece carefully measured. Now the piece was heated ten times to a bright red heat, and dipped each time in cold water, but no distortion could be detected. After fifty repeated heatings and coolings, a distortion of 0.002 inch was recorded in the diameter of the piece. An ordinary sand casting made from the same iron, and prepared in the same way cracked to pieces after the third cooling. The permanent mold casting thus differs from the sand mold casting also in that it does not "grow" when subjected to repeated heating and coolings. This is one of the valuable characteristics of this product.

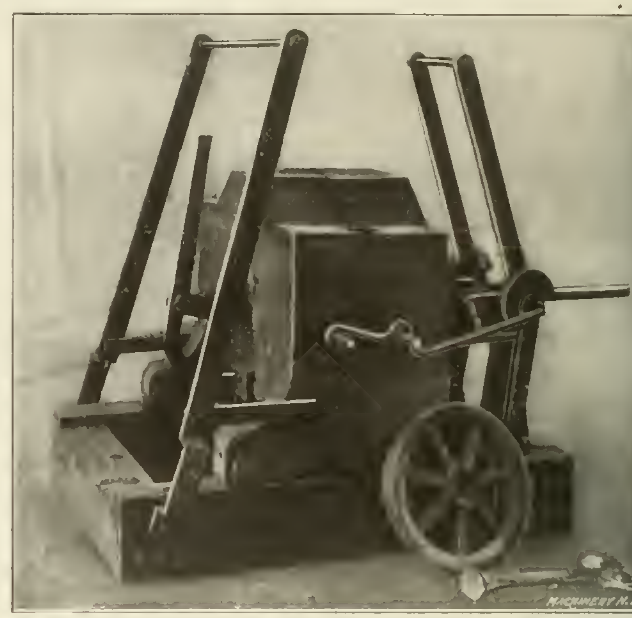


Fig. 6. Mold for Mining Car Wheels, ready to pour

The reason for the peculiar properties of the iron cast in permanent molds is to be found in the fact that the carbon in it is not found in the graphitic form, as in ordinary cast iron. The absence of shrinkage strains is explained by reference to the method of cooling the casting. The phenomena are explained by Mr. Custer as follows: Carbon exists in molten iron in solution, and is then in the combined form. If molten iron is instantly chilled and solidified, all the carbon will still be in the combined state, and there will be no free carbon in the metal, assuming that the metal could be chilled instantly to a black heat. In actual practice, when the iron is chilled swiftly from the molten state, as in the permanent mold, all the carbon at the time of setting is in the combined form, but as it cools a certain proportion of the carbon is changed into the free state, although not to the form which is commonly known as "graphitic." The free carbon collected after dissolving the iron will be found to exist in such a fine powder as to have no crystalline formation, even under a high-power microscope. This form of carbon is commonly known as "annealing" carbon and will be found in malleable castings. It is a desirable form of carbon, and in order to get it in as large a proportion as possible it becomes necessary to chill the metal swiftly, and to do this

Fig. 7. Mold for Mining Car Wheel, Mold open, Casting removed

it is necessary to use large iron molds of so great a bulk that their heat capacity is sufficient to accomplish this result and, at the same time, not overheat the molds.

The point next to be considered is that while it is evident that this sudden chilling can be accomplished with castings having a thin section, with castings having a thick section, say two inches square, it would be necessary, in order to set them to their full thickness, to hold them in the mold so long that the outer portion would become chilled. Here is where the well-known fact that iron increases in bulk from the molten state until it reaches the point of setting is taken advantage of. Thus, when a casting of large section is poured in an iron mold of the required bulk, the outer portion, say $\frac{3}{8}$ inch in depth, sets almost instantly, and the interior of the casting remains molten. At this point it is removed from the mold and the casting now has a hard set exterior with the interior in the molten state, and, as it loses its heat, the molten iron in the center tends to expand. This expansion is held in check by the hard walls. The force, therefore, is turned back upon the molten metal, and this produces, when cold, a uniform, fine grain from the center to the outside of the casting. There can be no chilling of the metal, since the casting is removed from the mold before the chilling point is reached and the natural physical force of cooling accomplishes the desired result. It is well known that it is almost impossible to cast a ball 6 inches in diameter, in a sand mold without the interior being more or less spongy. When the same ball is cast in a permanent mold, the whole ball is of a homogeneous structure throughout.

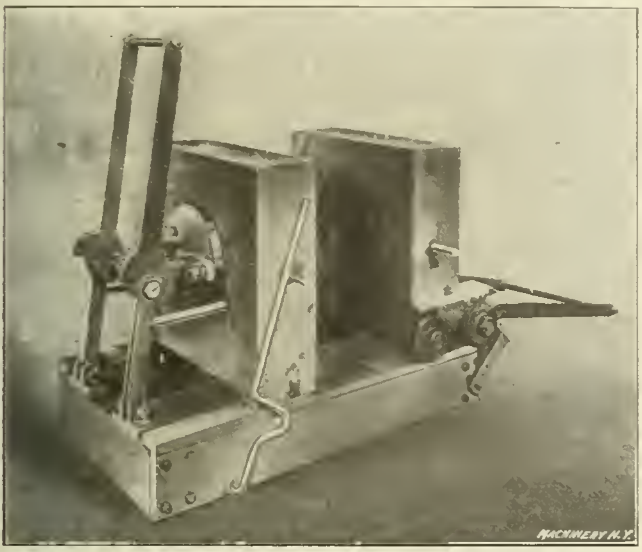


Fig. 8. Mold for Casting Heavy Pipe Flanges

Economy and Scope of Process

It is evident that where a great many duplicate castings are to be produced, the process of casting in permanent molds makes it possible to produce castings very much cheaper than by sand molding. Ton for ton of castings produced, the first cost of the molds is ordinarily only one-half of the cost of patterns, cores, sand and flasks; and the labor cost is very much less, because the skilled molder required for sand molding can be substituted by a laborer, so that this cost, on a tonnage basis, can often be reduced to one-third.

As an example, it may be stated that in a case where a good molder can cast, in sand, about 900 pounds a day, the production of one laborer working with permanent molds averages one ton a day. As the molder's wages are nearly double that of the laborer, the difference in cost, on a tonnage basis, is considerable. When using permanent molds it is, of course, necessary for economical production that iron be furnished to the molds continuously, and the great advantage of the process as regards quantity of product lies in the fact that castings can be made continuously all day. The only skill that is required in working with the molds is that of pouring the metal at a uniform rate, but this skill a man can acquire in a short time. The castings come out of the molds with a very clean surface, and no chipping is required except to remove a slight fin formed where the molds come together, similar to the fin on a drop forging.

It is evident that small castings can be produced at a more rapid rate than large ones, because they do not heat the mold so fast. It has been found that the molds will deteriorate quickly if raised to a red heat, so the time elapsing between each pouring must be gaged according to the size of the casting and its consequent heating effect on the mold.

The heaviest casting that has so far been made by this process weighs 200 pounds, but there is apparently no good reason why much heavier castings cannot be produced by the process. In fact, molds are now being made for a casting which will weigh 750 pounds. As examples of work cast in permanent molds, may be mentioned 6-inch sewer pipes, 5 feet long, weighing 100 pounds; mining car wheels weighing 100 pounds; and heavy 6-inch T-castings weighing about 200 pounds.

The process is not applicable to the making of a few castings of a kind, on account of the expense of the molds. It occupies in this, as well as in many other respects, the same relation to the regular foundry practice as the drop forging process does to ordinary blacksmith shop work. If the casting is small and simple, it may pay to make a mold for a couple of hundred castings, but, in general, the process is only used where several thousand duplicate castings are to be made. It is at the present time being used by two large concerns besides the Tacony Iron Co., and efforts are being made to interest several other firms in securing the rights to use the process in their plants.

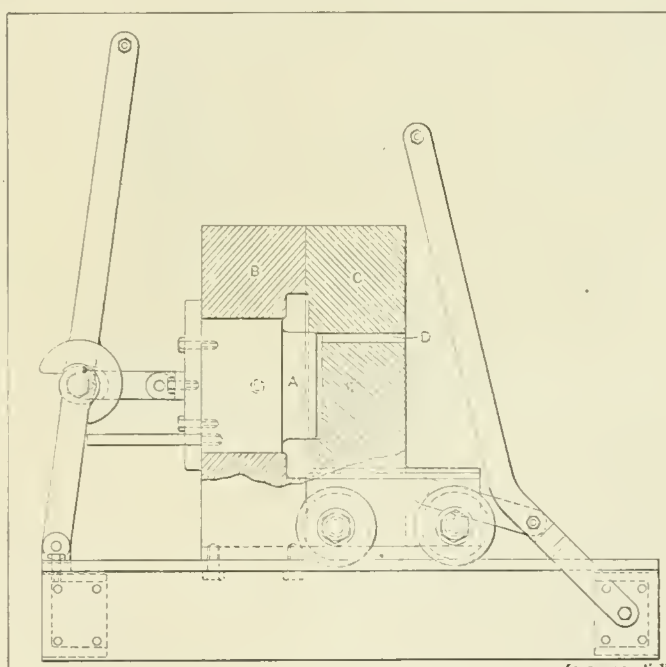


Fig. 9. Section of Mold shown in Fig. 8

Experiments have also been carried on with the permanent molds for making castings of steel, brass and bronze. With manganese bronze the same success as with cast iron has been attained, but the other experiments have not as yet been carried to a point where any definite statements as to the application of the process can be made. The experiments, however, are continued, and judging from the results so far obtained with cast iron, it is reasonable to expect that, with certain modifications, perhaps, it can be used for other metals as well.

Advantages of the Process

To sum up, the main advantages to be gained by casting in permanent molds are the uniformity of the metal cast, the absence of shrinkage strains, the exact duplication of

the mold, and the cheap production cost. The molds themselves are made comparatively cheaply for most shapes. The matrix is milled and bored out, and ordinary machine finish is all that is required. The process also introduces another possibility not found in the sand molding method. It is possible to produce a casting partly soft and machinable, and partly chilled and hard. This effect is accomplished by removing the mold from contact with the iron at such points as are required to be soft almost immediately after pouring, but permitting the parts to be chilled to remain in contact with the mold for a somewhat longer period. An example of this will be referred to in the following concrete examples of actual work done.

Examples of Molds and Castings Made

The accompanying illustrations show a number of the molds used. The mold shown in Fig. 1 is used for making two bevel gears at one pouring. The gears are 8½ inches in diameter and weigh 7½ pounds each. Two gears, one showing the face and one the back side, will be seen in the illustration. One of the requirements for these gears is that the teeth shall be as hard as possible, while the hub part must be soft so as to be easily machinable. This is accomplished in the following manner: About two seconds after the metal

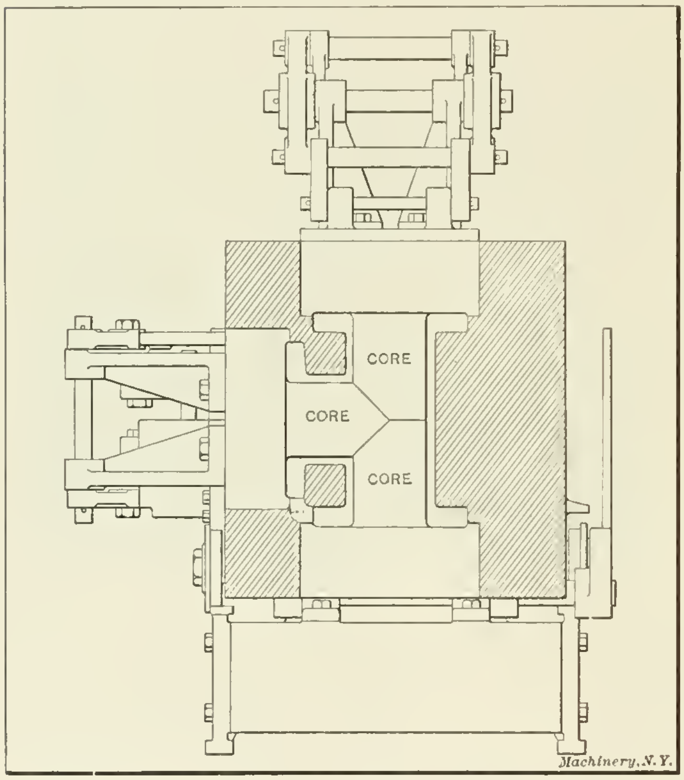


Fig. 10. Mold for a Heavy T-casting

has been poured into the mold, the cores are withdrawn by operating the smaller of the two hand levers shown to the left of the mold. The mold is also slightly opened so as to remove the back of the gear from the chilling influence of the mold. This is done by operating the larger of the two hand levers. Then about four seconds is allowed for hardening the teeth, after which the larger lever is operated to open the mold as far as its design permits. In doing so, the two large center plugs, one of which is clearly shown in the illustration, are forced forward, throwing out the casting between the molds, from where it is then removed by a pair of tongs.

The whole operation, from the beginning of the pouring until the casting is removed from the mold, does not occupy more than 15 seconds. A mold of this type can be poured about every four minutes, and about ten molds would be used in a battery, thus producing 300 gears an hour. The gate of this mold is placed in the center, and the metal flows from the common gate to the gear-molds on each side. Small vent holes are provided in the face of the left-hand mold as shown. There is very little trouble with entrapped air, however, on account of the fact that the molds are made in two sections separated vertically, which permits the air to escape between the halves of the molds as well as through the vent hole. Practically all the molds are made so that they part in a vertical plane, this being done especially in order to facilitate the operation and the rapid removal of the finished casting.

In Fig. 2 is shown a mold for making a 5 by 4 inch reducer, the metal in this being ¼ inch thick, and the casting weighing about ten pounds. In this case one-half of the mold is hinged so that it can be easily opened and closed. The cores are shown parted from each other, but not fully withdrawn. When the mold is closed, ready to pour, the strap shown bolted to the top of that part of the mold which is swung out in the illustration, rests on top of the stationary part of the mold, thus preserving the alignment. When in operation, the vertical lever to the right is thrown back immediately after the pouring is finished, this motion withdrawing the two cores. Immediately after having withdrawn the cores, the mold is opened and the casting is taken out. The total time required from the beginning of the pouring until the casting is taken out from the mold is about eight seconds.

Figs. 3, 4 and 5 show different views of a mold for making 2-inch eighth bends. In Fig. 3 the mold is shown closed, ready to be poured. In Fig. 4 it is shown open, the cores having been withdrawn and the casting removed. In Fig. 5 the cores are shown in position for the next pouring, it only being necessary to close the mold before making a new casting. The block bolted to the base of the machine supports the hinged half of the mold when it is in its closed position. The metal in this casting is ¼ inch thick. Its shape requires that the cores be withdrawn one from each end. The metal is poured, the cores withdrawn, the mold opened, and the casting removed, as fast as the operator can work. The time elapsing from the beginning of the pouring until the finished casting is removed in this case is about eight seconds. It will be noted that the metal enters into the mold from the gate by means of two channels, this being done because it has not proved successful to permit the molten metal to strike and pass by the joint of the cores as it must do if supplied from one channel only. There is no special locking device for holding the two halves of the molds together. In the case of small molds like the one here illustrated, the weight of the mold itself is enough to prevent opening up when the metal is poured.

In Figs. 6 and 7 is shown a mold for casting a mining car wheel 16 inches in diameter, and having a section of ¾ inch; this wheel weighs about one hundred pounds. The tread is chilled, but the center is soft. This is accomplished by first removing the core by means of the center lever to the left, within about two seconds of the pouring of the metal; then the lever at the right is operated, withdrawing the large plug, shown in Fig. 7, which forms the spokes in the wheel. This removes any chilling influence from the center of the wheel, but the outside or tread part remains in the mold for about six to eight seconds longer, at which time the plug in the right-hand half of the mold is moved forward again, throwing the casting out of the mold. The whole cycle of operations requires 40 seconds.

In the case of a big mold of this type it is necessary to hold it together while pouring. The two parts of the mold are held together by means of a bent rod or hook, as shown on the side of the mold in Fig. 6. It will be seen that this method of holding the two halves of the mold together permits of a slight expansion, which is absolutely necessary on account of the expansion of the parts due to the heat.

In Fig. 8 is shown a large mold for making a ten-inch extra-heavy pipe flange, 17 inches outside diameter and 2¾ inches thick, this casting weighing about 130 pounds. As soon as the casting is poured, the large center core is withdrawn, and then the mold thrown open. The casting is then removed by pushing the center plug or core in again, which forces it out, the same as in the case of the mining car wheel. When taking out the casting a hook is used for lifting it out and laying it on the floor. The two halves of the mold are held together by a bent hook or rod, the same as in the pre-

vious case. The leverage arrangement used to the left in Fig. 8 for withdrawing the core is of special interest. The levers are so arranged that considerable power and very little motion results when the lever is first pulled backward towards the operator. This is necessary in order to provide for the power that is required for starting to remove the core from the casting. Then, as the lever gradually descends to a horizontal position, the rapidity with which the core can be moved out is greater, as may be seen from the illustration.

The strength and the bulk of metal in the molds are the two main features to be taken into account in designing these machines, and they must be arranged so that they can be easily manipulated. In the case of the heavier molds it will be seen that the movable half of the mold is mounted on small wheels. In Figs. 3, 4 and 5 is shown how an extension lever is applied so as not to necessitate having so long a lever provided for every one of the molds in a battery.

If the mold should rust, the first few castings do not come out very well, the rust causing air holes. The casting process, however, is carried right on, and after a few castings have been made the difficulty will be overcome. For this reason the first castings in a new mold that has been shipped for some distance are often not satisfactory, because there is likely to be more or less rust formed in the mold in spite of the precautions that have been taken to prevent it. In the mold shown, castings are made having a thickness of from ¼ inch up to 2¾ inches. This gives a good idea of the range and possibilities of this process for castings of various types.

In Fig. 9 is shown a line engraving of the mold illustrated in Fig. 8. The part constituting the mold itself is shown in section, and the action of the device is clearly indicated. The plunger *A* is the core, *B* is the stationary, and *C* the movable part of the mold. The actual construction of the lever arrangement to the left, previously referred to, is also clearly indicated. Ample clearance is left in the mold *C* for the end of the core, and a hole *D* is provided for letting out the air in front of the core.

In Fig. 10 is shown a section of a mold for a 6-inch flanged extra heavy T; this mold is not shown in the half-tones. In this case three cores are used, one entering from the top, one from the bottom, and one from the side. The top and bottom cores are operated by the same lever, and the side core by an independent lever. The mold is then opened by a separate lever system, pulling the molds apart in a direction towards the observer in Fig. 10. The T cast in this mold weighs about 200 pounds. The molds shown in Figs. 9 and 10 were made for the Tacony Iron Co. by the Morris Engineering Co., Philadelphia, Pa., and the engravings are reproduced from drawings furnished by this company.

* * *

A convenient tool indexing system is used by the Acme Machine Tool Co., Cincinnati, Ohio. The tools, jigs and fixtures used in the manufacture of the company's product are placed on shelves, each tool being numbered separately. The numbers of the tools to be used for any particular piece of work are marked directly on the drawing of that piece, so that when the workman is given the drawing, he also knows immediately what tools to call for from the tool-room in order to complete the work in hand. This has been found a very convenient system. It saves a great deal of clerical work and eliminates mistakes. If the tools used for making any given pieces should be changed, it is a small matter to change the number on the tracing and make a new blueprint, or to change it directly on the blueprint, if desired.

* * *

Foreign users and builders of machinery seem to be much more particular about the proper location and cutting of oilways than they are in America. So little attention is given to this important detail here that there is no general-purpose oilway cutting machine on the market that meets with the approval of foreign manufacturers. We infer that a simple, low-priced machine adaptable to grooving large and small cylindrical bearings, either axially or helically, and also flat ways, would meet with considerable sale.

SYSTEM, EASY MONEY AND HONESTY

By A. TRAVELER

"The big plant of the Titan Engine Co. over there seems to be running pretty quiet now."

"Yes," said the Man Waiting for a Car, "they are practically down and out. The engine and boiler business has gone completely to smash. They are working now mostly on auto parts."

"What's the matter—thought the company was one of the biggest and strongest in the world?"

"It was and so it would be still if they'd let old Nat Greene, the superintendent, alone. You see he was a bit old-fashioned, and when the company became rich a number of youngbloods were brought in who thought they must have up-to-date methods and management. What did they do? Well, it's a rather long story, but I guess I'll have time to tell it—these cars run on a go-as-you-please schedule and the next one may not be along for ten minutes yet.

"In the first place the president, Hugh Bishop you know, had to go to Florida two years ago for his health. He was so bad off that he had to give up everything. He left the secretary in charge, and say! he and his clique didn't do a thing to the business. About the first shot out of the box was hiring one of them systematizers from Erie, to modernize the plant. This fellow put in what they called a premium system. I don't know just how it was supposed to work, but it worked out here to be a premium on dishonesty. Those boiler-makers pitched right in, and the way they turned out boilers was a caution to cats. Some of them made $8 a day right along, and they turned out boilers so fast that the company couldn't get cars enough to take them away.

"In the office things was just humming, too. The systematizer put in the most wonderful accounting system you ever heard of. He could tell to the tenth of a cent at any minute day or night what a governor ball cost, and could show you what it cost last month, the month before and so on *ad infinitum*. Gee! it was great! You ought to have seen the clerks —one hundred and fifty-seven of 'em—working away like mad tabulating statistics, filing cards, making out reports and other forms too numerous to mention.

"Old Nat Greene was just about crazy. He didn't know what to do or what his place in the new system was, but he knew things were going bad. All the men were eaten up with the idea of making big money and the systematizer and his crew was just pushing 'em along. 'Twas a good thing that Nat up and died from worry when he did for they'd have 'dumped' him anyway, and that would have broken his heart.

"After they had been working the new system for about six months the men didn't like things so well; the premium rates were changed and you can bet they weren't changed for the better. It was cut-and-cover then to keep up their pay anywhere near what it was before. You see the scheme was about like this. The head ones in the system were given big bonuses to secure a certain production and they took the profit out of the men.

"Well, about this time those boilers built under the new system began to give trouble. When they were set up in the power plants and fired up some of them leaked at every joint. It was terrible. Fifty of the best men had to go out on the road to fix up botched work, and then some of the boilers wouldn't stay sold! You can see a lot of 'em right over there now.

"But the boilers weren't any trouble at all compared to the engines. Along with all the other changes, they'd designed a new engine that was going to be a world beater, and they were so confident that they went right ahead and took contracts from nearly everyone in sight, putting up power plants. You ought to have seen some of the guarantees—they certainly did read fine. They say there is over a million dollars worth of them engines waiting to be hauled out and sold for scrap. They're absolutely no good.

"Well, after all these troubles things got real interesting in financial ways and the bankers took a hand in the business. The president got wind of the trouble and came hustling home

sicker than ever, I can tell you when he found out how things were, but it was a case of take the helm or go to smash entirely. Some of the items he found on the books about the City Hall boilers and bribing the city fathers he told about right out in Sunday school, and they sure did make a sensation. Two of the head men skipped out and went to Europe and several others resigned in a hurry."

"You don't think the system was to blame, do you?"

"Well, perhaps not, but it seemed to make everybody crazy for easy money and when men get after that, honesty and morality seem to sort o' fade away. Hello, here comes my car at last. Goodby."

* * *

LUMINATOR TREATMENT OF WATER

A very novel treatment of water, the invention of a German scientist, Herr Brandes, is being promoted in this country by the Luminator Water Co., 24 Cedar St., New York, this company holding the American patents.

This treatment of water for the prevention of scale in boilers without the use of chemicals consists in simply allowing water to run down an aluminum plate of special dimensions, with corrugations of a particular size, according

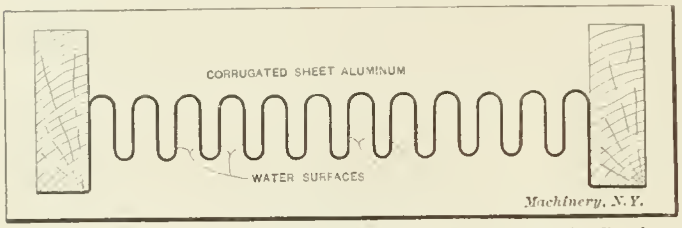


Fig. 1. Cross-section of a Luminator Plate, corrugated longitudinally, the Water to be treated passing down in the Corrugations

to the character of the water to be treated. The cross-section of one of these luminators is illustrated in Fig. 1, and a typical installation of a battery applied to softening water for railway service is shown in Fig. 2, which represents an installation on the Philadelphia & Reading Railway.

As shown in Fig. 1, the water passes down corrugated surfaces, inclined at a slight angle to the vertical; the corrugations present a large surface of contact between the aluminum and the water. No chemicals are required, it only being neces-

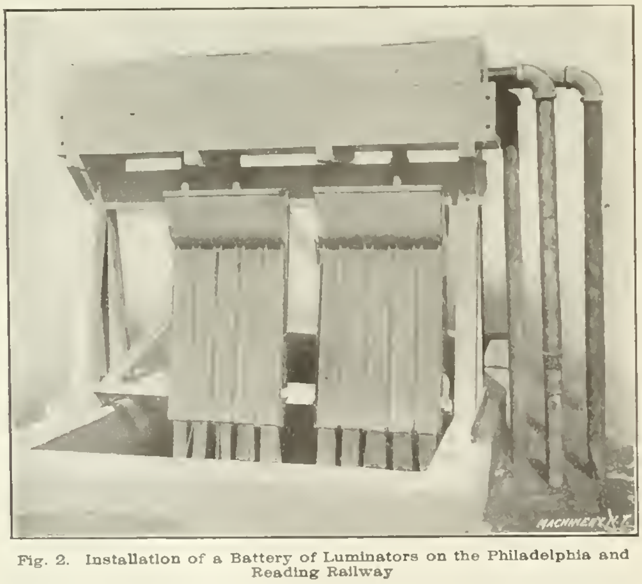


Fig. 2. Installation of a Battery of Luminators on the Philadelphia and Reading Railway

sary to brush off the corrugations at more or less frequent intervals, in order to clean and free them from deposit.

The discovery of the luminator was somewhat of an accident, and the phenomena accompanying its operation have been explained as follows: The passage of the water over the metal channels at certain speeds induces a very slight current of electricity, the water being negative and the plates positive. This causes the salts to ionize, and instead of taking a crystalline form they become amorphous; at the same time a new and particular action goes on, for the aluminum, by friction and electrical action, is abraded from the surface as a colloid, which after a period undergoes changes in the water.

Another remarkable feature of the luminator is that the best results are obtained when it is facing either north or south and exposed to direct light. The north and south direction is explained by the fact that when in this position the lines of force of the earth's magnetism are cut at right angles by the passing water, thereby inducing a small E. M. F., with the result that a slight electrolysis occurs, precipitating aluminum hydroxide in the solution. The presence of light is necessary to polarize the salts in the solution.

The action of water thus treated within a steam generator is somewhat obscure, but it is thought that the colloidal aluminum acts as centers for the evolution of carbon dioxide and the crystallization of salts; also the aluminum particles will combine with the dissolved oxygen of the water causing a marked de-oxygenation.

* * *

BARBERS' CLIPPERS NOT MACHINE TOOLS

The following United States Customs rulings made March 29 and reported in the New York *Times* are of considerable interest to those who are endeavoring to formulate a concise and comprehensive definition of the term "machine tool."

The Board of United States General Appraisers decided that hair-clipping instruments used by barbers for cutting hair are not "machine tools" within the meaning of the Tariff Act of 1909. The merchandise in controversy was entered by Sears, Roebuck & Co., of Chicago. The Custom House authorities classified the articles as "manufactures of metal" and imposed a duty of 45 per cent. Under the claim made by the importers the duty would be 30 per cent. The written decision of the board states that the tribunal is not satisfied that the articles under consideration are machine tools, it being maintained that the hair-clipper is an instrument of manual operation and would answer in that respect to the definition of a "tool." At the same time the board takes the view that the article in no way partakes of the character of power tools and is not within any of the definitions of the term "machine tools" as given by the lexicographers. The importer's claims were accordingly overruled.

Another claim involving the aforesaid tariff paragraph for machine tools was filed by the American Steel & Wire Co. The Collector of Customs at Cleveland assessed a 45 per cent duty on cast-steel rolls for rolling mills, on the ground that the rolls are for "manufactures of metal." It appears from the testimony that the articles are merely hardened cast-steel tools. The decision of the board states that while the articles may be parts of machine tools, they are not entitled to classification under the provision for machine tools. On this point the decision reads:

"The cold rolling mills of which these rolls are to form a part would, if imported, be subject to the classification at the rate claimed, but the steel rolls considered separately would no more be entitled to such consideration than would the gear wheels if imported alone. The protest is overruled and the decision of the collector affirmed."

* * *

TO MILL LONG NARROW SLOTS ACCURATELY

A valuable wrinkle worth remembering when milling long narrow slots in steel is that the feed should be in the same direction as the cut if absolutely straight slots are required. The reason is that thin slotting saws or cutters, which are very limber and easily sprung sideways, "track with the slot" when the feed is with the cut. The teeth strike into the metal fairly and there is no tendency to run. If the feed is against the cut a hard spot in the steel is likely to throw the cutter over to one side, and the teeth begin to run out of line. The portion of the slot already cut tends to guide them farther and farther away from the line of the slot, the result often being that the teeth are broken off. Feeding with the cut means a straight slot; feeding against the cut often means a spoiled cutter and a spoiled job.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A STAMPING PUNCH AND DIE

Among the numerous articles manufactured by Adolph Muehlmatt, Cincinnati, Ohio, are screw backs for lapel buttons of different kinds. These button backs are made of two pieces of sheet brass, the inner one being held in place by the edges of the outer disk which are cup-rolled over it in a punch press. Many of these button backs are stamped with the name of the purchasing firm when ordered in a sufficiently large quantity, the stamping being done immediately after the blanking operation.

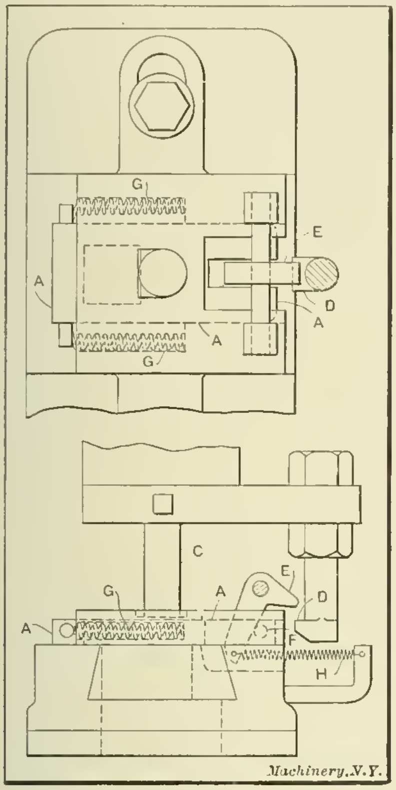


Fig. 1. Plan and Side Elevation of the Stamping Punch and Die

As the time taken to place and remove these disks from a common hollow stamping anvil-die was too great for economical production, the mechanism shown in the illustrations was designed to automatically drop the stamp disks as the press arose. By some, a disk feed might be preferred, but save for a little greater safety in operation, the mechanism shown has every advantage over the disk feed, when only a few thousand are to be run through at a time; nor is the factor of safety low, for as the stamping punch is considerably smaller than the disk, and also because of the squared outer corners of the plate, a sufficient margin is left for the fingers to drop the disks into place. Figs. 1 and 2 clearly show the construction of this mechanism, while Fig. 3 shows it in place in the punch press.

In Fig. 2, the anvil block *A* is shown partly drawn back, that its action may be more clearly illustrated. The anvil slide is made of machine steel with a piece of hardened tool steel *B* set into it directly in line with the stamping punch *C*. It is operated by the finger *D* pulling up on the hook *E*

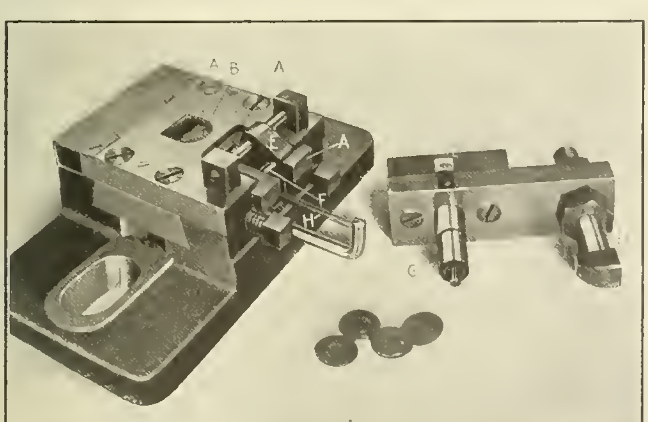


Fig. 2. Stamping Punch and Die with Samples of Work

as the ram rises, which causes it to push out on the pin *F*, drawing out the slide and thereby letting the stamped brass disk drop down through the bed plate into a box below. The continued upward movement of the ram releases the hook *E* from the finger *D* and the anvil flies back into place propelled by the springs *G*. The spring *H* is used to cause the hook *E* to catch promptly, as gravity alone will not bring it back with sufficient rapidity. Plunger *I* in the end of the punch *C* is a

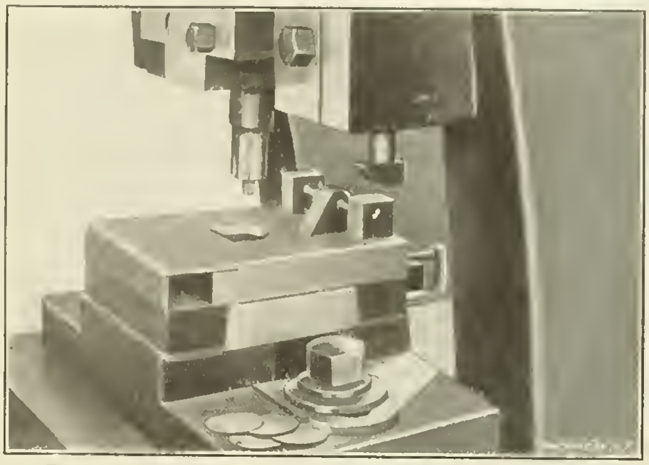


Fig. 3. Stamping Punch and Die in Position on the Punch Press

knock-out to prevent the punched disk from sticking to the lettering as the punch rises.

E. V.

SQUARE-THREADED TAPS

The making of taps which will cut a good square thread in a nut is a very difficult proposition, and, in fact, it has been found almost impossible to cut what might be called a perfect thread in a nut with a square-threaded tap. The usual way, and, undoubtedly, the best method of cutting threads of this kind is to use a set of taps, usually three or more, each one of these taps being passed through the nut successively. The taps should all be provided with a pilot at the end, as shown in the accompanying illustration Fig. 1. This tends to guide the tap straight, and improves its cutting qualities

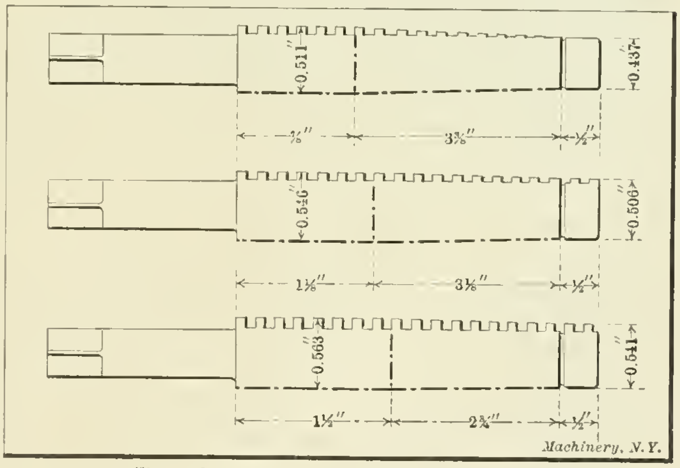


Fig. 1. Set of Three Taps with Square Threads

in general. The diameter of the pilot on each succeeding tap should be about 0.005 inch smaller than the full diameter on the top of the thread of the straight portion of the preceding tap. It is advisable to provide the first tap in a set with a left-hand spiral flute, to make it cut more freely. In Fig. 1 a tap having eight square threads per inch, 9/16 inch in diameter, is shown, and the proper proportions for a set of three taps of this diameter and number of threads are indicated.

When it is required to thread only a comparatively few nuts, it is possible, however, to do the work with but one tap, made as indicated in Fig. 2. When the tap is made in the manner indicated, as good a thread will result as if a set of taps were used, but, of course, the tap does not cut as freely and easily, owing to the fact that it removes considerably more metal in a shorter space of time, and with a smaller number of cutting edges. In this case the threads of the tap

are chamfered on the top as usual, down to a few thousandths of an inch over the root diameter of the thread. The reason for not chamfering the threads on the top fully down to the root diameter is to make it possible for the tap to "take hold" immediately in a plain hole. The tap is also tapered in the bottom of the thread for about one or one and one-half inch from the end of the threaded portion, and afterwards the square corners of the thread are removed by a 60-degree V-tool, having a flat equal to the flat at the bottom of the square thread. When chamfering the square corners of the threads with this tool, the taper attachment should be so set that while the tool enters clear to the bottom of the thread at the entering end of the tap, it gradually recedes so that at the upper end of the chamfered portion of the thread it does not enter any deeper from the top of the thread than it does at the beginning of the cut. This is indicated at A in the illustration. Taps made by this method have given satisfaction, and as one tap made in this way is considerably cheaper than a set of three taps made as outlined in Fig. 1, a considerable saving results in cases where only a comparatively few holes are to be tapped. CORRESPONDENT

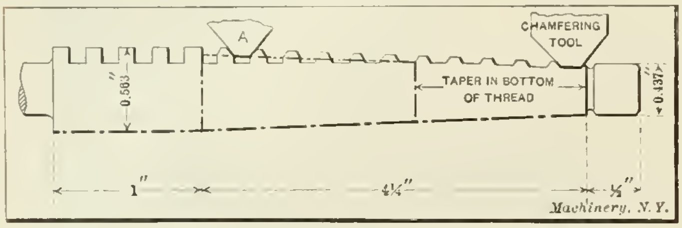
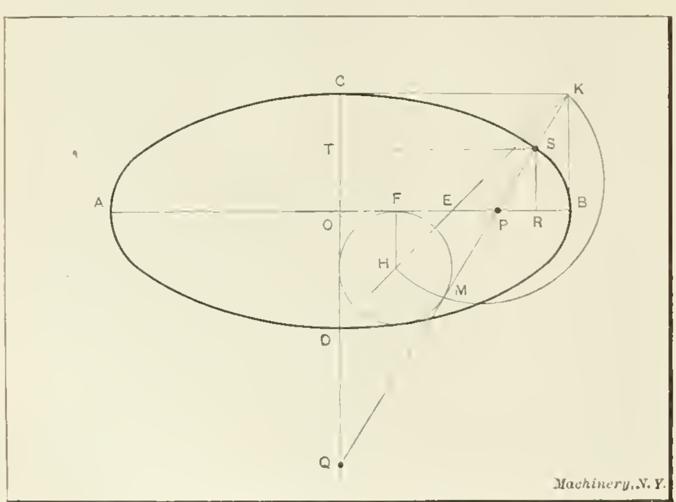


Fig. 2. Single Tap designed to perform the same Work as the Three Taps in Fig. 1

"A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION"

The article entitled, "A New Circular-Arc Ellipse Construction," which appeared in the March number of MACHINERY, engineering edition, interested the writer to such an extent that he investigated the subject still further, the results of his investigation being embodied in this article.

In the illustration AB and CD are the major and minor axes of an ellipse, equal to $2a$ and $2b$, respectively. On AB, lay off BE equal to OC; and bisect OE at F, erecting the perpendicular FH. Draw CK and BK, respectively parallel to AB and CD, and join KE, producing it to cut FH at H. With center H and radius equal to one-half OE, draw the circle FM; also draw the semicircle HMK on diameter HK, and through the point of intersection of these two circles, draw the line $KPMQ$, cutting AB at P, and CD produced at Q. P and Q will then be the centers of the component circular arcs, having common tangents at S.



Circular-arc Ellipse Construction

For the proof, the problem will be divided into two parts; the first part considering the condition to be fulfilled when the two arcs BS and CS shall have tangents in common with the ellipse at B and C, and also have a common tangent at S. From the similarity of the triangles EBK and EFH, and also as BK equals BE, FH equals FE. But FE is equal to $\frac{OB-OC}{2}=\frac{a-b}{2}$; therefore $FH=\frac{a-b}{2}$, which makes the radius of this circle dependent only on the axes, so that the only condition for these three points being in the same line is that this line be tangent to the circle of radius $\frac{a-b}{2}$.

Also the line that bisects and is perpendicular to the chord BS, must bisect the angle OPQ and contain P; and similarly the bisecting perpendicular to the chord CS contains Q. The intersection of these two lines would be at H, which must be the center of the inscribed circle in triangle OPQ.

The second part of the problem is to locate point S so that the compound curve will approach as nearly as possible to that of the ellipse. For the matter of proof, consider that the point S is contained in the ellipse. Let SQ and SP be represented by R and r respectively. In the triangle OPQ, $\overline{QP}^2 = OP^2 + QO^2$

$$(R-r)^2 = (a-r)^2 + (R-b)^2$$

Hence

$$2\,(R\,b + r\,a) = a^2 + b^2 + 2\,R\,r \qquad (1)$$

The triangles STQ, SRP and OPQ are similar; therefore

$$x = \frac{a-r}{R-r}\ \text{and}\ y = \frac{(R-b)\,r}{R-r}$$

When the ellipse contains S, the equation to the ellipse must hold good at that point; or

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

Substituting the above values of x and y in this equation gives

$$(a^2+b^2)\,R\,r + 2\,a^2\,b^2 = 2\,a\,b\,(R\,b + r\,a)$$

which by introducing the value of $Rb + Ra$ above, reduces to

$$Rr = ab \qquad (2)$$

The condition to be fulfilled when the meeting of the two arcs is a point of the ellipse will therefore be that the line containing the two centers cuts the axis in points P and Q so that PB and b are inversely proportionate to QC and a. This will occur when the tangent PMQ passes through K.

By solving Equations (1) and (2) the values of the radii are deduced as follows:

$$R = \frac{(a+b)^2 + (a-b)\sqrt{a^2+b^2-6\,a\,b}}{4\,b}$$

and

$$r = \frac{(a+b)^2 - (a-b)\sqrt{a^2+b^2-6\,a\,b}}{4\,a}$$

In practice, this construction may be simply done in the following manner: When the lines CK and BK are drawn, draw lines through O and K, forming an angle of 45 degrees with AB. With their point of intersection as a center and the distance to one of the axes as radius, draw an arc at M. Drawing a tangent to this arc at M from the point K locates the two centers P and Q. J. H. V. BRAMMER

Duquesne, Pa.

USE OF RUBBER STAMPS ON TRACINGS

The accompanying description is of a method which has been successfully used by the writer for over five years for the purpose of stamping tracing linen. Any kind of rubber stamp that is made for use on flat surfaces is applicable, for success lies merely in the way the ink is applied.

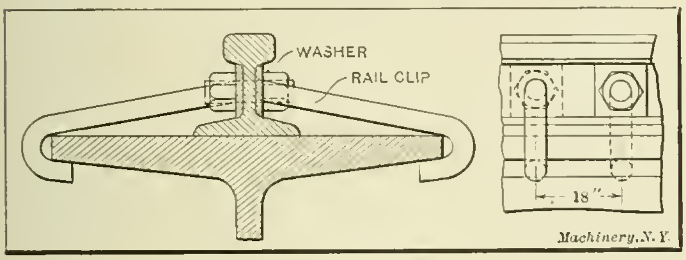
The method is as follows: Take some "Original Nubian Black," No. 6729 printing ink, which may be obtained in very small cans, and put a very small portion on a piece of plate glass; about one-quarter the amount that can be put on a dime will be sufficient. Spread this small amount of ink with hand roller, such as are furnished with small name card printing presses. Continue this process until the ink is of an even thickness all over the roller; the latter should

then be run over the face of the stamp until the types are evenly covered with ink. An impression can now be made with the stamp. After doing this, take a can of cheap commercial talcum powder and sprinkle a very small quantity over the impression, spreading it lightly with a cloth. Dust off all the surplus that is not absorbed by the ink; this dries up the damp surface and keeps it from blurring. It can now be used for making blueprints and there will be no danger of the ink smearing if it has not been put on too thickly. This latter can be best determined experimentally.

This ink is a very deep black, but is soluble in gasoline; and consequently, if an unsatisfactory impression is made on the tracing cloth, it may be easily washed off. In the use of this process, it is advisable also that all ink be washed off the stamps and roller before putting away. The glass plate, however, need only be washed off once a week, or as often as experience dictates, provided however, that it is kept from the air and dust while not in use. W. G. W.

RAIL FASTENINGS FOR CRANE RUNWAYS

When designing a shop that is to have runways for overhead cranes, the use of Bethlehem beams or I-beams will be found practical. Up to the present time, Bethlehem beams have not been used to any great extent for this purpose on account of the great cost of making holes in the flanges for



Rail Fastening for Crane Runway

bolting or riveting on the rail. These holes would have to be drilled, as the flanges are too thick for punching. By using a clip such as shown in the accompanying sketch, a Bethlehem beam can be used, and punching or drilling done away with. For a 40-pound or heavier rail, it would be advisable to use ¾-inch round iron for the clips and place them at 18-inch alternate spaces. A washer can be put under the nut of the clip to make a flat bearing surface on which the nut can turn. By loosening one clip and tightening the opposite one, the rails can be straightened or adjusted to the proper gage. EDWIN J. KNAPP

Cleveland, Ohio.

TAPPING A LEFT-HAND THREAD WITH A RIGHT-HAND TAP

One of the men in the shop performed a little kink a short time ago which was so novel to the rest of us that the writer thought it was worthy of further publicity.

A ⅝-16 left-hand tapped hole had to be made in a piece of work and as there were no ⅝-inch left-hand taps in the shop, and also as the swinging of the piece on the lathe was out of the question because of the bulkiness of the work, some

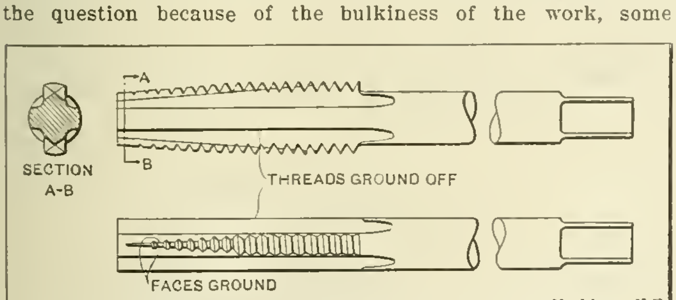


Fig. 1. Right-hand Tap ground in Such a Manner that it will tap a Left-hand Thread

means of doing the job had to be improvised. This was accomplished by taking a ⅝-16 right-hand starting tap and treating it as shown in Fig. 1. Two of the opposite lands had their threads completely ground off and the edges of the two remaining lands were so ground towards the point as to leave just a narrow section of thread. This narrow section of thread, therefore, conformed quite closely to that of a similar section in the left-hand tap.

In tapping the hole, the tap was entered gradually by turning it to the left, as little pressure as possible being exerted, thereby preventing the tap from reaming or cross threading. The tapped hole showed a clean thread which satisfactorily answered the purpose for which it was intended.

CHAS. DOESCHER

Waterbury, Conn.

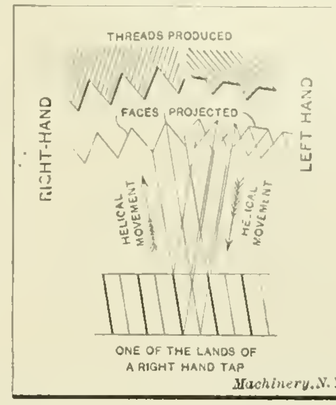
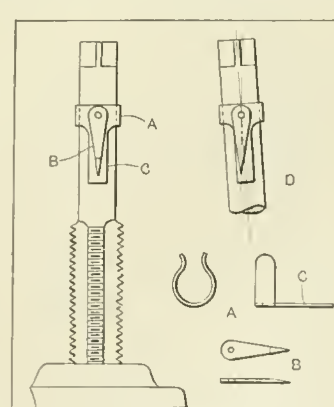


Fig. 2. Diagrammatic Representation of the Cutting of a Left-hand Thread with a Right-hand Tap

[As might be inferred from the method of tapping, the thread produced will not be perfect. The reason for this is graphically shown in Fig. 2, which is a somewhat exaggerated representation of one of the lands of a right-hand tap. In cutting in its normal manner, *i. e.*, cutting a right-hand thread, the helical movement will be as shown. The projection of the teeth on a surface normal to the helical direction is the same as the cross-section of the teeth, and therefore a perfect thread is produced, all as represented on the left side of the illustration. On the other hand, if the same tap be used to cut a left-hand thread, the helical movement will be around a helix ascending in an opposite direction. The projection of the right-hand teeth of the tap on a plane normal to this left-hand helical direction will be as shown. The face of the teeth will cut a perfect thread but the rear portion of the land, being helical in a different direction, will drag, making the bottom of the thread flat and scraping the side off of the adjoining teeth, which condition is represented in the upper right-hand corner of the illustration. However, for the purpose for which it is intended it seems to have given satisfaction. A sample cast-iron nut sent for inspection with the tap, showed a very nearly perfect thread, having the general characteristics of the U. S. standard; for, while theoretically it should not flatten at the top of the thread, it apparently has done so, though to nothing like the exaggerated extent represented in Fig. 2 for the thread bottoms.—EDITOR.]

A TAP PLUMB

The accompanying illustration shows a simple device for use when tapping holes in work which has previously been leveled, and on which it is impossible to use an ordinary square for determining whether the tap is going in square or not. This device consists mainly of a band *A*, which is bent into a circular shape to fit the shank of the tap. A pointer *B* is riveted to this band, but is allowed to swing freely, so that it can register whether the tap is going in square or not. An index line is scribed on the projection *C* of the band *A*, and when the pointer registers with this line the tap is in a perpendicular position in one plane. Of course this device cannot indicate when the tap is out of plumb on the side to which the pointer is attached, as is shown clearly at *D* where the tap is slightly inclined to the left, but it can be turned to any position. The band is made from sheet steel and tempered, and the pointer is also made from sheet steel, but not tempered. J. E. C.



Application and Details of Tap Plumb

A FRICTION CLUTCH

The accompanying illustration shows a friction clutch designed by the writer for starting, stopping or reversing. This clutch was made for a drilling machine and it will easily transmit the power delivered by a 3-inch belt, running on a 14-inch pulley, at any speed up to 500 or 600 revolutions per minute.

In the particular machine for which this clutch was designed, the clutch-shaft was entirely independent of the rest of the machine (being coupled to the clutch body), so that to save machining the shaft was cast integral with the clutch body, as shown in Fig. 1.

The friction rings were first made of mild steel, but we found that cast iron was preferable. It may also be interesting to know that the 42 by 6 pitch miter gears by which the clutch was driven were also made of cast iron.

The levers which expand the rings are of tool steel, hardened at the wearing end, this hardened end pressing against the hardened tool-steel pads which are dovetailed into the rings. Fixed on the inside of the sliding collar *A* is a hardened tool-steel cam or wedge *B*, which provides the necessary movement to the levers, through small screws having rounded ends, these screws being checked by locking-nuts. The cam, or at least the working face of it, forms part of a circle so that the motion of the levers is a harmonic one; that is, the leverage increases as the friction rings begin to take hold. This is required to prevent the clutch from slipping, and also to keep it from working out of engagement by vibration.

Another detail (not shown in the illustration) is the milling of, say, a dozen grooves about 1-4-inch wide and 1-16 inch deep, across the face of the rings. This increases the pulling power of the clutches considerably. RACQUET

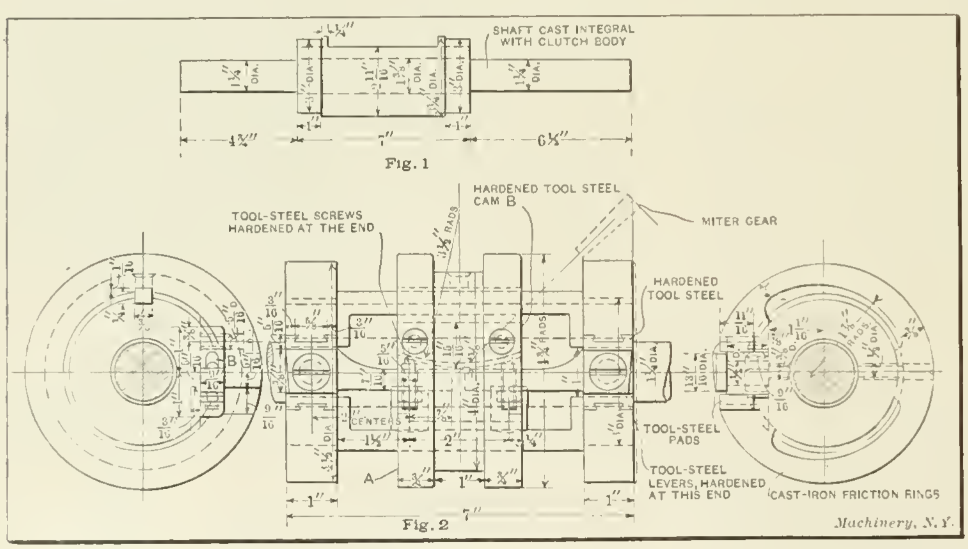


Fig. 1. Detail of Shaft and Clutch Body. Fig. 2. Assembled View showing how Clutch is operated

CUTTING A MULTIPLE-PITCH WORM

Being particularly interested in the cutting of multiple-threaded screws in the lathe, the writer would like to add a further contribution to what has already appeared in the November and February issues of MACHINERY under the heading of "Cutting a Multiple-Pitch Worm."

Both contributors have given a rule whereby, under certain conditions, the lead-screw of the lathe may be employed for the purpose of dividing the lead of the worm being cut; but in neither of the two articles has any reference been made to the pitch of the lead-screw, and as this is one of the chief factors in problems of this kind, the rules which have been quoted must be considered as incomplete.

Now in all cases the pitch of the worm (lead of the worm ÷ number of threads) and that of the lead-screw bear a definite relation to each other; and if it is desired to use the lead-screw for the purpose of spacing the threads, then, generally speaking, either one or the other of the following conditions must be satisfied: (a) The pitch of the worm must be equal to, or a multiple of, the pitch of the lead-screw; or (b) In the case of fractional pitches, the distance represented by the least common multiple of the pitch of the lead-screw and the product of the pitch of the worm and a whole number—either one more or one less than the number of threads in the lead of the worm—must not be a multiple of the lead of the worm. In all other cases, the required division must be obtained, either by "chalking the change gears," or using some one of the different methods described in MACHINERY's Reference and Data Sheet Series.

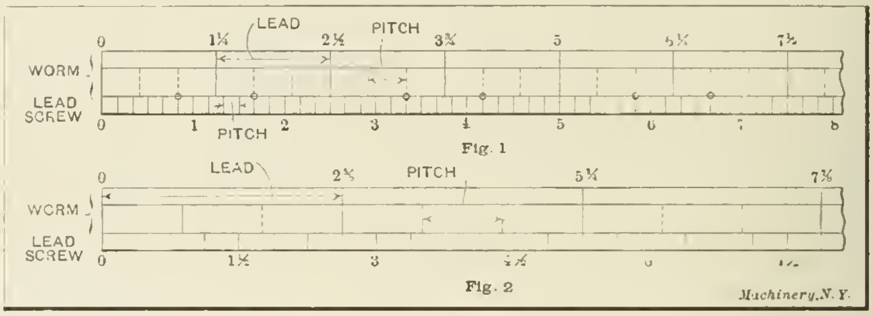


Fig. 1. Cutting a Triple-thread Worm having a 1 1/4-inch Lead with a 6-pitch Lead-screw. Fig. 2. Impossible Conditions of Cutting a Triple-thread Worm having a 2 5/8-inch Lead, with a Lead-screw having a 3/8-inch Lead

Multiple-threaded screws which satisfy (a) will also satisfy (b), and present no serious difficulty when cutting; but those screws which meet the requirements of (b) only, are more troublesome to deal with. The following example quoted by O. G. will be worked out: The lead of the worm is given as $1\frac{1}{4}$ inch and it is triple threaded; therefore the pitch is equal to $\frac{1\frac{1}{4}}{3}$ or $\frac{5}{12}$ inch. As the pitch of the lead-screw is not given, assume it to have six threads per inch or a 1/6-inch pitch (a reasonable assumption for American practice) so that from (b) it is required to find the least common multiple of $\frac{5}{12} \times 2$ and $\frac{1}{6}$ which is equal to $\frac{5 \times 1}{6}$ $= \frac{5}{6}$ inch.

This distance of 5/6 inch not being a multiple of $1\frac{1}{4}$ inch (the lead of the worm), the division of the lead may be obtained from the lead-screw from rule (b) as follows: After taking the first cut and stopping the lathe, the screw-cutting stop must be set a distance from the end of the saddle equal to 5/6 inch multiplied by any whole number such that the product is not a multiple of the lead of the worm. This distance depends, of course, on the length of the worm, as for example, if the length of the worm were 3 inches, then the stop would be set back a distance of $\frac{5}{6} \times 4 = 3\ 1/3$ inches where it will be found that the clasp-nut will gear in, and when the lathe is again started a second thread would be formed, and so on until the worm is completed. This will be readily seen from a reference to Fig. 1, which consists of two scales, the lower representing the threads of the lead-screw, and the upper, those of the worm; the lead of the worm is shown by full and the pitch by dotted lines.

As the distance the saddle may be moved for the clasp-nut to engage is always equal to a complete number of the threads of the lead-screw, if the tool is to generate a second thread the scales must coincide at some other points besides those of the lead of the worm; otherwise, the division is impossible, as in Fig. 2.

In Fig. 1 the threads coincide every 5/6 inch, and it is obvious that after the first thread has been generated if the clasp-nut were engaged at any of the circled points, the lead would be divided as required. These distances, measured from the zero of the scale, correspond to the results obtained from working out the example.

Consider next the worm example given by S. H. C. Here the length of the worm is $4\frac{1}{2}$ inches, lead $2\frac{5}{8}$ inches, and it is triple threaded. Assuming that the pitch of the lead-screw is $\frac{3}{8}$ inch (frequently the case in English lathes), it is necessary to find the lowest common multiple of $\frac{2\frac{5}{8}}{3} \times 2$ and $\frac{3}{8}$, which is $\frac{14 \times 3}{8} = \frac{42}{8} = 5\frac{1}{4}$ inches. But $5\frac{1}{4}$ inches is twice the lead of the worm; in other words, it is a multiple and does not satisfy the conditions of (b), so that the division in this case is impossible, as may readily be seen by referring to Fig. 2. It will be noticed that by taking other pitches for the lead-screws the rules obtained by S. H. C. and O. G. will be reversed, showing the need for the more explicit statements given in (a) and (b).

While in no way detracting from the truth of the above statements, it may be observed that when the lowest common multiple obtained is great in comparison to the length of the screw, it is a questionable policy to adopt this method, as probably more time would be taken in traveling over this distance than would be by adopting other methods.

Belfast, Ireland. G. H. Longworth

ORGANIZING A DRILLING DEPARTMENT

How to make the drill gang pay, was for a long time a big question in our shop. High-priced men were found to be accurate, careful mechanics, but much too slow, spending altogether too much time grinding their drills to standard plug when they were to be used for such purposes as clearance bolt holes, etc. Low-priced men were equally unsatisfactory for the opposite reason; but the real difficulties occurred when an attempt was made to mix the two kinds of mechanics.

After many trials the drill gang was arranged as shown in Fig. 1, and has given very satisfactory service, no trouble

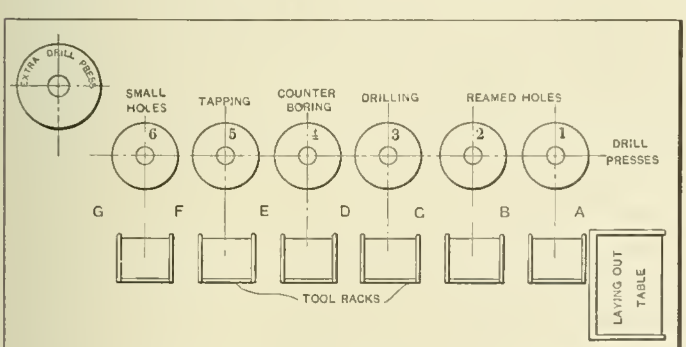


Fig. 1. Manner of Arranging Drill Presses to expedite Work

being experienced from the different qualities of labor. The gang is what the "old man" calls "self-driven," and everyone is satisfied. In this arrangement there are six drill presses with accompanying tool-stands or tables, an extra drill press and the laying-out table, as Fig. 1 shows. Numbers 1 2, 3, 4, etc., designate the machines in their order of importance, the most important being nearer the laying-out table so that any information may be obtained from the "layer-out." The better mechanics are placed at this end, grading down to the less skillful ones on the farther machines. This arrangement gives the operators of the lower-priced machines an incentive to work up, as the better job is always just ahead.

To consider the system in operation, the production of a sample piece, such as is shown in Fig. 2, might be followed through. Suppose ten of these pieces are to be produced. The pieces are brought, in a rough state, and placed upon the laying-out table where they are laid out, and dropped on the floor at *A*, the drawing being tossed over onto the tool rack in front, where the first drill-press hand has an opportunity to examine it. The operator on the first drill has instructions to drill all holes which are $1\frac{3}{4}$ inch and over. He sets up, drills, and reams the 2 1/16-inch hole shown, and throws the piece down at *B*. Number 2 being instructed to drill all holes which are $1\frac{3}{4}$ inch and under, sets up, drills and reams the $1\frac{1}{2}$-inch hole shown, dropping the piece at *C*;

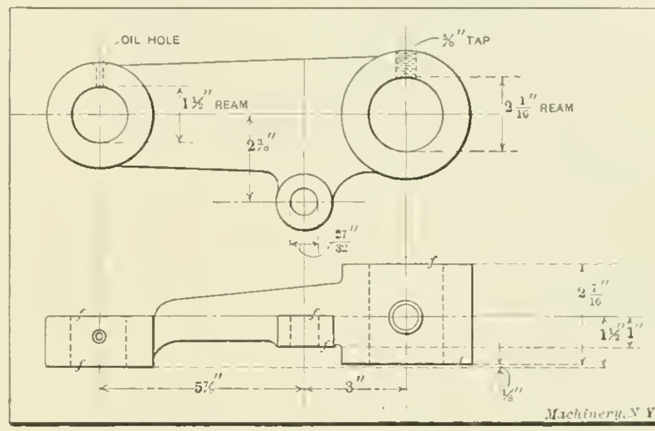


Fig. 2. Sample of Work serving to illustrate the Operation of the System

Number 3 drills the 27/32-inch hole, dropping the piece at *D*. Number 4 places it on the counterboring block and faces the two large bosses, omitting the small boss, and then drops it at *E*. Number 5 clamps it to an angle-plate and taps a 5/8-inch hole, dropping it at *F*; and Number 6 drills and countersinks the oil hole, finally dropping the piece at *G*. At this point the apprentices get their practice, for they face off the small boss and pile the work up. The drawing, which has proceeded from the lay-out table down to the sixth drill, has been sent on with the first piece passed along. It is finally taken away with the work. Holes that would interrupt the series in this rapid passage are passed through the bank of drills and left for practice by the boys. Where there are two reamed holes in a piece, both of which would be within the range of the first drill, this operator has instructions to do only one, leaving the other hole for the second drill. Sometimes as many as three drills may have to be assigned to reamed holes, a matter which, of course, is determined by the conditions of the work. In the use of this system it will be found advisable to employ apprentices in carrying drills back and forth for the drill press hands, as under this system the drill-men will be busily engaged all the time.

It might at first appear to the uninitiated that this system does not balance properly; that is, that all the drills will not be fully employed; one may be working at its top notch, while another is only working at part of its capacity. This largely depends upon the "layer-out," who should also be the gang foreman. It is his duty to distribute the work when there would not be sufficient work on one series for the whole "bank" to be engaged upon. It may sometimes be necessary to lay out straight drill work, tap holes, etc., for the men on the low-grade machines—a matter that depends entirely upon the judgment of the foreman. Chips

PHYSICAL INJURY FROM DRAFTING

After reading the article by B. L. W. in the January, 1911, issue of Machinery, engineering edition, we would naturally arrive at the conclusion that drafting work is literally "slow death," that it would work havoc with the most robust of constitutions, and that internal members are sure to show the harmful effect. If the calling is pursued in the manner indicated, these facts cannot be disputed, but the writer is of the opinion, taken from personal experience and observation,

that conditions normally should not be as deleterious as those cited, in a profession requiring mainly brains, sight and touch.

Undue pressure, or in fact any pressure against the drawing-board, is absolutely unnecessary. The work does not call for such use of this portion of the anatomy, and its application rather denotes laziness on the draftsman's part; for him to inflict self-injury in this manner is an act of indiscretion. The drafting-board should be of sufficient height so that either in standing or sitting the workman has access to it without any effort; it should allow bending at the proper line, the waist, and should offer positive freedom from contact. With large drawings, covering the entire board in width, such as a machine assembly, etc., it is difficult to work on the farther side, and it is far better to kneel on the stool, keeping the body clear of the board, than to create a strain or pressure on the abdomen. The practice, however, of using small drawings in sets, which is rapidly becoming universal, makes such an incident as this rather infrequent. The vertical board, so often recommended, hardly ever finds a place in large drafting-rooms, except for sketch making; it does not seem conducive of accurate work.

The greatest injury due to drafting work is apparently neglected in this article—that to the eyes. This occupation, more than any other form of clerical work, requires excessive application, and the draftsman should use the utmost care; the light should fall on the work properly and with sufficient volume; artificial light should be used as little as possible, and should never be resorted to throughout a bright day—the effect of this practice will soon become noticeable. The stooping tendency, or round shoulders, which easily grows on any one no matter in what walk of life, is easily corrected with proper treatment. Drafting work requires of its followers a steady hand and a clear brain, and he who would be successful must regulate his life accordingly.

The drafting-room is usually the starting place for a successful career in the mechanical and kindred trades, and such a training invariably makes a far more efficient man in line for a position "higher up." To the young draftsman setting out in life, it is not very encouraging to see held up before him as in a mirror the detriments of his profession, especially through misuse of a portion of the body which should be inactive. L. R. W. Allison

Los Angeles, Cal.

WORM VS. CHAIN DRIVE FOR AUTO TRUCKS

The attention of the writer has been directed to the editorial on "Worm vs. Chain Drive for Auto Trucks" which appeared in the March number, engineering edition, and as the statements made are opposed to the experience of the very considerable number of engineers who have now for years been engaged in building automobiles, both pleasure cars and trucks, equipped with worm drive live axles, some remarks in reply seem necessary.

It must be understood, that unless the best workmanship is available, any kind of worm gear is best left alone, and in this matter the writer is entirely in agreement with the editorial. The latter, however, proceeds to state that the efficiency is at best "still relatively low." At this point it becomes evident that modern practice and modern engineering literature have alike been overlooked. The efficiency of worm gears properly designed and correctly mounted is as high as 95 per cent. This statement is made from the writer's own observation and can be calculated from the formula:

$$e = \frac{1 - \mu \dfrac{P}{\pi D}}{1 + \mu \dfrac{P}{\pi D}}$$

where μ = coefficient of friction,

P = axial pitch of worm, and

D = pitch diameter of worm.

On page 746 of the "Automobile Trade Directory" published in January, 1911, will be found a table by Worby Beaumont, an engineer of high professional standing in England; as consulting engineer to the Royal Automobile Club, he may be supposed to speak with some authority. This table gives the efficiency of various types of transmission mechanism. Here it will be found that one set of gears will absorb 5 per cent of the efficiency and two chains 6 per cent, or a total of 11 per cent, giving for a bevel and chain transmission of the usual type a total efficiency of 89 per cent against 95 per cent for a worm transmission.

Were it possible to employ for a large truck a single final bevel reduction, the efficiency of the bevel gear would be equal, but not superior to, that of the worm gear; owing to the size of gear which this would involve, such an arrangement is not possible, however, and chains must be employed, making the further reduction in efficiency referred to. Beaumont's figures, however, are for new chains, and it is a fact well known to all engineers that their efficiency falls off rapidly as they become stretched and their sprockets become worn from use, so that the 89 per cent efficiency when new, is probably as low as 75 per cent long before the chains are worn out. It is therefore difficult to see in what way the efficiency of the worm gear is "relatively low" particularly when it is remembered that the wearing of a worm and worm-wheel does not reduce its efficiency at all, owing to the fact that the tooth sides are flat and remain so in spite of wear.

The article next makes mention of the "self-locking feature" of worm gears; it is not a little curious that this point is so frequently brought up; it is so obvious that no automobile could exist with a worm gear were it not possible to "coast" as freely as with a bevel, that it is difficult to conceive any engineer building such a machine unless he had first proved the fallacy of this impression.

Irreversible worm gears are so common in such mechanisms as elevators, and the dividing heads of machine tools, that the uninitiated are apt to overlook the geometrical principles on which the operation of any worm gear depends, and which make it an easy matter for the designer to make the gear reversible or otherwise at his option; it is only a question of varying the gliding angle, which is always a function of the spiral angle, though never equal to, but always greater than this.

As to durability, which is the next point raised, it is probably not generally known that heavy trucks fitted with the worm gear are in general use in England and have been for the last 7 or 8 years. In London omnibus work, where three-ton chassis are employed in what is admitted to be the most severe work to be found, worm gears have given satisfactory results for the last five years.

The writer has before him at present, a letter from the operating engineer of Thos. Tilling, Ltd., the owners and operators of a large number of public service vehicles in London, in which is the statement: "The average life of a worm drive on a ———— omnibus is between 28,000 and 30,000 miles; now that we have re-designed the torque-rod, the life should be 40,000 miles." The writer has yet to find any chain which will in average working approach one-half this distance.

Reliability is much the same as durability, but as the two are mentioned separately in the editorial they will be dealt with in the same manner here. To take only one example, Messrs. Dennis Bros. who were the pioneers of the worm drive for trucks have always given a specific guarantee of two years with every worm-driven rear-axle they have made, and their range of models has for five years included those of five tons capacity. Has any manufacturer of other forms of drive exceeded this?

Lastly the editorial introduces the old argument of complication and unsprung weight and all the disadvantages thereof. This is such an old friend; those of us who have had some experience in the automobile industry have lively recollections of precisely similar objections when the gear drive was first substituted for chains in the lighter vehicle; those familiar with present-day practice know how far they were removed from fact.

The analogy between pleasure cars and trucks is largely in

favor of the latter, inasmuch as their slower speed is in their favor size for size, the destructive effect of shocks, etc., being measured by the energy stored in the vehicle. Since Energy $= \frac{WV^2}{64.4}$ foot-pounds, it follows that destructive action will vary directly as the weight and the square of the velocity. Hence it is simpler to make a live axle for a truck than a pleasure car because of its lower speed.

With regard to repairs, it is obvious that a broken chain can be easily repaired; it is equally obvious that such repairs are unnecessary if no chains exist. If a worm gear will last from 30,000 to 40,000 miles as it does, it may be assumed that roadside repairs are not a frequent occurrence, and as far as the axle itself is concerned it becomes a problem of every-day mechanical engineering to design what will be strong enough for the purpose.

Lastly, the whole question of worm drive for automobiles is regarded as a new and obscure thing—not fit to be understood. That this is the case in this country must be the result of accident or prejudice; it was past the experimental stage ten years ago in England, and such names as Lanchester, Napier and Daimler in pleasure cars and Dennis, Halley and Leyland in trucks, not to mention many others, should be sufficient guarantee that the worm axle is a practical and reliable proposition. H. Kerr Thomas

Buffalo, N. Y.

AN EXPERT MACHINIST AND ENTERPRISING INVENTOR

I notice the announcement of the recent death of Henry D. Dunbar, inventor of the Dunbar steam-adjusting piston packing. I came in contact with him for a short time about fifty years ago, and have always remembered him as an expert machinist, so it would seem to be eminently proper to say a few words about him, and what he did within my own knowledge.

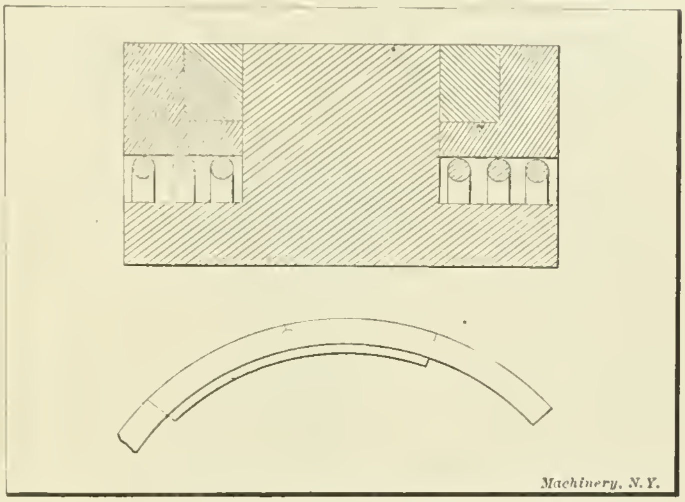
He came to the Starbuck Iron Works, Troy, N. Y., in 1861, and personally introduced and applied his recently patented piston packing, which was at that time a novel departure in that line. The Starbucks were then the builders of tugs for river service, and steam engines, both portable and stationary, so they had considerable use for the packing. Dunbar had been introducing his packing in railroad shops in the South, but when the war began they at once ignored his patent, and made packing *ad libitum*, so he was driven North to see what he could do with it.

When he went to an engine works of any kind he only asked an opportunity to put in a set of the packing, and to show how perfectly it would work; and incidentally he showed how cheaply it could be made. At the time he came to Starbuck's I was running a 20-inch screw-cutting lathe with a swing head, tilting rest, etc., and doing an endless variety of work. In front of me and back to back to my lathe was a 30-inch lathe, strong enough in pull, but rather awkward to handle, none too reliable in any of its movements and with no cross-feed.

One morning when work began there was Dunbar with a "chunky" ring casting near him, and entirely without help he soon had it chucked and started to make a set of packing—bull ring and the small rings, as shown in the accompanying illustration, which were for a 16-inch piston. A little before 6 o'clock (of a ten-hour day), the entire job was completed, the rings sawed, the stop-pins inserted, one in each ring. so as to make them always break joints properly, the plain round wire springs which hold the ring out when the steam was not on were bent and cut to length, and the whole job was laid out in good shape on a board.

It was all done so easily that no one at the time thought it anything remarkable, but when we tried it later no one was able to come up to it. He turned out probably about half a dozen sets while he was working at Starbuck's, and the time made on the first set was about the average for any that he completed. He carried about three special lathe tools in his kit; he also had a circular saw on an arbor with a dog on all ready to stick on the centers, which he used in a small lathe. These were all the special tools that he had.

The Starbucks used this packing on all the engines that they turned out for years, but some changes were later made in it. The two pieces for each section—the rings being sawed in six pieces—were riveted together, and a flat spring was fastened by a screw to each section; but I doubt whether after all, they worked any better than the original Dunbar packing. Dunbar at that time was less than thirty years of age; it is to be hoped that he was fairly paid for his in-



Section of Original Dunbar Packing

vention and for his pushing of it, but it soon began to be crowded and pushed out by improvements, and so it goes.

Mr. Dunbar later and for many years was erecting engineer for the Baldwin Locomotive Works, and it has been stated that it was while holding this position he invented his piston packing; but that cannot be correct. The date of his patent was August 14, 1860, and his residence then was Memphis, Tenn., which corroborates my statement above. Mr. Dunbar died at Evarts, Vt., January 18, 1910, in his 78th year. Frank Richards

New York.

AUTOMOBILE MATHEMATICS

Let $U =$ driver of motor,
and $V =$ velocity.

If a sufficiently high value be given to V, it will finally reach $P. C.$

V instantly becomes zero.

For low value of V, $P. C.$ may be neglected; but on the contrary, if V be high it is usually best to square $P. C.$, for by Euclid (Book No. ?) $P. C. +$ £. s. d. $= \overline{P. C.}^2$.

If the value of £. s. d. be sufficiently great $P. C.$ will vanish, and V may be extended indefinitely.

Should the difference betwe n U and $P.C.$ be great, $J.P.$ may be substituted for $P. C.$, in which case the problem is difficult of solution, because no value of £. s. d. has yet been found to effect the elimination of $J. P.$ $\overline{J. P.}^2$ is, in fact, an impossible quantity. P. H.

[We would suggest that in following out the above reasoning, police constable, the English term for policeman, be substituted for the expression $P. C.$ Other substitutions become self-evident.—Editor.]

HACKSAW KINKS

The manipulation of a hacksaw is pretty familiar to all mechanics, yet there are some little points that may be unknown to some. For example, wheu attempting to saw a piece of tubing, if the blade is reversed in the frame, no trouble will be experienced, as the blade will operate smoothly. Also if it is desired to saw a piece of sheet metal, by placing a piece of inch board behind the sheet in the vise, the plate can be sawed through as readily as the board alone.

St. Paul, Minn. Joel C. Stuart

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

GASHING WORM-WHEELS

R. H.—How is the cutter for gashing worm-wheels selected? How should one proceed in gashing worm-wheels? How deep should the gashing cutter be sunk?

A.—The process of gashing worm-wheels was described in detail in the January, 1909, issue of MACHINERY in an article entitled "Machine Shop Practice—Gashing and Hobbing a Worm-wheel," and in the Shop Operation sheets, Nos. 85, 86 and 87, accompanying the same issue.

ELECTRIC WELDING OF SHEET STEEL

J. S.—Can 30 gage, tin-coated, lead-coated, zinc-coated (galvanized), or plain black sheet metal be either lap welded, spot welded or butt welded electrically?

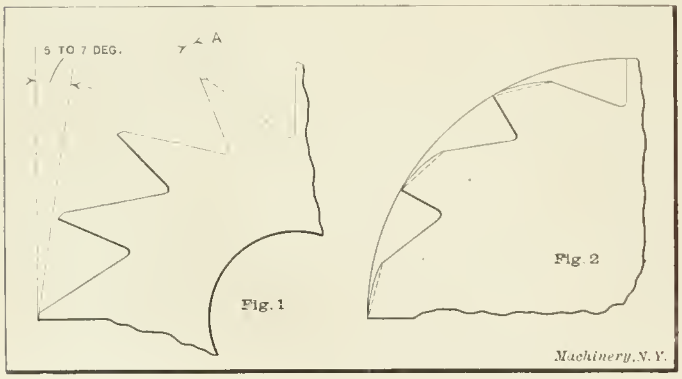
Answered by Toledo Electric Welder Co., Cincinnati, Ohio

A.—It is not a practical proposition to butt weld sheet steel less than 16 or possibly 18 gage. In regard to spot welding sheets which have been tin coated, lead coated or zinc coated, it is more difficult than to weld the plain sheet metal. We have experimented to quite some extent with tin and find that strong welds cannot be made without interposing a thin piece of plain steel. The piece is interposed to increase the resistance at the point of the spot weld. We believe that any of the above metals can be spot welded successfully in this way.

RELIEF OF TEETH OF CUTTERS AND REAMERS

R. H.—In grinding milling machine cutters, should or should not the teeth be backed off up to the cutting edge, or should enough of the cylindrical surface be left back of the cutting edge to support it? Are reamers backed off or relieved on the same principle?

A.—When grinding milling cutters, the teeth are backed off clear to the cutting edge, there being no part of the cylin-



drical surface left on the teeth. The cutter teeth should be so milled and ground that the width of the land *A*, shown in the accompanying illustration Fig. 1 has the values given below for cutters of different diameters:

Diameter of Cutters	A, inches
2 to 3 inches	1/32
3 to 5 inches	3/64
5 to 7 inches	1/16
7 to 10 inches	5/64

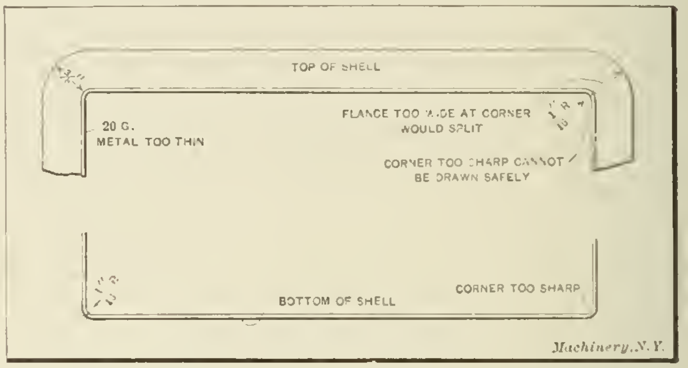
The angle of the clearance or the "backing-off" of the milling cutter tooth should be such that a tangent to the cylindrical surface of the cutter would form an angle of from 5 to 7 degrees with the line of the backed-off surface of the tooth, as shown in Fig. 1. Reamers are frequently relieved in the same manner, although in the case of reamers the width of the land is usually greater. Instead of a flat relief, as shown exaggerated by the dotted lines in the illustration Fig. 2, an eccentric relief, as shown by the full lines, is frequently used. This relief is produced by placing the reamer in a grinding machine as usual, but not on regular centers in line with the spindle, but on auxiliary centers, so that the reamer is held eccentrically. A rocking motion is then imparted to the auxiliary centers, and in this way the grinding wheel, traveling back and forth along the reamer, produces the eccentric or curved relief shown. This relief is particularly suitable for hand reamers which are not intended to remove a great deal of material. When reamers are to remove a considerable amount of metal, the flat relief should be used.

A PROBLEM IN SHEET METAL DRAWING

By A. C. R.

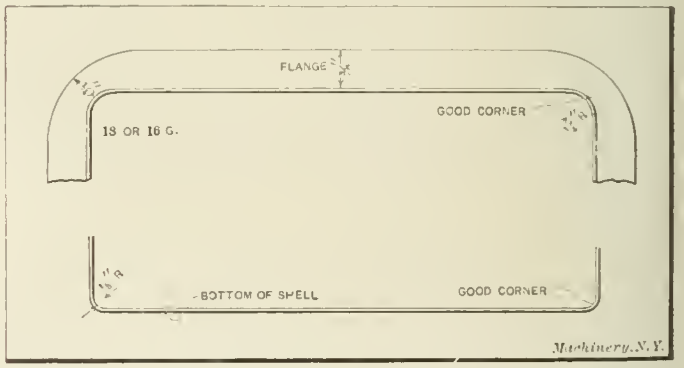
In reply to the query by H. W., with reference to the drawing of a rectangular shell, which appeared in the How and Why columns of the March number of MACHINERY, will say that the shell cannot be safely made as required by his specifications, as will be seen by the accompanying illustrations.

The nature and thickness of the material to be used, which he specifies as steel and No. 20 gage, or about 1/32 inch thick,



makes it absolutely impossible to draw a rectangular shell of the depth he mentions—6 inches—with practically sharp corners at both base and sides, and the leaving of a uniform flange of 3/8 inch all around, the corners included. Fig. 1 represents the shell desired as per specifications, and shows the corners, both base and sides and the flange. In drawing a rectangular shell, the concentration of the metal at the corners in going down is very severe and the radius as given, 1/16 inch, prevents the metal from reducing properly and the result is that the shell is torn at this point in the operations previous to the last, on account of the peculiar shape of these previous successive operations. The corner at the base is entirely too sharp also, as the punch or plunger in drawing will force this bottom through, as the metal is so thin, and it will not stand the strain in reduction.

Fig. 2 shows how this shell can safely be made as to depth and flange. The material is heavier, Nos. 18 or 16 gage being



used, and has a corner substituted, with 1/4-inch radius at the sides and 1/8-inch at the base. In bringing this shell down to size there is a peculiar condition at the corners, and as this flange has to be flattened or straightened at this point before being trimmed, a corner such as shown in Fig. 2 is safe and will not split or crack.

Possibly your correspondent can change the specifications to conform to Fig. 2, and if so, the writer will be pleased to furnish particulars to accomplish this. As the matter stands now the shell he specifies is out of the question entirely and practically impossible.

[The query as it appeared in the March number did not give all the data shown in Fig. 1, which was ascertained on further inquiry.—EDITOR.]

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

LARGE TOLEDO SINGLE-CRANK PRESS

The manufacturers of sheet-metal products, as well as the builders of machinery of various types, will undoubtedly be interested in the illustrations and description given herewith of a single-crank belt-driven press of enormous size and weight, recently built by the Toledo Machine & Tool Co., Toledo, Ohio. This press is capable of exerting a pressure of approximately 2000 tons, and it is intended for use in the manufacture of heavy steel products such as embossed plates for burial vaults or caskets, steel doors, parts of Pullman cars and passenger coaches, steel axle housings, large brake drums for automobiles, and other work of a similar nature.

This machine, which is illustrated in Fig. 1, weighs, complete, 275,000 pounds. The slide and connectors are provided with the usual threaded pitman screw, fitted with a power elevating attachment. This attachment is controlled by a lever on the left side of the press and it is operated through a pair of friction clutches, (not visible in the illustration) that are attached to the arch in the rear of the press.

Power is transmitted from these clutches by means of miter gears to a shaft connecting, by a second pair of miter gears, with a vertical shaft in front which, in turn, connects with the pitman screw through spiral and worm gears, as shown. Provision is also made for applying a handwheel attachment for obtaining a very close adjustment of the slide when necessary.

The press itself is operated by a very large and powerful friction clutch that is attached to a shaft running in pedestal bearings mounted on an extension that is accurately fitted, doweled and bolted to the main frame of the press. With this construction, a true alignment of the shafts for the pinions and gears is maintained. The press is double back-geared and the gearing is in the ratio of 54 to 1. The back shaft, to which is attached the steel pinions that mesh with the large twin gears on the crankshaft, is large enough to prevent any possibility of torsion between the main gears. This construction equalizes, between the main gears, the great driving power required for obtaining the necessary pressure on the ram or slide.

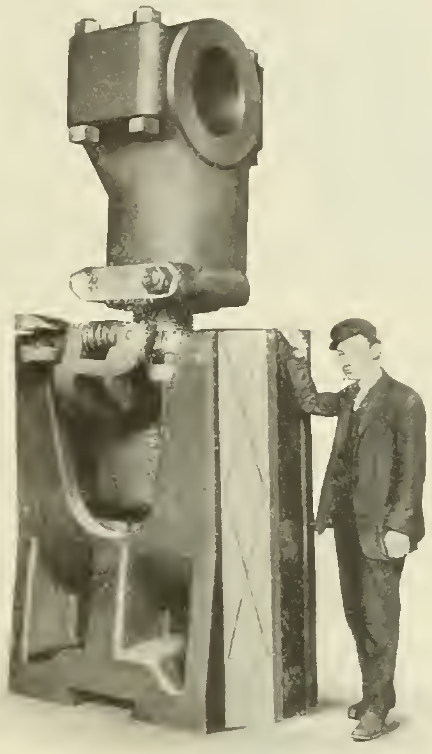


Fig. 2. Assembled Slide and Pitman

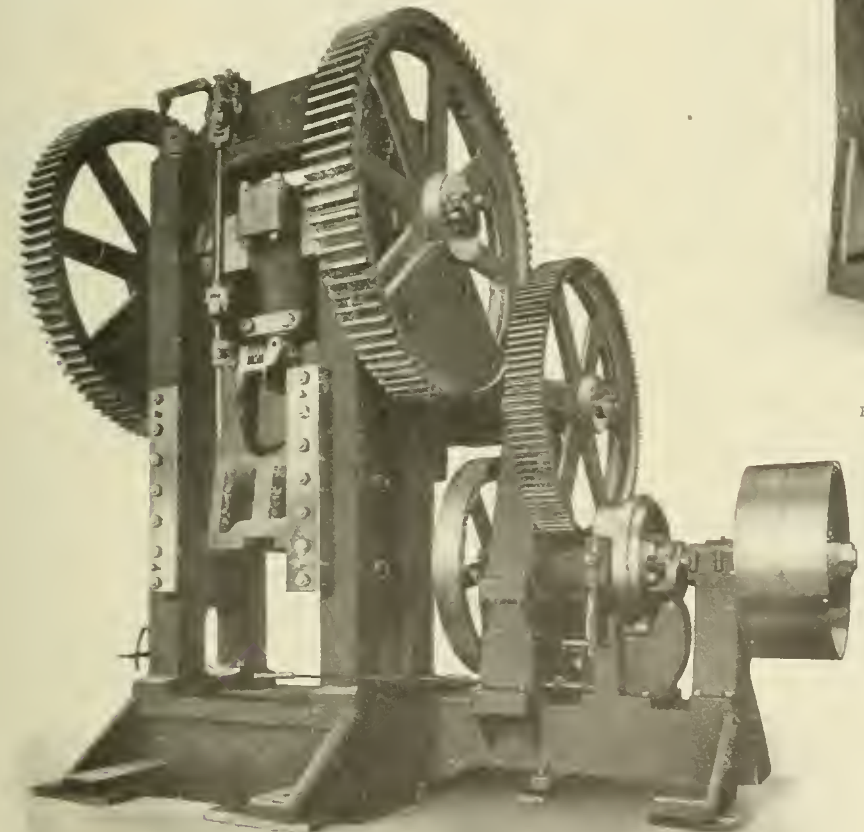


Fig. 1. 275,000-pound Press, built by the Toledo Machine & Tool Co.

Fig. 3. The Pitman Screw

The main frame of the press is reinforced by four steel rods 8½ inches in diameter, which extend from the bottom of the bed to the top of the arch. The press was completely assembled and tested in the works of the manufacturer before shipment was made, but the tie-rods were not shrunk into position, as the entire press was afterwards dismantled and the frame taken apart for convenience in shipping. The shipment comprised six carloads. After the press was received at the customer's works, the parts of the frame were assembled and the large steel rods previously referred to were then heated, placed in position in the frame

and allowed to cool, thereby shrinking the frame solidly together.

Some idea of the enormous size of this press may be obtained by referring to the accompanying illustrations and comparing the height of the parts illustrated with the men standing by them. Fig. 4 shows the crankshaft with the two main gears attached. The forging for this shaft weighed

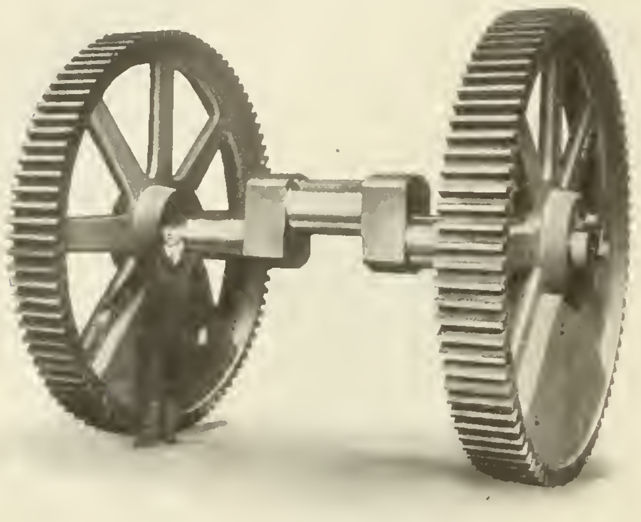


Fig. 4. Crankshaft and Main Gears of Toledo Press

14,000 pounds, and the diameter of its bearings is 16 inches. The two main gears are 123 inches in diameter, and the castings for them weighed 19,000 pounds each. The crankshaft and also the pitman screw are made of high-carbon steel forgings. Fig. 5 shows the friction clutch and shaft for carrying the belt pulleys and balance wheel. This friction clutch is operated by a steel spider which has a double facing of hard wood and is keyed to the shaft. The driving pressure or friction is obtained by means of powerful bell-cranks that are connected to the sliding spider or collar, as shown. Fig.

Fig. 5. Press Clutch and Shaft

2 shows the slide and pitman assembled, and Fig. 3 illustrates the size of the pitman screw.

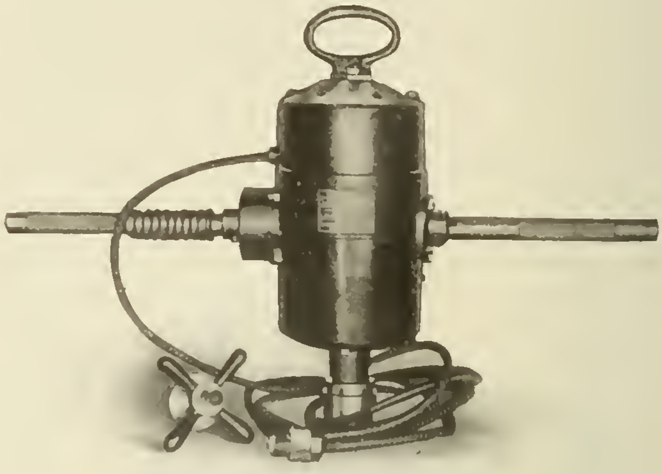
The over-all height of this press is 23 feet. The width between the housings is 60 inches, and the stroke of the ram, 18 inches. The belt pulleys are 60 inches in diameter, 12½ inches wide, and are intended for a 12-inch double belt. This press was designed for the Youngstown Iron & Steel Co., Youngstown, O.

CINCINNATI PORTABLE REAMING AND DRILLING MACHINE

A new design of reaming and drilling machine of the portable electric type, recently brought out by the Cincinnati Electrical Tool Co., Cincinnati, Ohio, is illustrated herewith. The machine is especially intended for drilling and reaming in structural work and bridge building, but can, of course, also be used wherever a portable tool is required. The special feature is that the gearing, which runs in grease, is entirely enclosed, so that there is no chance for the lubricant to work into the armature winding. On the left-hand handle a quick-acting switch is provided, actuated by the corrugated sleeve shown. This sleeve slides back and forth, cutting out the current when in an outward position and closing the connections when moved inward.

The motor is series-wound, and of the air-cooled type. Small holes are provided in the frame for cooling the motor. The latter is geared down to the proper speed for the drill or reamer, the spindle speeds being 200, 350 and 500 revolutions per minute, respectively, for the three sizes manufactured. These sizes have a maximum capacity of ½-, 1-, and 1¼-inch diameter drills or reamers.

The gears are made of high-carbon steel and hardened, and as they constantly run in grease, they will wear indefinitely. The spindle in the largest of the three sizes made, has a hole for a No. 4 Morse taper shank, the medium size for a No. 3, and the smallest size for a No. 2 shank. The two largest sizes have screw-feed for the drill spindle, the spider for the screw-feed being shown beside the tool in the illustration. In-



Electrically-driven Reaming and Drilling Machine

stead of the Morse taper, the smallest size may also be provided with a chuck.

The machine is equipped with Hess-Bright ball bearings throughout, no bronze bushings being used for any of the bearings. The weight of the three sizes is about 25, 70, and 85 pounds, respectively.

HAUCK PORTABLE HEATING OUTFIT

In the department of New Machinery and Tools for June, 1910, we illustrated a kerosene blow torch made by the Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y., that is adapted to brazing and general shop work. This company has added to its line the portable outfit shown herewith, which

Hauck Portable Kerosene Oil Heater with Two Adjustable Burners

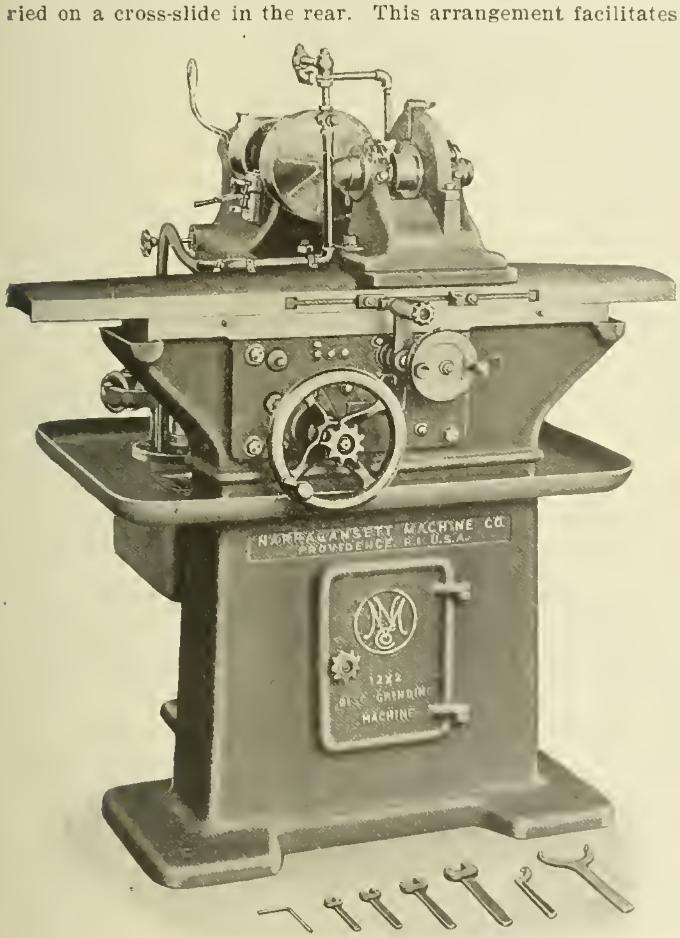
also uses kerosene as fuel. This outfit consists of a seamless tank, equipped with a hand air pump and pressure gage, two sets of burners which are connected with the tank by 12-foot lengths of hose, and two adjustable stands for holding the burners in the proper working position. The particular equipment illustrated is recommended where it is desired to heat both sides of the work simultaneously.

The burners are comparatively simple in construction and so designed that they give a powerful, clean flame which can be easily regulated. This heater is adapted to all kinds of machine shop work, such as melting soft metals, brazing, pre-heating and general repair work. The torch is so arranged that the tank remains perfectly cool while the burners are being used. It is claimed that these kerosene burners produce a more intense flame than can be secured with gasoline.

In preparing the heater for use, it is simply necessary to operate the hand air pump a few minutes, after having first filled the tank with kerosene oil. As the whole outfit weighs less than 100 pounds, it can easily be carried from one place to another.

NARRAGANSETT DISK GRINDING MACHINE

A disk grinding machine that is designed for grinding both accurately and economically all parts within its range, has been brought out by the Narragansett Machine Co., Providence, R. I. This machine is especially adapted to the grinding of disks, thrust-washers, piston rings, saws, and work of a similar nature. By referring to the accompanying engraving it will be seen that the wheel-head is mounted on a sliding table and is traversed instead of the work-head which is carried on a cross-slide in the rear. This arrangement facilitates



Narragansett 12 by 2-inch Disk Grinding Machine

the operation of the grinder and enables the operator to see the work without difficulty.

The sliding table, which is heavily constructed, has an automatic traverse in either direction that is controlled by adjustable dogs operating against a reversing lever in the usual manner. A spring plunger in this reversing lever can be withdrawn and the table run beyond the reversing point without interfering with the adjustment of the dogs. The table has three feeds for every work speed.

The wheel spindle is hardened ground and lapped and runs in phosphor-bronze bearings. It is provided with means for taking up wear, and it is self-compensating for changes in temperature. The boxes have hinged caps which allow the spindle and wheel to be quickly removed.

The work spindle is threaded on the end to receive a magnetic or other type of work-holding chuck. Its bearings are hardened, ground and lapped and run in phosphor-bronze boxes. Means are provided for taking up wear, both longitudinally and radially. The spindle is driven by a friction-clutch pulley which allows the chuck to be started and stopped independently of the feed or wheel. This clutch is operated by the lever seen to the left of the head, and when used in conjunction with the knob in the center of the traverse handwheel, the work can be placed in position or removed without stopping the countershaft. The spindle has five speed variations ranging from 40 to 263 revolutions per minute. The work head is pivoted so that it can be set at an angle to the ways for grinding conical or concave surfaces. The position of the head is indicated by suitable graduations. This angular adjustment is particularly useful for grinding saws, milling cutters, etc. A taper dowel pin positively locates the head in the zero position. A fine adjustment is obtained by a screw and hand knob. A diamond-tool holder is attached to the side of the work-head allowing the wheel to be trued without removing the work. The work is moved laterally by a handwheel at the front of the machine, graduated to read to thousandths of an inch and equipped with a suitable stop for sizing duplicate pieces.

The feed mechanism is mounted on a plate attached to the front of the machine and is self-contained. When the feed is disengaged by a knob in the center of the traverse handwheel, the table can be quickly traversed by hand. The reversing mechanism is of the well-known "load-and-fire" type. It is positive in its action and will reverse with accuracy at the same point for each stroke. The tripping plates are adjustable for wear and adjustment can be easily made without removing the mechanism.

When so ordered, this machine will be equipped with an automatic cross feed. This feed is varied by simply turning a knob, and can be set to indicate one-quarter thousandths on the work. There is also an adjustable stop which disengages the feed when the work is ground to the size for which the stop is set. This automatic feed is recommended where more than one machine is used.

The base of this grinder is of a T-section and supports both the table and work-head from the floor. The interior is fitted with shelves, thus forming a closet for small tools, wrenches, etc. There are three contact points with the floor so that any unevenness will not influence the machine's accuracy. These machines are furnished either with or without a pump and water connections. The pump is of the centrifugal type and revolves in a horizontal plane. It is completely immersed, and is, therefore, always primed and does not require stuffing-boxes or packing. The water is returned to a sediment pan in which the particles of emery and steel settle, instead of being carried into the tank. Traps are also provided for catching any oil before it passes into the tank.

This grinder has a capacity for work up to 12 inches in diameter and 2 inches thick. The bearings and working parts are carefully protected and well lubricated. The ways of the cross-slide and bed are always covered and the top of the bed is enclosed to protect the feed mechanism. Dust caps are provided for the spindle bearings and feed shafts, and all oilers are self-oiling and dust-proof.

"LIBBY" 18-INCH TURRET LATHE

The International Machine Tool Co., Indianapolis, Ind., has brought out an improved design of the "Libby" turret lathe, views of which are shown in Figs. 1 and 2. This machine is driven either by belt or motor and it is equipped with a power rapid traverse for each carriage; automatic trips for each position of the turret; automatic trips laterally for the tool-post; positive geared feeds, and other features to facilitate the rapid and accurate production of work.

The Turret

The turret is of the hollow hexagon type with six holes bushed to 3¼ inches and the faces drilled to receive the various tools. The center of the turret hole is 9 inches above the

ways, and a 10-inch die-head will swing clear. The lock-pin is of hardened tool steel and the lock-pin hole is lined with a hardened steel bushing. Both the lock-pin and clamp are operated by one lever. The turret is operated by hand and as one revolution of the pilot wheel gives a movement of 1 inch, the operator has a good leverage for feeding against heavy cuts. The power rapid traverse for the carriage operates in either direction at the rate of 40 feet per minute, regardless of whether the feeds are on or off. The automatic feed trips are positive and disengage the feed at any predetermined point with accuracy. After these trips have operated, there is an index pointer and graduated scale on the turret which can be used to indicate the depth of the cut being taken; this is a convenient feature when forming work to an accurate depth or thickness. The feeds for the turret carriage are independent of those for the toolpost carriage, both as to amount and direction, and are reversible. The feed variations range from 1/256 inch to 1/4 inch.

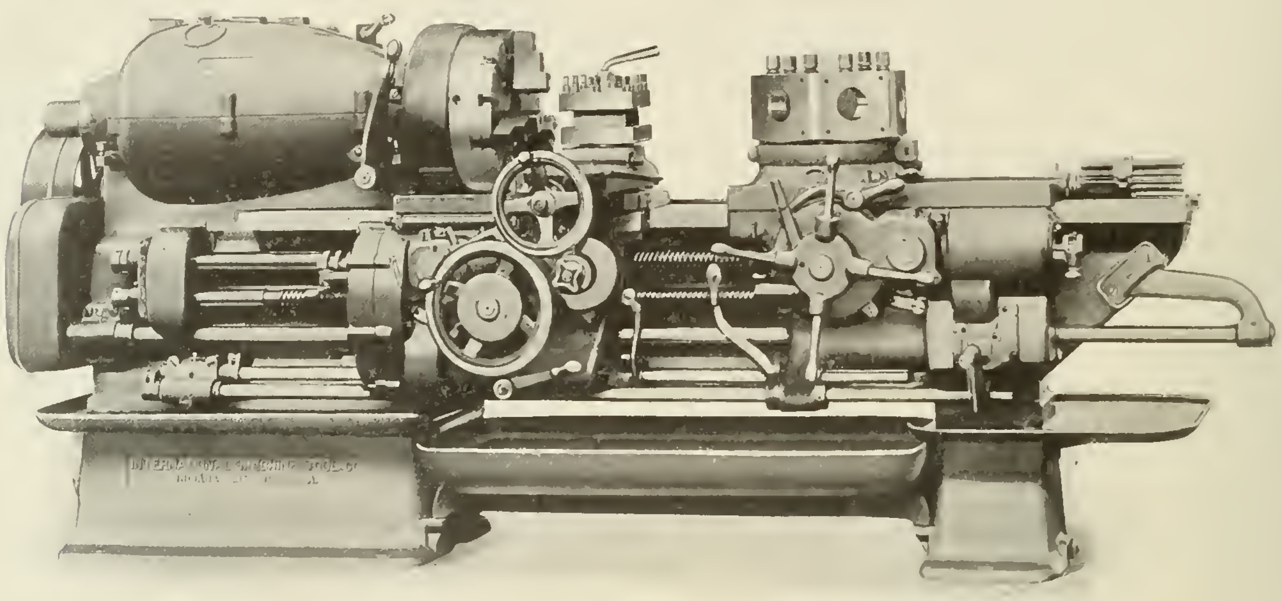


Fig. 1. Eighteen-inch "Libby" Turret Lathe, built by the International Machine Tool Co.

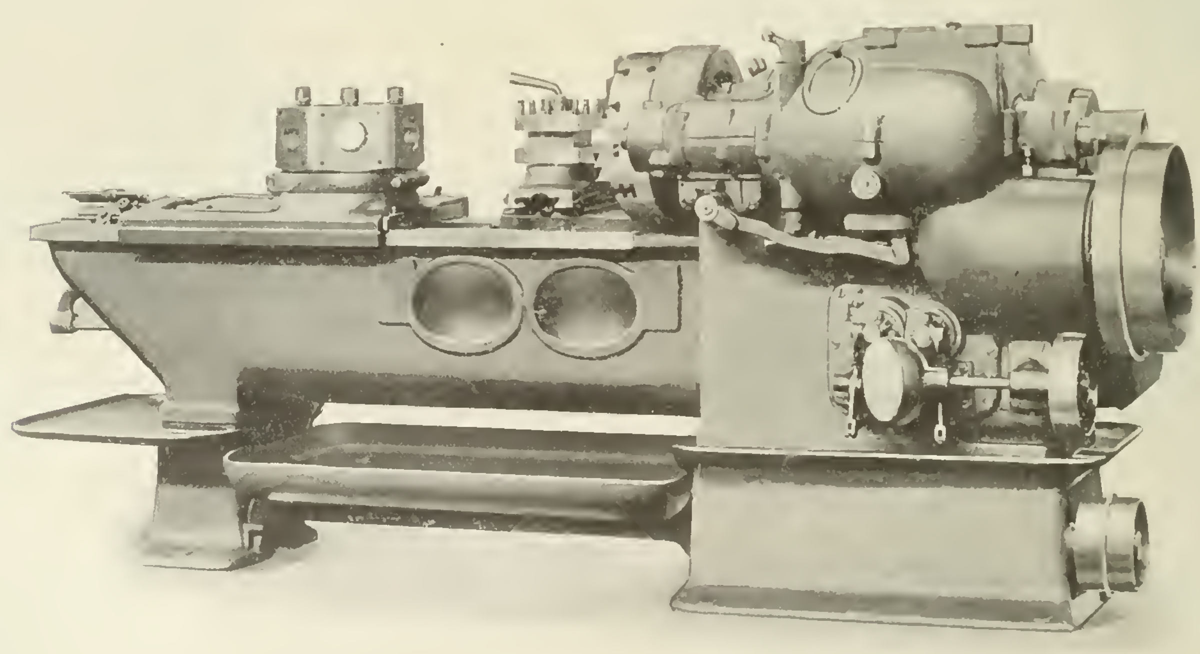


Fig 2. Rear View of "Libby" Turret Lathe

Carriage and Toolpost

The toolpost carriage is of the side type, having a bearing on the front way with a long taper gib on the inside. It is also gibbed to a 60-degree angle on the lower side of the bed to take care of the cross strain. By transferring one bearing to the lower part of the bed instead of having it on the rear way, the full swing capacity of the lathe is obtained. This construction also permits the toolpost to pass the chuck and the turret to come up flush with the chuck, thus doing away with long overhanging tools. The feeds for this carriage range from 1/128 to ¼ inch. The cross feeds for the toolpost are one-half the longitudinal feeds on a standard machine, but they can be made the same as the longitudinal feeds if desired. Hand feeds are possible on both carriages, one revolution of the wheel moving the carriage one inch.

Rapid Power Traverse

The rapid traverse for the two carriages operates at the rate of 40 feet per minute, and when disengaged, stops instantly. The traverse for the two carriages is also independent, and it can be operated in either direction regardless of what the other carriage is doing, or with the feed on or off. None of the headstock gears or feed gears are used in the operation of this traverse, so that neither the pilot wheel on the turret slide nor the handwheel on the toolpost carriage, turn when the traverse is engaged. The drive is obtained from the main shaft of the machine.

Driving Mechanism

The single belt driving mechanism is separate from the headstock proper, and is fitted into a housing cast integral with the bed and headstock, so that the whole mechanism can be removed in case of repair or adjustment. This mechanism is composed of two friction gears, and drives onto an intermediate shaft giving two forward speeds which, together with the four mechanical changes in the headstock, makes eight forward speeds in all. There are two double frictions in the headstock, one being a band friction in the driving mechanism, and the other a cone friction on the intermediate shaft. In both cases the locking mechanism is such that it gives the effect of a positive clutch, without its disadvantages. All the wearing parts of the friction dogs are of hardened tool steel. These frictions give the operator absolute control of the spindle and chuck.

Bed-lubricating System

The bed and the headstock housing are one casting. The bed has heavy flat ways and, in addition to a rib extending longitudinally through the center, it has cross ribs every 13 inches. The width of the front way is 5⅞ inches, and the back way 3½ inches.

The lubricating system is as complete as possible. The main bearings have ring oilers and reservoirs with sight gages. The oil is carried forward and back on the shafts by means of spiral grooves. All parts in the apron, feed box and rapid traverse requiring lubrication have tubes leading from the outside to the bearings. All oil pans drain into a large pan in the center of the machine containing a strainer. The lubricant flows from this pan into the base beneath the headstock end, which forms a reservoir, and from which the oil is pumped back to the work by a rotary pump. This pump is located in the rear of the machine and is driven from the rapid traverse shaft. A pressure valve causes the oil to be pumped back into the reservoir when the flow is shut off from the work.

Miscellaneous Equipment

The main chuck is 16 inches in diameter and of the three-jawed universal type built especially for heavy service. A two- or four-jawed independent or combination chuck can also be used, and a collet chuck can be furnished for bar work. When a steady-rest is required, it is feathered to a heavy shaft at the back of the machine, in such a way that it rests firmly on and is clamped to the back way when in use, and can be thrown out of the way when not required. This rest is not fastened to and does not interfere with the use of any other part of the machine. This lathe will swing 18 inches over the ways and 16 inches over the carriage. The travel of the turret is 40 inches, and the hole in the spindle is 3⅛ inches in diameter. The shipping weight of the machine is 6000 pounds.

CINCINNATI NO. 5 AUTOMATIC GEAR-CUTTER

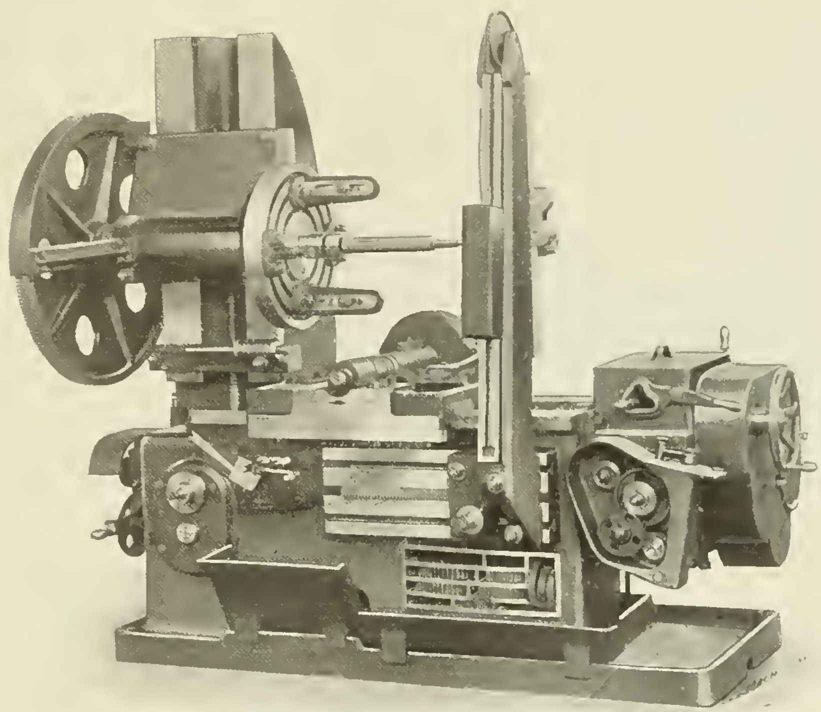
The gear-cutting machine shown in the accompanying engraving is a 48- by 16-inch size, now being built by the Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio. This machine has been designed rigidly, with large wearing surfaces, and with parts of simple construction.

The power is transmitted through a single pulley which runs at a constant speed, and the various speeds and feeds are obtained by transposing conveniently-located gears. All gibs are of the taper type and are adjustable from the ends. The shafts and spindles are all ground and journaled in bronze bushings. The movements are entirely automatic and each movement is dependent on the preceding one so that it cannot take place until the other is completed.

The work saddle is so gibbed to the housing that the work arbor and blank do not drop out of parallelism when the clamps are loosened for adjusting the work to the tooth depth. The power elevating device for the work saddle is operated in either direction by a single lever, and, as the power is taken from the machine pulley, no separate belt is required. There is also a hand adjustment and a micrometer collar reading to thousandths of an inch.

The work arbor is journaled in bronze bushings and it has provision for taking up wear. The arbor is drawn in and forced out by a threaded shaft and handwheel. The faceplate has concentric T-slots, as shown, which are turned from the solid and contain the slotted dogs and jacks. This arrangement enables the dogs and jacks to be clamped in any position. The outer work arbor support is counterbalanced by a weight guided in a dovetail slot.

The cutter slide has rectangular guiding surfaces and long taper gibs for taking up wear. The length of the guiding surface is five times its width thus reducing any binding action. The tappets or dogs for adjusting the length of the cutter slide feed, are operated by a crank-wrench from the front of the machine. A retractable tappet is provided for the dogs so the slide can be run to the extreme backward position for removing blanks without disturbing their position. A disengaging crank-wheel is provided for moving the slide by hand. The return speed of the cutter slide is constant, regardless of the rate of feed. There are two series of slide feeds, each of which has twelve variations with extremes of ½ inch and 15½ inches per minute. The cutter spindle is large in diameter and has convenient means for taking up wear. The spindle is journaled in a bronze bearing that is adjustable endwise for centering the cutter with reference to a gage furnished with the machine. The drive is through worm gearing and there is means for taking up end thrust wear of the worm. The cutter end of the spindle has a No. 11 B. & S. taper hole for the cutter arbor; this arbor is keyed in the spindle and is drawn in or removed by a threaded bolt. A removable bearing is provided for supporting the outer end of the cutting arbor. One arbor having a diameter of 1½ inch is regularly furnished, but others can, of course, be substituted. The cutter spindle has six changes of speed varying from 24 to 120 revolutions per minute.



Cincinnati 48- by 16-inch Automatic Gear-cutter

It is claimed that the indexing mechanism of this gear-cutter has less gears in the index train than any other machine on the market. The indexing worm can be disengaged from the wheel quickly and be brought back to the exact

meshing depth, or the worm can be disengaged from the index gears and be rotated any desired amount for resetting work and again secured to these gears. This mechanism is so interlocked with the cutter slide feed that it is impossible for the cutter to advance until the work is properly indexed. It is also impossible for the indexing movement to take place while the cutter is feeding, so that work cannot be spoiled. The work spindle can be made to space once, or be revolved continuously by hand movement. Index change gears are furnished for cutting all numbers of teeth from 12 to 100, and, with the exception of prime numbers and their multiples, from 100 to 450. In addition, special gears for cutting other numbers of teeth can be supplied extra.

A countershaft is regularly furnished with the machine, though, if desired, tight-and-loose pulleys will be mounted on the initial shaft. The machine can also be arranged for a motor drive.

STANDARD ELECTRICALLY-DRIVEN ROLLING MILL

The rolling mill illustrated in Figs. 1 and 2 is a recent addition to the extensive line of rolling mills manufactured by the Standard Machinery Co., 7 Beverly St., Providence, R. I.

The mill as illustrated has regular square-section roll housings fitted with rolls 12 inches in diameter and 20 inches wide. The roll journals have heavy phosphor-bronze bearings with crucible steel adjusting screws, but patented roller bearings can also be provided. The upper boxes are supported by side yokes which straddle the adjusting screws that are connected to the boxes by straight rods for lifting purposes. The top of the upper box has a hardened and ground tool-steel washer to take the thrust of the screw. The outer housing for the rolls is attached to the bed with T-bolts so that it can be adjusted in and out, thus permitting the use of rolls having different lengths. The minimum length is 10 inches and diameter 12 inches.

The rolls are driven through cast-steel wabblers and cast-steel wabbler couplings directly connected with herringbone

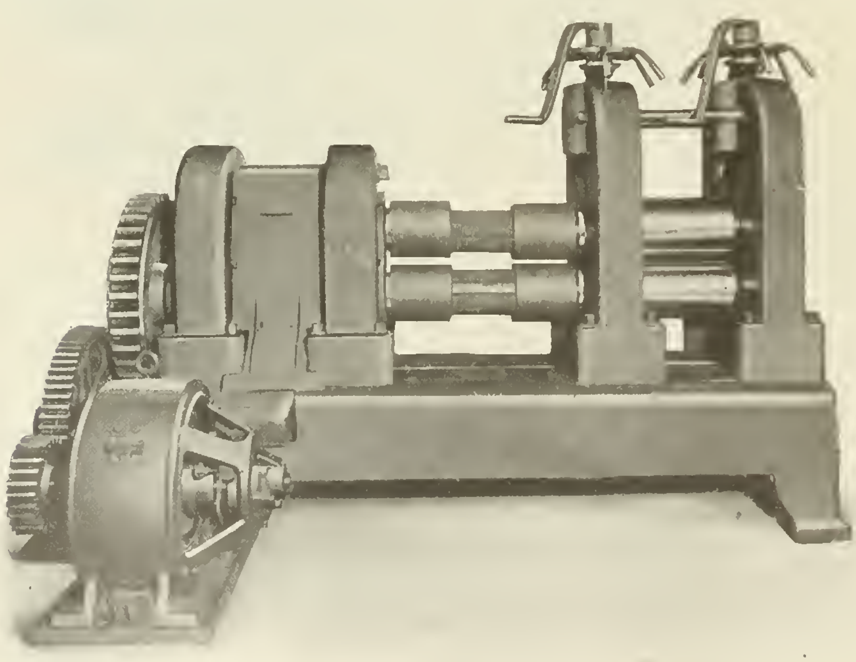


Fig. 1. Electrically-driven Rolling Mill, built by the Standard Machinery Co.

pinion shafts in the gear housings. These herringbone pinions have a pitch diameter of 13 inches and a face width of 14 inches. They are forced onto crucible steel shafts which have bearings in the housings. These pinions are made of forged steel and the teeth are cut, thus giving a uniform drive to the rolls. This is a very important feature, as it makes possible a uniform rolling of the stock without any wrinkles, waves or other imperfections caused by speed variations or "jumping" of the roll surfaces. If any back-lash in the gearing is transmitted to the herringbone pinions, they act as compensators and do not transfer the movement to the rolls, which would result in unevenness in the stock.

This machine is adapted, when equipped with rolls of special form, to the rolling of copper of large section, moldings, automobile rims, etc., and it is also applicable to the rolling of sheet steel, sheet copper, zinc, German silver, nickel, gold plate, and gold. When used on precious metals, the ingots

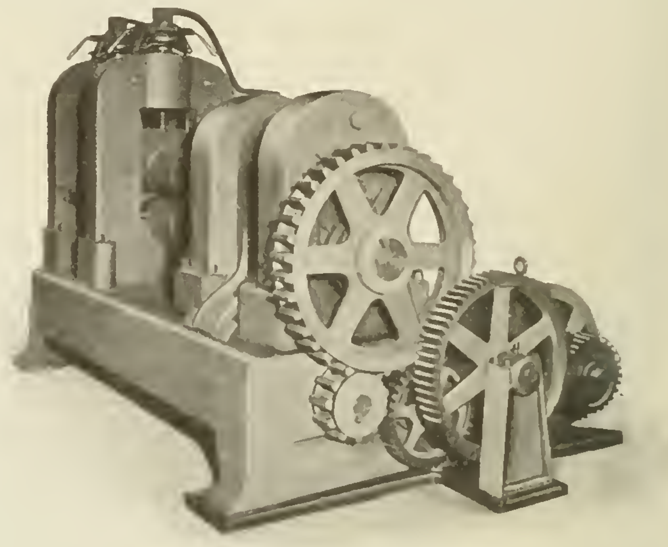


Fig. 2. End View of Rolling Mill, showing Driving Gears

are reduced to a thickness of about 1/8 inch after which they are transferred to finishing or mirror-lapped rolls. It is customary to equip the machine with chilled iron rolls, although when specially ordered, they are furnished with solid hardened and ground steel rolls. Instead of solid steel rolls, those of the shell type are sometimes made by forcing a shell over hardened arbors. The roll ends are threaded to permit the use of cooling water when necessary, the water being forced through special chambers made on the inner sides of the roll. These chambers for chilled iron rolls are cast with two ports on the inner part of the body, and the water is forced in one and out of the other, thus keeping it in continual circulation. When water is to be used with a hardened steel roll, it is necessary to make the roll of the shell type, and the water chambers are cut in the arbor.

The illustrations Figs. 1 and 2 show front and end views, respectively, of an electrically-driven machine, and Fig. 3 shows the same type of mill equipped with a friction clutch. This view also shows the herringbone pinions. The motor-driven mill has a variable speed arrangement consisting of a controller mounted in a panel attached to the side of the mill. This is advantageous for operating the mill quickly, as well as for providing variations in the peripheral speeds of the rolls.

Exclusive of both the motor drive and herringbone pinions, the mill is triple trained, and when the motor gears and herringbone pinions are considered, it is five trained. The total ratio including all the gears is 84 to 1, and the ratio between the driving shaft of the mill and the rolls is 35 to 1. When roller bearings are employed, this ratio is reduced to 24 to 1. The necks of the rolls are chilled, as well as the body, when roller bearings are used, though sometimes they are made of steel and welded into the body of the roll. The roll journals are 9 inches in diameter and 9 inches in length. The main driving gears are made of gun iron and shrouded, and the two trains of gearing contained in the mill proper have cut teeth and are of cast steel.

The adjustment of the rolls is controlled by a spanner arrangement and, for heavy strains, by offset wrenches which are brought down to the height of a man's shoulders. The total weight of this machine including the bed-plate and motor is 27,500 pounds, and it is made in various styles, hav-

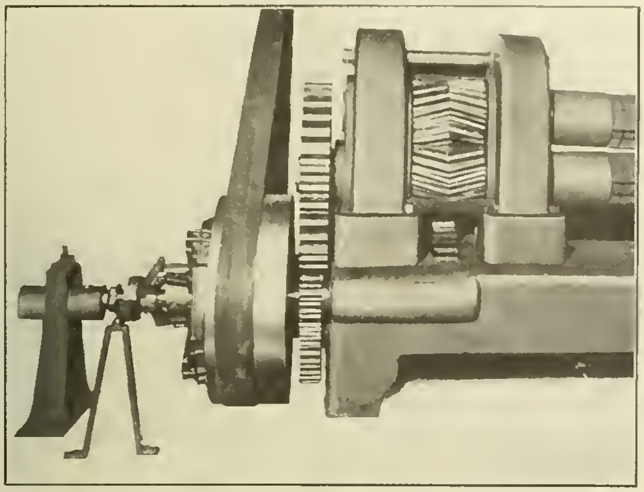
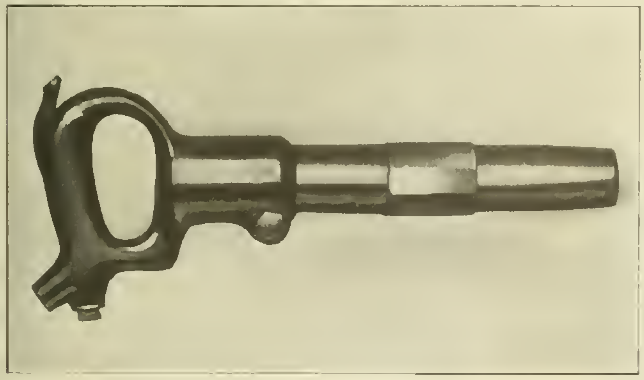


Fig. 8. Rolling Mill equipped with Friction Clutch

ing both single and double housings. The mill is also fitted either with a friction clutch drive, chain drive or direct gear drive as illustrated.

DAYTON PNEUMATIC CHIPPING HAMMER

An addition to the line of pneumatic hammers known as the "Dayton" and "Green" types has recently been brought out by the Dayton Pneumatic Tool Co., Dayton, Ohio. This new hammer (see accompanying illustration) is called the "No. 44 Dayton" and differs from the Green type only slightly in design, the main difference being that the Dayton type has



Pneumatic Chipping Hammer manufactured by the Dayton Pneumatic Tool Co.

an outside trigger, whereas the trigger of the Green type is on the inside. The new hammer is intended especially for use in steel foundries, where the requirements are more severe than in cast iron foundries.

One of the features which especially adapts this hammer to the work for which it was designed, is the long plunger or piston with which it is provided. The object of this is to obtain more bearing and consequently greater wearing surface, which is desirable and necessary in a hammer for steel foundry use, on account of the fine dust which in these places penetrates into the barrel of even the best protected tool, and which in a short time affects the fit of the cylinder surface and consequently causes leakage. The longer piston makes it possible for the tool to stand up for a much longer time.

Another feature is the poppet style of throttle valve introduced in this hammer, which has been thoroughly tried out for a year past in the company's hammers. This throttle valve is guided by, but not fastened to, its stem, so that in this way the valve has perfect freedom to adjust itself to its seat at all times, and no leakage is possible when the valve is closed. The lower part of the valve body has slots of various depths milled through it, so that a gradual inlet of air is provided for, and thus a perfect regulation is obtained.

The main valve is made of alloy steel and hardened by a process which makes it almost impossible to break it, the hardening method providing for the most effective combination of hardness and toughness. In fact, the company guarantees that the main valve will not break during the life of the hammer. The general simplicity of the hammer, and the few parts of which it consists, makes it very easy and cheap to repair, when necessary.

The sizes of this new design are the Nos. 33 and 44 Dayton and Green chipping hammers, having strokes of 3 and 4 inches, respectively.

PATTERSON ADJUSTABLE ELECTRIC LIGHT BRACKET

Proper lighting facilities are, of course, very essential to any shop, as poor light breeds spoiled work and also affects the rate of production. As artificial light is necessary during certain periods even in shops that are well lighted naturally,

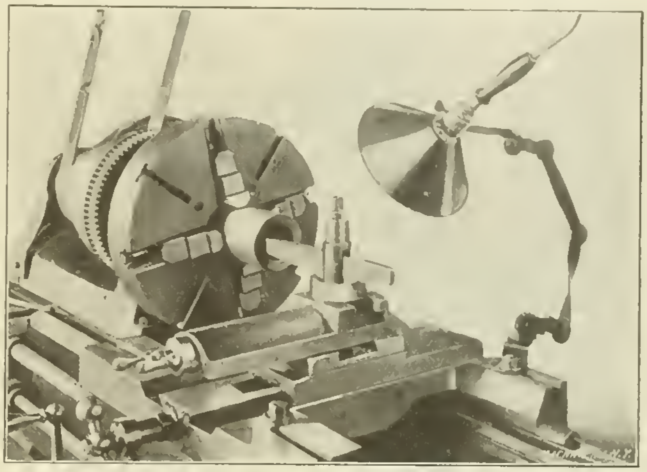


Fig. 1. Adjustable Light Bracket attached to a Lathe

it is important to have such light as effective as possible. The electric light bracket illustrated in Figs. 1 and 2, which is now being marketed by the Patterson Tool & Supply Co., Dayton, Ohio, is universally adjustable so that the light can be directed anywhere it is needed. This bracket is so arranged that it can be attached to a machine, as illustrated in

Fig. 2. Adjustable Brecket with Base for Bench Work

Fig. 1, or by the addition of a heavy cast-iron base, it is adapted to bench work, as shown in Fig. 2.

The adjustable arms of the bracket are made of sheet steel, and the disk joints connecting them operate on leather frictions and are bound together by strong rivets. The base pieces for machine brackets are made in different forms and have ½ inch holes in which retaining bolts can be placed as

illustrated in Fig. 1. These bases are also provided with four screw holes for locating the brackets permanently. This view also shows how the bracket can be adjusted to throw the light directly in a hole being bored, or at any other point. Fig. 2 shows a bench bracket arranged to direct the light on the face of the work to enable the lines on that side to be seen. If, in this case, it should be preferable to have the light come through the opening from the rear, this adjustment could, of course, easily be made.

The electric lamp is held in the bracket by a screw clamp or with a spring clip. The bench bracket is 23 inches high, and when the first adjustable joint is in a right-angle position, the distance from the center of the stand to the light is 16 inches. The machine bracket has a radius of 21 inches from the center of the base to the light, and it will, therefore, cover a circle of 42 inches in diameter.

CINCINNATI 20-INCH HEAVY-DUTY PULLEY LATHE

The Cincinnati Pulley Machinery Co., Cincinnati, O., has recently placed on the market a 20-inch heavy-duty pulley lathe, embodying features not found in previous designs. A general view of the machine is shown in Fig. 1. The particular feature in which this design differs from the company's previous machines is the feed arrangement which is entirely new; in addition, a power cross-feed has been provided.

In Fig. 2 is shown a view of the feed gearing and transmitting mechanism, the headstock of the machine having been removed to show these features clearly. The feed mechanism is driven from a gear on an intermediate shaft, located just above the pulley shaft, as shown in Fig. 1. This intermediate shaft has its bearing in the headstock and is, therefore, removed in Fig. 2. The gear on the intermediate shaft meshes with the intermediate gear *A*, which, in turn, meshes with gear *B*, and the latter is fastened onto the projecting hub of the clutch gear in the feed box at the end of the machine.

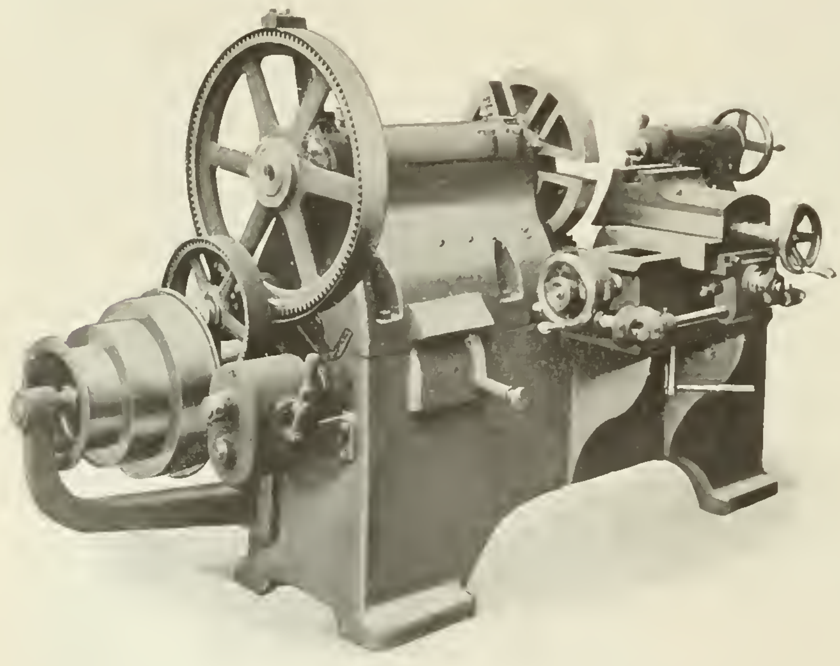


Fig. 1. Pulley Lathe, built by the Cincinnati Pulley Machinery Co

One set of feeds is obtained by direct drive through this gear, and one set of feeds through the feed box gearing by changing the position of a lever on the feed box at the end of the machine. The change gearing underneath the headstock, which is of the well-known tumbler gear design (as shown in the dismantled view), provides for six changes, so that, in all, twelve feed changes are available. The ratio of the smallest to the greatest feed is as 1 to 16, so that ordinarily a feed range of from 1/64 to 1/4 inch is obtainable. The driving feed gearing can, however, be so modified, if desired, that a feed range of from 1/32 to 1/2 inch may be obtained.

From the cone-gear shaft, the feed motion is transmitted to the carriage of the lathe by means of a pair of bevel gears, universal-joint shafts and a worm and worm-wheel, as indicated. The universal joints between the bevel gear shaft and the worms, permit swinging the table for turning the crowned faces of pulleys. This feature of the design constitutes a considerable improvement over previous methods used for transmitting the feed, and provides for a positive feed motion at all times.

The power cross-feed is obtained directly from the feed gearing. The shaft of the worm for the longitudinal feed mo-

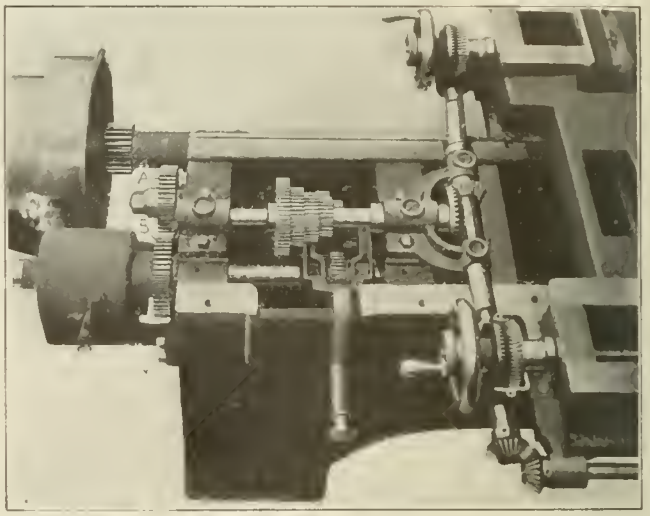


Fig. 2. View of Pulley Lathe with Headstock removed to expose Feed Mechanism

tion projects beyond the worm-gear, and on its end is placed a bevel gear meshing with another gear on the feed rod. The feed rod has a worm mounted on it inside of the apron, and this worm meshes with a worm-wheel on the friction shaft, on the end of which is the friction knob shown on the apron in Fig. 1. The friction shaft also carries a cone friction, engaging with the worm-wheel, the friction having keyed to it a spur gear meshing with the tumbler gears used for reversing the feed motion and which, in turn, mesh with the gear on the cross-feed screw.

As in previous designs, the spindle has six speeds, obtained by means of a two-speed countershaft and the three-step cone pulley. The range of spindle speeds is from 7 to 30 revolutions per minute. The ratio of the gearing from the cone pulley to the spindle is 18.1 to 1.

The table of the machine swivels about its center, and a series of holes is drilled on one side so that a different pre-determined taper will be obtained from each hole. Thus, when the table is adjusted, both rails are set simultaneously.

As will be noted, all gearing is provided with suitable guards, and the worm and worm-wheel operating the feeding mechanism, and all other feed gears, are entirely enclosed. The machine is especially intended for turning and facing pulleys, gears, flywheels, couplings, and work of similar character. This machine is provided with an ordinary engine lathe tailstock, which was not regularly furnished with previous designs. The capacity of the machine adapts it to the turning of pulleys from 4 to 20 inches diameter, and up to 18 inches face. The floor space occupied is 8 by 5 feet, and the weight of the machine is 4500 pounds.

DRESES DRILLING, BORING, FACING AND TAPPING MACHINE

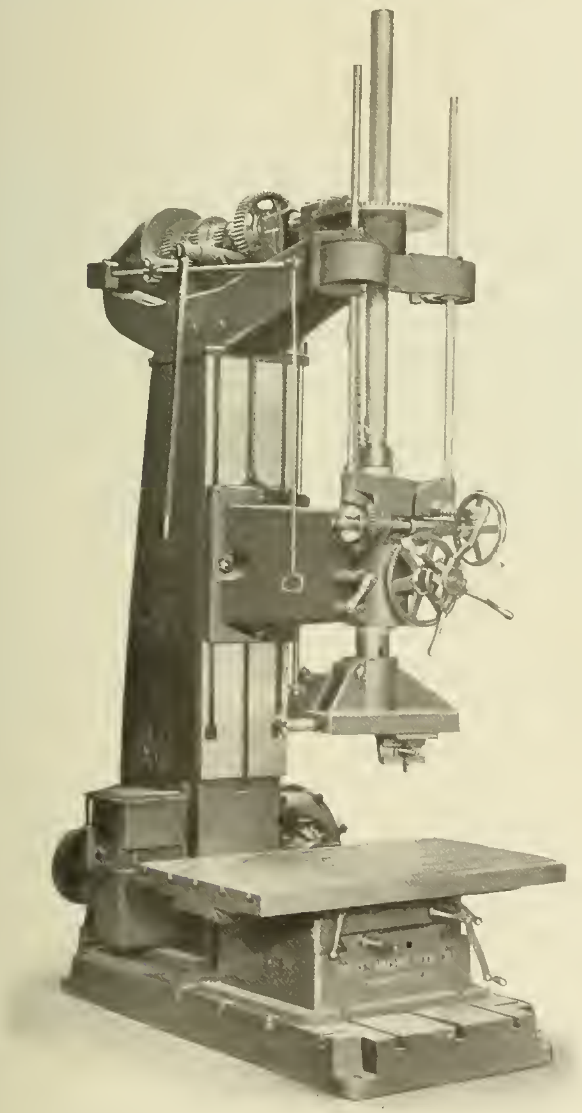
The Dreses Machine Tool Co., Cincinnati, Ohio, is now building the 60-inch drilling, boring, facing and tapping machine, illustrated herewith. This machine is intended for heavy drilling or tapping operations, for machining holes in

steel plates, bars, or connecting-rods, and for boring and facing parts that cannot conveniently be machined in a lathe or boring mill.

The driving mechanism of this machine is similar to that of an upright drill, but it is provided with a frictional starting, stopping and reversing device that is operated by the handle located at the side of the head. This handle is adjustable so as to be always within easy reach of the operator. The horizontal bar to which the fork and friction clutch arrangement is attached, is balanced with a weight as shown, and there are also spring dowel pins so that the clutch cannot engage itself. The back-gears are operated by steel clutches, and engagement or disengagement is effected by the vertical lever seen to the left of the column.

As the illustration shows, the feeding mechanism of the head is connected with the spindle by two vertical shafts, arranged on each side, which connect through bevel gearing with the worm-shaft for the feed. This arrangement gives two different kinds of feeds. The rod to the left operates four fine feeds that are used for ordinary drilling and boring, whereas, the right-hand rod gives a feeding movement equivalent to the leads of standard pipe threads.

A facing head that is used on this machine is shown attached to the nose of the spindle in the illustration. This

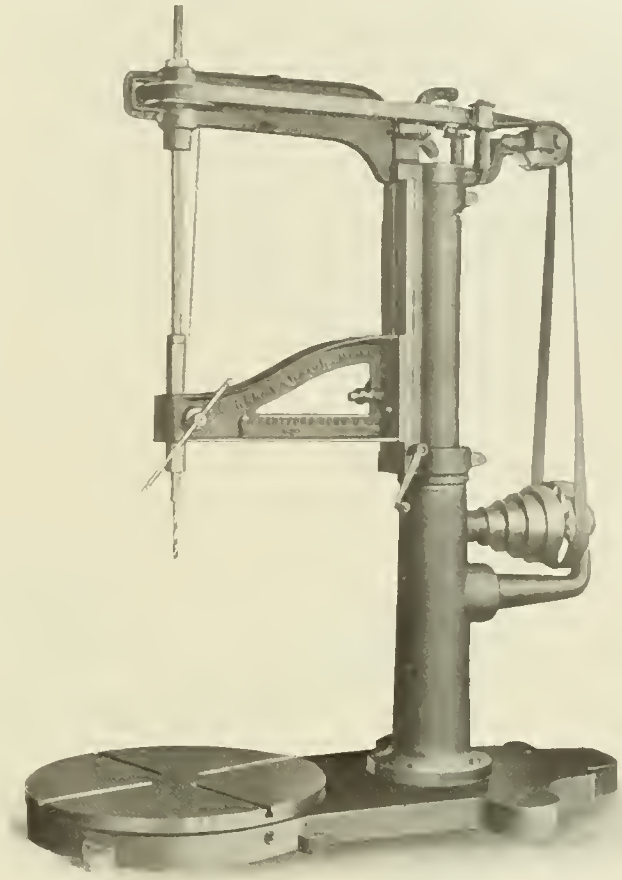


Heavy Drilling, Tapping, Boring and Facing Machine, built by the Dreses Machine Tool Co.

head is operated by a star feed and its construction is obvious. Both the spindle and its head are balanced by a weight located inside the column. The table is of the compound type and has a longitudinal movement of 40 inches and transverse movement of 8 inches. The machine illustrated is driven by a multi-phase, constant-speed, twelve-horsepower motor, and the speed changes are obtained by a five-step cone and the back-gears.

HENRY & WRIGHT HIGH-SPEED RADIAL DRILLING MACHINE

The Henry & Wright Mfg. Co., Hartford, Conn., has designed a high-speed radial drilling machine especially for driving small drills that depend more on speed than feed for efficient operation. Experiments made by this company show that when drilling holes ½ inch or less in diameter, power can be more economically and efficiently used by dividing it so that the greater part is expended in the form of speed, and



Henry & Wright Radial Drilling Machine, designed especially for Drilling Small Holes

the least in the form of feed. In other words, the power for speed should be greatest for driving small drills and gradually decrease as ½ inch is approached; a point is then reached where to obtain the highest efficiency, the power should be divided equally in the form of speed and feed. From this turning point, power should be used in an increasingly greater proportion in the form of feed with a corresponding decrease in the form of speed. These results indicate that machines for driving drills larger than ½ inch, should be built much stiffer and heavier than for driving smaller drills, whereas a machine used for holes averaging less than ½ inch, should be constructed for fast operation and without those features which make the heavier design cumbersome and inefficient for small work.

The light high-speed radial machine shown herewith is designed especially for drilling small holes, and it is not intended for the field covered by heavier machines. This machine can be driven much faster than the more powerful designs, and it uses only a fraction of the power which the heavier types require. It is equipped with ball bearings throughout, including the swinging column, thus reducing friction and wear to a minimum. The column and table are equipped with locking screws so that they can be rigidly held in the desired position. The overhang of the arm is 30 inches, but as the table revolves on ball bearings, the operator can frequently reach a point 60 inches away from the column by simply revolving the table with the foot. The machine is driven by a 2-inch belt which connects with the spindle, as shown, and there are eight speed changes.

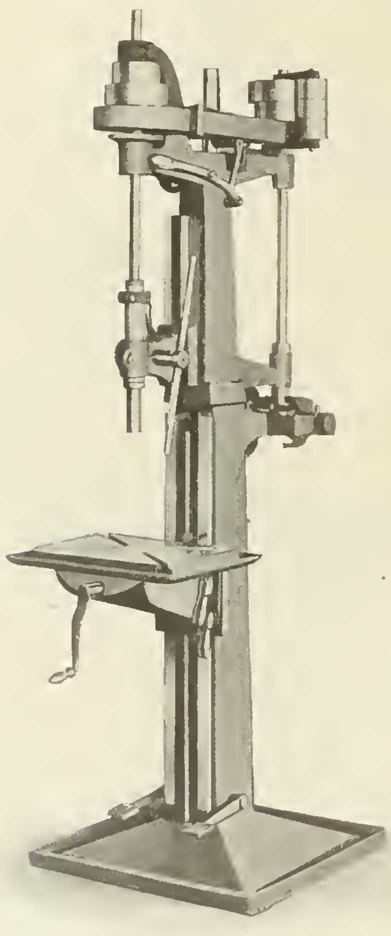
A new feature of the spindle drive is the method of transmitting power to the spindle below instead of above the

pulley, which allows the use of a shorter and stiffer spindle. The spindle pulley is enclosed in a bracket so as to eliminate as far as possible all belt strains. This machine has sufficient power to drive drills up to 1⅛ inch in diameter, and it can be used for tapping holes up to ½ inch in diameter.

The equipment includes a countershaft with a clutch, and a sub-table for handling small parts. This machine is especially efficient for drilling small holes in bulky parts, and the swinging spindle in conjunction with the rotating work table, enables the drill to be quickly located.

REED HIGH-SPEED DRILLING MACHINE

A high-speed sensitive drilling machine of the straight-line box type has been designed by Francis Reed Co., 43 Hammond St., Worcester, Mass., to meet the demand for a machine that is both sensitive and capable of driving comparatively large drills. During the test to determine the machine's capacity, a 1-inch hole was drilled through an inch of cast iron in eight seconds, and a ½-inch hole was drilled through an inch of cast-iron in three seconds, high-speed drills being used in both cases.



16-inch High-speed Drilling Machine, built by Francis Reed Co.

This machine has a cone belt shifter, a belt tightener and a line belt shifter. The cone belts are shifted mechanically by a lever located on the right side of the column. This lever is moved vertically to shift the belt, which passes through eyes in the ends of the shifting levers. These eyes or guides are located near the cones and the belt is easily changed from one step to another.

The belt tightener swivels about the vertical driving shaft in the rear, and, in addition to increasing the belt tension, it also increases the arc of contact, thus giving greater pulling power. This tightener is operated by a handwheel on the left side of the machine, through a rack-and-pinion movement, and it is interlocked with the belt shifting device so that the initial movement of the shifter releases the belt tightener, thus making it unnecessary to shift a tight belt. The belt itself is of special heavy leather, and endless. The line belt is shifted by two pedals located on each side of the base as shown; a slight pressure on either one starts the machine, and a repeated pressure on either stops it.

This machine has been designed with a view to accessibility and convenience, and it is easily controlled by the operator from the working position. The table tightening handles, the elevating crank, the cone belt shifter, and the line belt shifters are all operated from the front. The spindle is bored to receive a No. 3 Morse taper to accommodate all drills up to the full capacity of the machine. The spindle cone has a heavy top support to relieve the spindle of strain. All shafts are ground, and fast-moving shafts run in bronze boxes of large area and are interchangeable. The bevel gear on the vertical driving shaft at the rear is made of composition fiber to insure a noiseless transmission. These machines will be built with from one to four spindles. The weight of the single-spindle type illustrated is 480 pounds.

Some of the principal dimensions are as follows: Vertical feeding movement for the spindle, 6¼ inches; vertical adjustment of the head, 9½ inches; vertical adjustment of the table, 30 inches; size of table, 12 by 16 inches; maximum distance from spindle to table, 36 inches; diameter of spindle in the quill and cone, respectively, 1 inch and 15/16 inch. The machine will drill to the center a 16-inch circle.

CENTERING TOOL FOR THE LATHE

The illustration Fig. 1 shows a tool for centering work in the lathe known as the "Sure" center finder. The body of this centering tool contains a combination drill and countersink at one end and it has an enlarged 60-degree center at the other which fits on the regular tailstock center of the lathe. When it is held against the tailstock center as illustrated in Fig. 2, it aligns itself, and the combination drill can be used for centering by feeding it against the work with the tailstock in the usual manner. The friction between the body of the tool and the lathe center is sufficient to hold it for drilling and countersinking, so that it is simply necessary to steady the tool with the hand. Each center finder is provided with a combination drill and countersink which are stock sizes with many manufacturers.

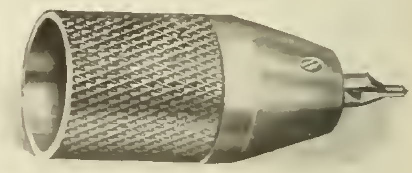


Fig. 1 Lathe Centering Tool

These tools are made in four sizes having drill diameters ranging from 3/64 inch to 1/8 inch. The first two sizes have a single-end drill and countersink to make them more compact, though the double-ended type may be used if desired.

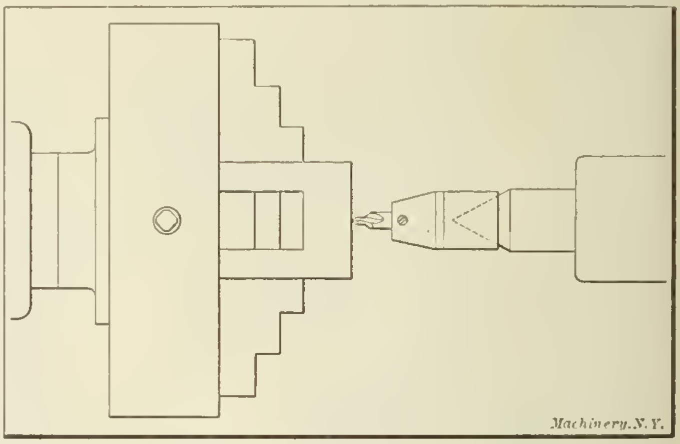


Fig. 2. Method of using Centering Tool

The two larger sizes are regularly supplied with the double-ended drill and countersink. This tool is manufactured by W. A. Peck, 141 Brewery St., New Haven, Conn.

LE BLOND HEAVY-DUTY CRANKSHAFT LATHE AND EQUIPMENT

An improved form of lathe with special equipment for rough turning gas engine crankshaft pins, is shown in Fig. 1. This lathe is a heavy-duty type built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. It is equipped with special adjustable headstock and tailstock fixtures designed to take crankshafts having strokes up to about 6 inches. There is also a heavy carriage carrying a three-tool turret toolpost with individual cross-stops for each tool; a roller steadyrest; automatic stops for longitudinal feed; and a pan bed with pump for supplying cutting lubricant.

The headstock fixture is carried on a faceplate mounted on the spindle and so arranged as to be adjustable for different

throws. When the proper adjustment for a given throw has been made, the slide is secured by four T-bolts. A graduated scale and adjusting screw permit of accurate adjustments. The revolving fixture is accurately indexed by a hardened steel plunger in the slide which has hardened bushings in the fixture. The index is so divided that the fixture may be rotated 120 or 180 degrees, making it adjustable for 2-, 4-, and 6-throw cranks. After indexing, the fixture is clamped by two T-bolts which engage a circular T-slot. The revolving fixture is equipped with removable split bushings which can be replaced to fit the line bearings of different sized crankshafts. The work is driven by a V-shaped dovetail piece, having a hand-nut adjustment, which also centers the pin by the cheek or web. The crank is held in position by a hinged clamp on the fixture.

The tailstock fixture is also adjustable and it is mounted on a spindle which revolves in a bushing in the tailstock barrel. The adjustment is obtained in the same manner as on the headstock fixture, and removable split bushings as well as a hinged clamp are also employed.

The method of chucking a crank is as follows: The two fixtures are brought into alignment by two locking pins. One of these is located in the head and enters a bushing in the large faceplate, and the other is in the tailstock and engages the tailstock fixture. The crankshaft is delivered to the machine with the line bearings rough turned, and it is clamped

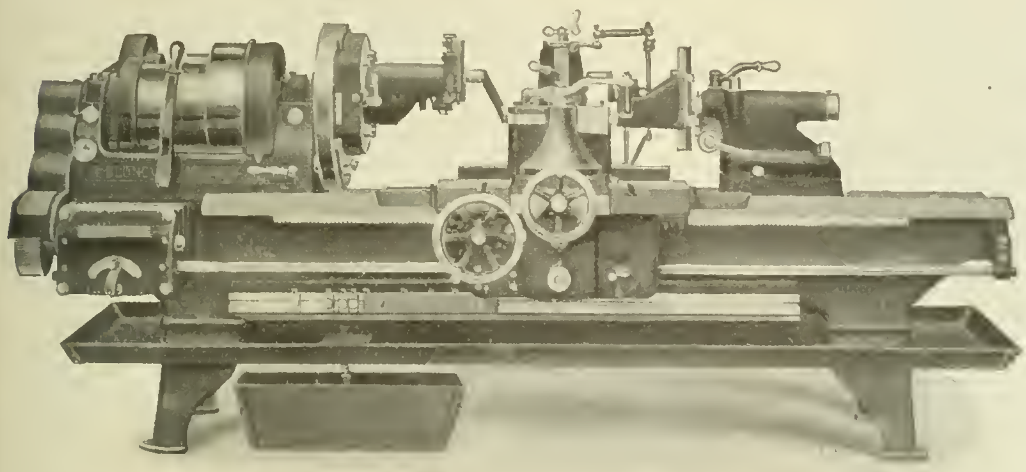


Fig. 1. Le Blond Heavy-duty Crankshaft Lathe

by the hinged clamp previously referred to and centered by the V-shaped driver. The locking pins for both fixtures are then withdrawn and the machine is ready to turn two of the pins. After these have been machined, the fixtures are again aligned by the locking pins, the two T-bolts of the headstock fixture and the hinged clamp at the tailstock are released, the indexing plunger is withdrawn and the headstock fixture and crank are turned 180 degrees or until the index plunger drops into place. The crank is then clamped at the tailstock end and the revolving fixture is secured by the two T-bolts

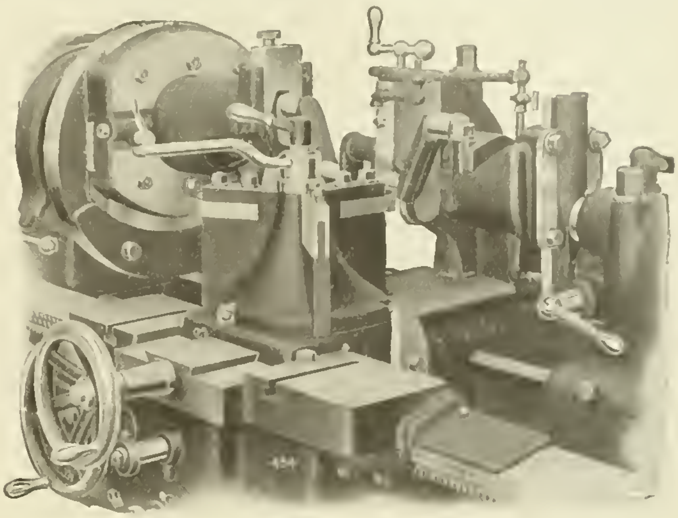
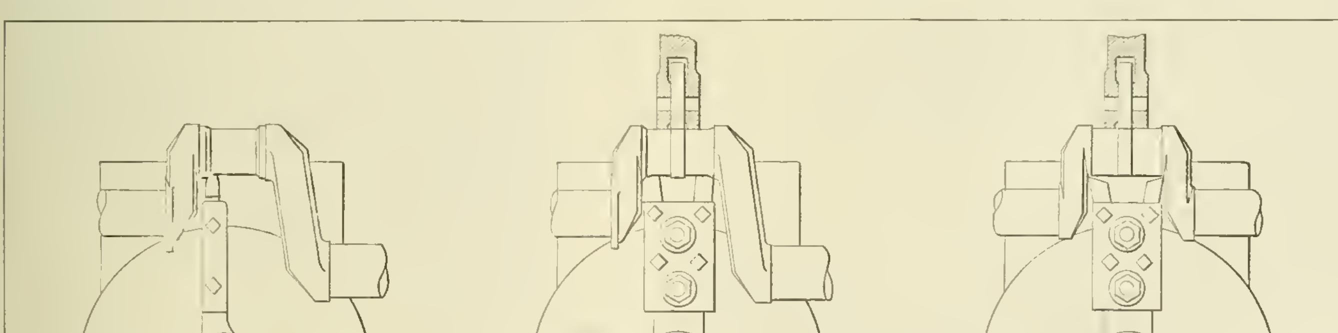


Fig. 2. Tool Equipment for Crankshaft Turning

previously referred to. After the locking pins are withdrawn, the lathe is ready to turn the two opposite pins.

The tool equipment on this machine, which is illustrated in Fig. 2, is something new in crankshaft lathe construction. Instead of using front and rear tool-blocks as with the old equipment (illustrated in the department of New Machinery and Tools, October, 1909), all the tools on this machine are carried in a three-tool turret tool-block. This gives a more substantial tool support, as all the stress is downward on the shears during the heavy filleting operation, thus eliminating the tendency to lift the carriage, as was the case when the filleting tools were mounted in the rear.

The method of turning a crankshaft is as follows: A round-nosed turning tool is first fed into a cross stop as illustrated in the plan view, Fig. 3, which gives the proper diameter. The feed is then engaged and the tool feeds across the pin until the automatic stop lever engages the first stop, which throws out the feed automatically. The carriage is then moved against a positive stop by means of the handwheel. The roller back-rest is next adjusted against the work by the cross-



Figs. 3, 4 and 5. Plan Views showing Arrangement of Tools in Turret Tool-block of Crankshaft Lathe, and Successive Steps in finishing Pin

feed handwheel operating through a telescopic screw, and the filleting tools are brought into position as in Fig. 4. These are run in against a stop, removing the part left by the turning tool and giving the pin the proper width and fillets of the correct radius. If the crankshaft has straight webs which must be finished, two tools are used as in Fig. 5, which face the webs to the correct width. During these last two operations, the crank is supported by the roller back-rest, thus eliminating any tendency of the work to spring.

After one pin is finished in the manner described, the back-rest is moved out of the way, the automatic stop lever raised and the carriage shifted to the next pin, and the operation repeated.

The tools are held in position on the turret by studs, and they can be moved and other tools quickly substituted, for pins of different widths. In fact, the equipment is designed so that the adjustment and changes for crankshafts of different sizes and styles can be easily and quickly made. The turret and principal parts of the fixtures are made of steel castings, and the index plugs and bushings are hardened. The lathe itself has a new form of compensating V and a single casting box-type of apron. The feed box has sliding gears and gives eight feed variations. All the gears in the apron and feed box are of steel. This machine is furnished either with a three-step cone and double friction back-gears, or with a single-pulley drive.

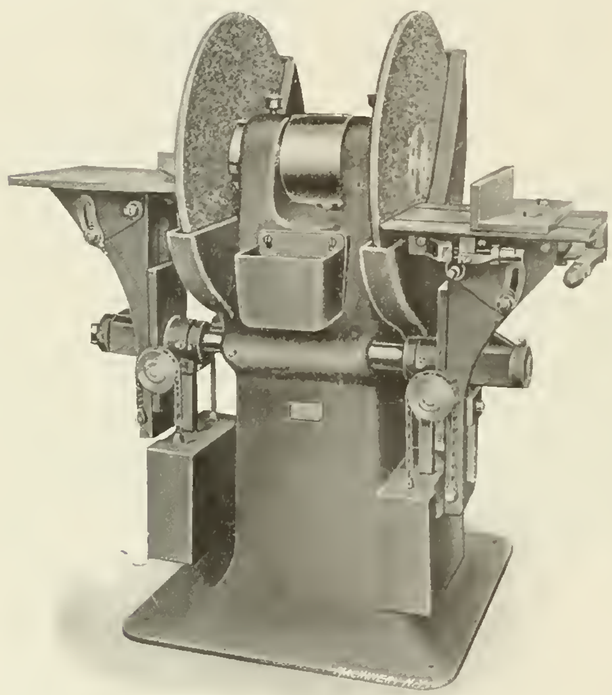


Fig. 1. Rowbottom 26-inch Disk Grinder

ROWBOTTOM 26-INCH BALL-BEARING DISK GRINDER

The Rowbottom Machine Co., Waterville, Conn., is now manufacturing an interesting design of disk grinder which embodies in its construction a self-contained dust exhauster, counterbalanced work tables, and ball bearings for the spindle. Fig. 1 of the accompanying engravings is a front view of this grinder, and Fig. 2 is a view of the rear which shows the exhauster.

Each table is counterbalanced, for convenience in making vertical adjustments, by a weight suspended on two chains that pass over sprocket wheels and connect with the table on each side, as shown. These tables can be given a rocking motion across the face of the disks or can be fastened in a stationary position. They also have an angular adjustment with relation to the faces of the disks. The weights are kept in alignment with the tables by guides which prevent any swinging movement. The right-hand table has a sliding motion to and from the disk, operated by the hand-lever shown and controlled by an adjustable stop-screw graduated in thousandths of an inch. This table also has two T-slots for attaching angle-plates or fixtures. The left-hand table is equipped with an adjustable gage for locating work in an angular position horizontally.

The dust exhauster, which is bolted to the pedestal, is driven from the same countershaft as used for the grinder. All sparks and dust are drawn by the exhauster fan down through the disk guards and the machine pedestal, into a removable water box. This box is located just beneath the fan, as shown, and it can easily be withdrawn for cleaning, when necessary The exhauster enables the grinder to be placed adjacent to other machinery without danger of injury to the bearings because of dust. As the exhauster is self-contained, piping to independent exhaust systems is unnecessary, and it also meets the approval of the fire insurance inspectors.

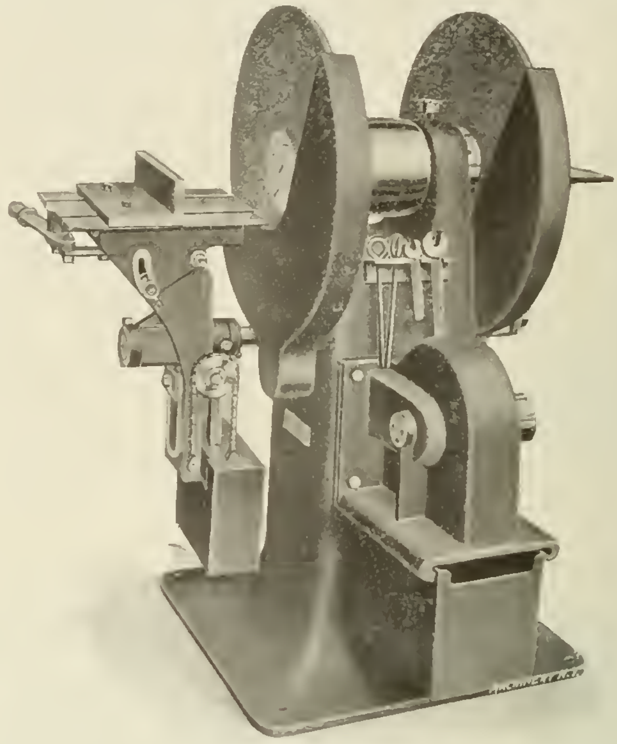


Fig. 2. Rear View of Disk Grinder, showing Self-contained Dust Exhauster

The ball bearings for the spindle are of the Hess-Bright type and are shown in the sectional view, Fig. 3. This construction gives durability and effects a considerable saving in power. The bearings also require little attention, as they are constantly supplied with lubricating grease from the cups shown.

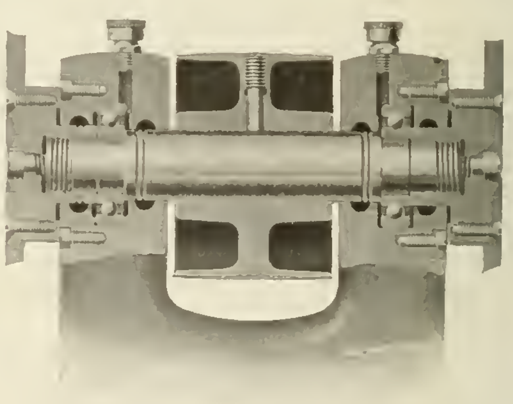
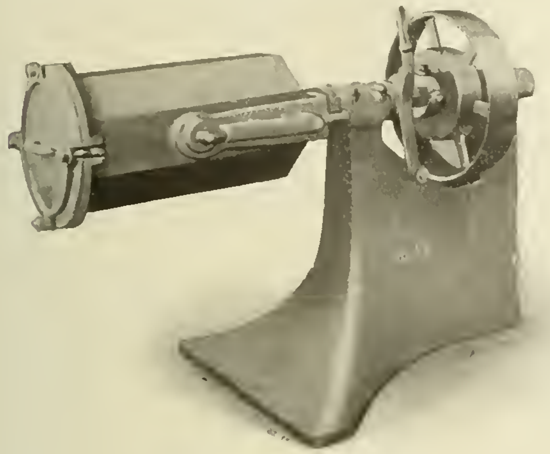


Fig. 3. Sectional View of Spindle and Bearings

The disks of this grinder are 26 inches in diameter, and the spindle pulley measures 8 by 5½ inches. The speed of the disks is 1200 revolutions per minute. The work tables have a width of 13 inches and a length of 17½ inches, and a vertical adjustment of 7½ inches. The equipment regularly furnished with each grinder includes all necessary wrenches, four steel disks, countershaft, cementing press, one dozen emery cloth disks, and one gallon of cement.

BAIRD SINGLE BALL-BURNISHING BARREL

The latest addition to the line of tumbling barrels manufactured by the Baird Machine Co., Oakville, Conn., is shown in the accompanying halftone. This is a single-barrel machine designed particularly for small concerns, and also for handling special or experimental work. It is equipped with a friction clutch drive, "tiltable" barrel, a brass cover, a wood-lined barrel, and other features common to the duplex

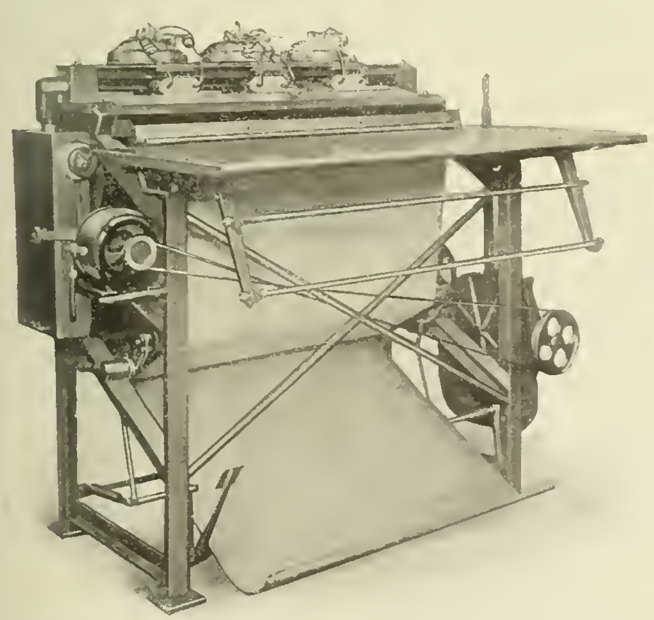


Baird Ball-burnishing Barrel

machine built by this company. The friction clutch pulley allows the machine to be belted direct to the main shaft, and either parallel or at right angles to it. This single-barrel type is built in two sizes, designated as Nos. 1 and 2. The barrel of the No. 1 size is 10½ inches in diameter and 24 inches long on the inside, and the No. 2 size is 16 inches in diameter and 30 inches long.

PEASE CONTINUOUS BLUEPRINT MACHINE

As the tendency of manufacturers is toward the use of small blueprints for shop use, the C. F. Pease Co., 166 W. Adams St., Chicago, Ill., has brought out the improved design of continuous blueprint machine illustrated herewith, which is made in 24- and 30-inch sizes, to meet the demand for a small machine. The illustration shows a 30-inch size or one



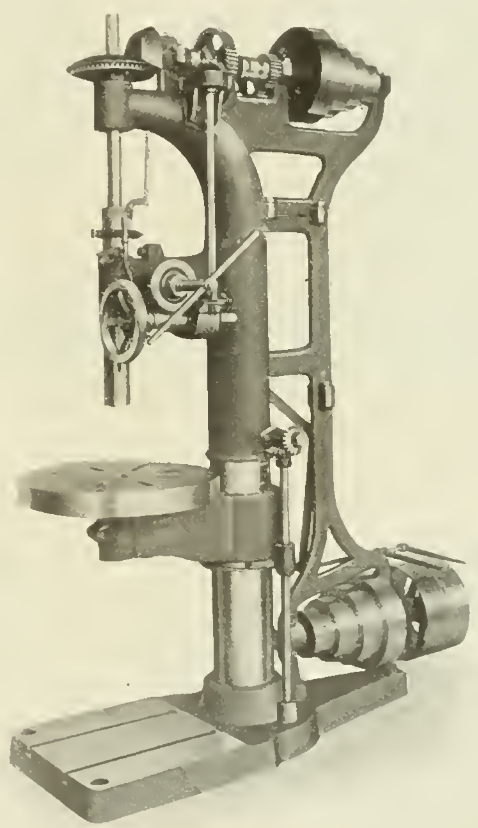
Blueprint Machine built by C. F. Pease Co.

for tracings up to 30 inches in width. This machine has three arc lamps of low amperage, and the 24-inch size, two lamps. The smaller size has a capacity for printing from fifty to seventy-five 24- by 36-inch prints per hour, or double that quantity of 18- by 24-inch prints. It occupies no more space than an ordinary desk or small drafting table, and can be placed in a corner of the drafting-room without annoyance, as it is practically noiseless.

All tracings are fed over the feeding table on top of the sensitized paper and right side up. There is no slipping of the tracings, and a good contact is obtained. The paper and tracings are carried down past the bent glass, by means of an endless canvas belt, into a tray below, from which they are removed by the operator at the front of the machine. This form of printer can be used for printing either from sheets or rolls, as desired. Any size sheet can be printed, from the very smallest up to the maximum width of the machine, with equal facility, and prints can be made to any length in one piece. It is also possible to print any portion of a tracing without running the entire tracing through. The machine is rapid in its operation, and the light is such that prints of any kind can be made. These printers are also furnished in any width up to 54 inches, with lamps corresponding in number to the size of the machine.

SIBLEY STATIONARY-HEAD DRILLING MACHINE

The distinguishing features of the new stationary-head drilling machines with geared feed (the first lot of which the Sibley Machine Tool Co., South Bend, Ind., has just completed) are simplicity and rigidity. The design of the machine and the geared feed, adapt it to the heavy duty inci-



Sibley Stationary-head Drilling Machine

dent to modern manufacturing methods. While having the same range as similar models formerly made by this company, this machine, a view of which is shown herewith, is considerably lower in height.

It will be noted that the feed mechanism derives its power from the top driving shaft, and all the gearing is completely enclosed and runs in an oil bath. Four changes of feed and a neutral position are effected by moving the small knob seen in the center of the handwheel; the convenience of this arrangement is obvious. An automatic stop collar on the spindle sleeve, trips a latch at the desired depth of hole and the worm swings away from the worm-gear. This feed has been given unusually severe tests, and the results were so successful that it has been adopted for the entire line built by this company, excepting the 20- and 22½-inch sizes.

This machine will drill to the center of a 24½-inch circle. The maximum distance from the spindle to the base is 42½ inches, and to the table, 27 inches. The table has a traverse

on the column of 16 inches, and its diameter is 21 inches. The spindle has a feed of 9 inches, and the four variations range from 0.007 inch to 0.020 inch per revolution of the spindle. The diameter of the column is 7 inches, and of the spindle 1½ inch. The height of the machine is 6 feet 10½ inches and the net weight, 1400 pounds.

ALINER-BOSWELL RADIUS PLANING ATTACHMENT

Various attachments have been devised for machining the links of valve operating mechanisms to the proper curvature or radius, especially in locomotive shops where links frequently have to be machined. After a careful study of practically all these devices, the radius planing attachment shown in Fig. 1 applied to a planer was designed. It is built by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa. In the construction of this attachment, the aim was to build a tool capable of rapid operation and one so arranged that wear would not affect the accuracy of the work.

This attachment, the construction of which is more clearly illustrated in Fig. 2, has a plate *A* which is fixed to the planer table and has integral with it a square projecting block *B*. This block fits into a cross slot in the ring *C*, which has an annular bearing in the top plate *D*. The latter forms the work table, and it is attached to a radial bar that passes through a double-trunnioned bearing mounted in an adjustable stand *E*. The ring *C* is kept down by a central plate, as shown, and the work table is provided with a retaining ring *F*. The movement of the planer table is transmitted by square projection *B* to ring *C*, which, in turn, imparts a circular movement to the work table; this is accompanied by a lateral movement of ring *C* with relation to the square driving block. With this arrangement the driving power is transmitted to the work table in the direction of the reciprocating movement of the planer, and the thrust of

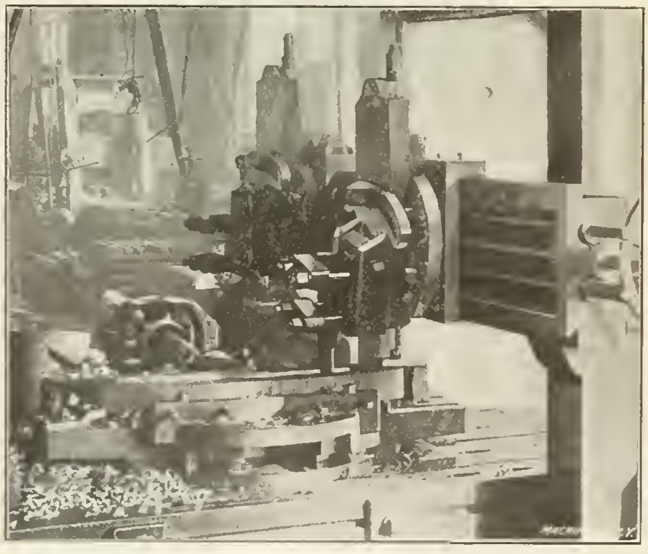


Fig. 1. Radius Planing Attachment for Machining Links, etc.

the tool's cut is also along parallel lines. Owing to the small amount of stress imposed on the radial bar, the latter is made comparatively light. This bar is of tubing and the attachment is adjusted for planing different radii by shifting stand *E* and its bearing along the bar at right-angles to the planer table. This radius attachment allows heavy cuts to be taken, and a link may be quickly located in the fixture by a center line marked upon the chuck.

Prior to planing the curved slot, the sides of the link are planed, the edges milled, and the clearances for the planing tools, drilled and slotted. The work is then placed in the attachment and the slot is rough planed by using two parting tools simultaneously. These tools cut narrow slots on each side, and the central part of the slot is removed in the form of a solid block. This parting operation, including setting up the link and removing the block, has been done on a 15-horsepower planer in thirty-five minutes, the link being of hammered steel and 3½ inches deep. After the link is roughed out in this manner, the slot is finished by side tools. This attachment can also be used for planing quadrants, dies, curved stone, etc.

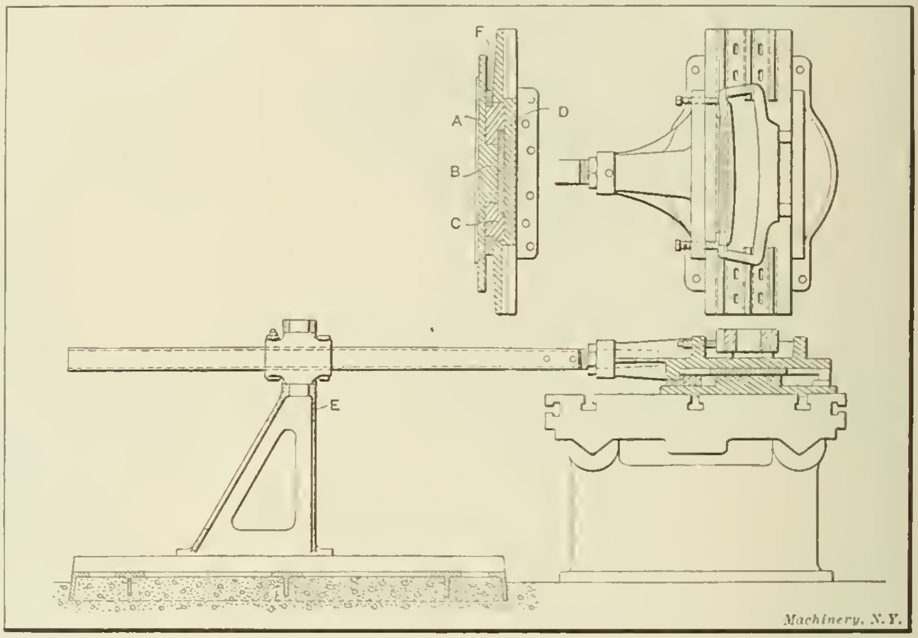
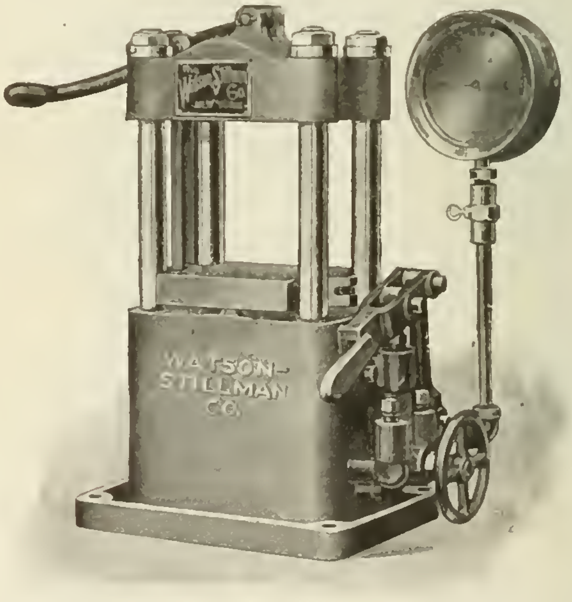


Fig. 2. Elevation and Plan of the Radius Planing Attachment

WATSON-STILLMAN HYDRAULIC PRESS

The small hydraulic press which we illustrate herewith was designed by the Watson-Stillman Co., 192 Fulton St., New York, for laboratory work and for crushing specimens of building material. This press is also useful in machine shops where small parts are press fitted, or where a high pressure must be brought to bear on any small article, whether for bending, straightening or flattening. It can also be applied to an endless number of odd jobs about any shop.



Small Hydraulic Press for Laboratory and General Shop Use

The convenient size permits the press to be mounted on a light truck and hauled from place to place. The ram is quickly traversed by the lever and connecting links shown at the left. The handle at the right on the extension lever

socket will operate the pump easily where only light pressures are required. By applying the extension lever, the press will develop a pressure of 30 tons. The platen is 8 inches square, the maximum opening is 8 inches, and the ram movement is 4 inches. The base measures 12 inches by 16 inches, and the height of the press over-all is 27 inches. The main cylinder is a steel forging, machined to fit perfectly into the reservoir, and the pump cylinder is of bronze. This press is designed to withstand severe service, and it is ideal for small work requiring high pressures.

EVANS AUTOMATIC TAPPING MACHINE

The Beaman & Smith Co., Providence, R. I., is manufacturing the automatic tapping machine, front and rear views of which are shown in Figs. 1 and 2. This machine, by making certain changes in the equipment, can be employed as a four-way tapping machine, a bushing machine, a union machine, or one for finishing valve bodies. The machine is changed for these various purposes by simply substituting a different front and head, the main body remaining the same.

The four-way machine is usually furnished with three heads, as shown in Fig. 1, for tapping L's, T's and Y's. For tapping crosses, one side is equipped with four heads, the extra head being taken from the opposite side. The work is held in a toggle-joint chuck which grips the fitting tightly. This chuck is of the floating type, to allow the taps to center themselves with reference to the rough cast holes. The chuck is mounted on a knee and it has both vertical and horizontal adjustments similar to a shaper table, which make it possible to tap return bends.

The bushing machine is suitable for all bushings except the face type, which can be handled to better advantage in the four-way machine. The special feature of this machine is an automatic chuck which opens, closes, and drops down for clearance, automatically. A plunger which operates the chuck holds the bushing and centers it. The union machines are of the same type, but the head, tail and nut are finished on separate machines differently equipped. Each part is finished complete in one chucking, and the work is accurate and uniform. There are no complicated tools, a hollow mill doing the work of reaming and facing, and a single tool the forming for the tail. The threads are all cut with leaders and Pratt & Whitney dies are used.

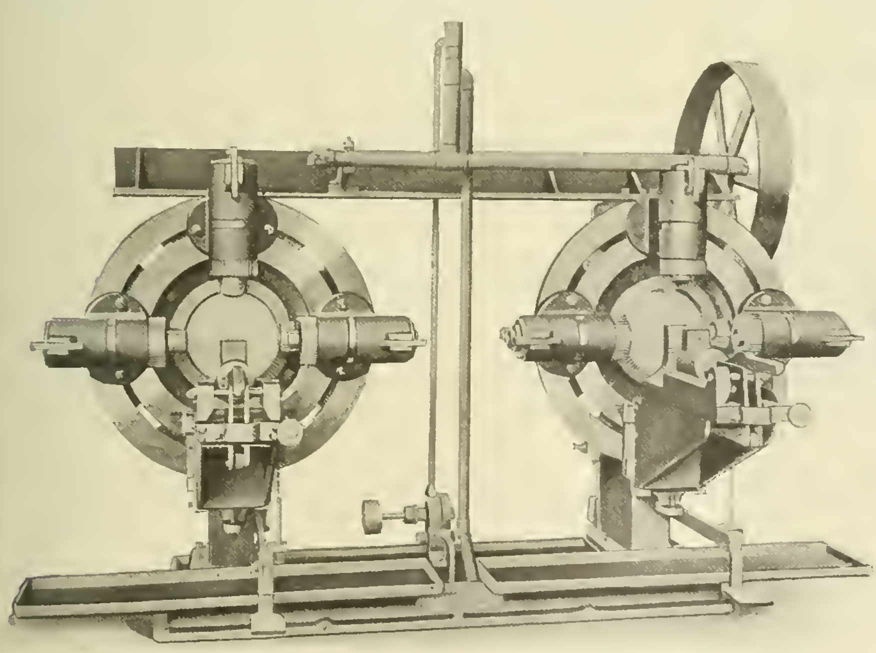


Fig. 1. Automatic Tapping Machine, built by the Beaman & Smith Co.

The valve machine finishes valve bodies in one operation, except the seat, which is done in a second operation on the same or another machine. This machine is identical with the four-way tapping machine, excepting the heads which carry the tap, reamer and facer, these being provided with compound spindles. The valve body is chucked in the usual way, and the taps and facer work simultaneously, so that the work of tapping, facing and recessing is finished in the time required for tapping. As the tapping and facing is done with one spindle, the faces are true with the tapped hole. The valves are also made uniform, as the spindles work to a positive stop. The tools required are one set of jaws, three taps, and three hollow mills.

Fig. 2 shows the driving mechanism, which is the same for the different machines. A horizontal shaft at the top connects, through bevel gears, with a vertical shaft in the rear which transmits the movement through a second set of bevel gears to a central gear in the front of the machine which drives the various tapping heads. The small inner bevel gear in the rear is for the reverse speed, which is three times that used for tapping. The change from one speed to the other is effected by a clutch interposed between the driving pinions, as shown. This clutch is operated automatically for the fast reverse, by the mechanism seen near the base. This consists of a slide that is moved vertically by the spur gears and screw shown, until a dog on it comes in contact with an adjustable screw, which causes the clutch to shift from the regular driving pinion and engage the reversing pinion.

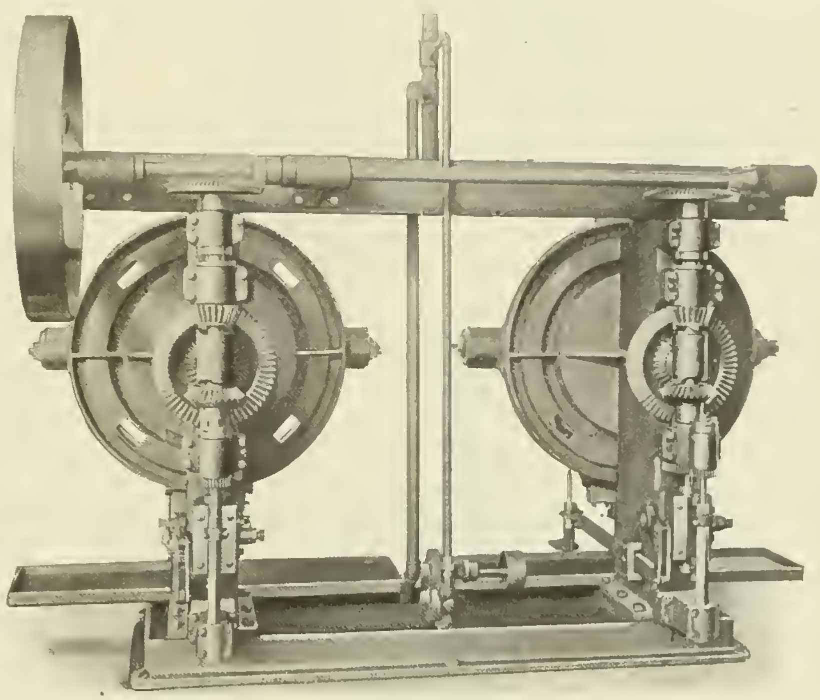


Fig. 2. Rear View of Tapping Machine, showing the Driving and Automatic Reverse Mechanism

By means of the adjustment connected with this mechanism, the number of revolutions for tapping a fitting can be varied to obtain any desired length of thread. For example, a ½-inch fitting is usually tapped with nine turns of the tap, and three turns are added to give clearance. In this case the increased reversing speed would remove the tap in four revolutions. A patent tap-holder is used for these machines, which allows the cheapest forms of taps to be used. The tap is held by the thread, which insures accurate alignment. The jaws of the tap-holders are interchangeable, so that changes for different sizes can be quickly made.

On these machines the heads can be adjusted to any angle, permitting L's or T's of any degree to be tapped. Each spindle also has a separate leader which allows any pitch to be cut. This leader can be adjusted so that a fitting can be gaged within a quarter of a turn. Special spindles with dies are used

to cut nipple L's, nipple T's, or plugs. Pratt & Whitney dies are used, and a special feature of the spindle allows the die to be quickly replaced. A special head is made for cutting right- and left-hand L's.

After one of these machines is set and started, the operator can attend to others, as the machine stops automatically when the work is completed. The entire time for chucking the work and starting the machine varies from three to six seconds, depending upon the size and character of the work. The chucking is effected by a single motion of each hand, and while this is being done, an automatic lock prevents the foot lever by which the machine is started from working, thus eliminating any danger of accident. The operator is further protected by cast-iron guards that are provided for gears, clutches and other dangerous parts.

The four-way tapping machines are built in 1-, 2- and 4-inch sizes; the bushing and union machines in 1- and 2-inch sizes, and the valve machines in 2-inch size.

GANG SENSITIVE RADIAL DRILL WITH ALL-BELT DRIVE

The radial drilling machine illustrated in Fig. 1 has been designed by William E. Gang Co., Cincinnati, O., for driving high-speed twist drills ranging from ¼ to 1 inch in diameter,

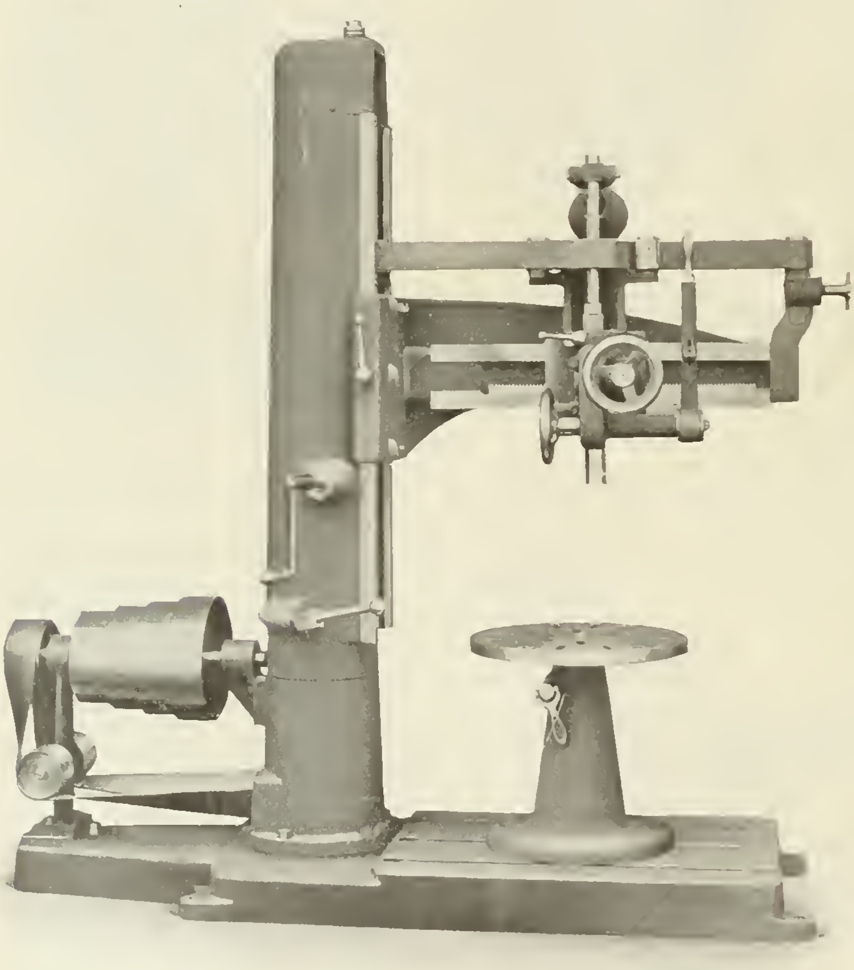


Fig. 1. Gang All-belt-driven Radial Drilling Machine

at their maximum efficiency. As this machine has an all-belt drive, with no gears whatever in the transmission, it is practically noiseless, even when operated at high speeds.

The power is transmitted from a cone-pulley at the rear, by a belt which connects with a vertical shaft inside the column. This vertical shaft, which extends the full length of the column, is splined to a pulley carried by a bracket extending in the column from the radial arm. From this pulley the power is transmitted by a horizontal belt to the spindle. This belt is so arranged that it encircles half the circumference of the spindle pulley constantly, and it has the same tension irrespective of the head's position. This tension is maintained by the position of the idler pulleys and without resorting to springs or counterweights. These idler pulleys are so located with reference to the spindle pulley that the driving belt has an equal contact on both sides of the spindle pulley, which exerts a balanced pull without lateral strains on the spindle annular ball bearing. Provision is made for taking up the slack of both belts due to stretching.

All running parts are in accurate running balance, and are carried on imported annular ball bearings. The mounting of these bearings was given much thought and attention, the arrangement being such that no running part rides upon a stationary part, the ball bearings taking all radial and thrust loads, thus reducing friction to a minimum. The ball bearings are encased to protect them from dust or injury, and they require lubricant only at long intervals. This machine has driven a ½-inch high-speed drill, running 900 revolutions per minute, through a 2-inch cast-iron plate, at the rate of 25 inches per minute, with a feed of 0.028 inch per revolution of the spindle, and drills of other sizes in proportion.

A two speed friction countershaft, in conjunction with the four step cone, gives eight spindle speeds, which vary in geometrical progression from 300 to 1170 revolutions per minute, giving an average velocity of 80 feet per minute for drills ranging by sixteenths from ¼ inch to ¾ inch inclusive, and by eighths from ½ inch to 1 inch inclusive. This speed has been found to give good results under average shop conditions, but, if desired, the countershaft can be speeded up to give the highest speeds that modern twist drills will stand.

The spindle of this machine can be rapidly traversed by a handwheel at the left of the head, and it is fed by the lever shown to the right. This lever has a ratchet so that it can be placed in the most convenient position for drilling. When the lever is turned to a vertical position, the latch automatically locks it and prevents it from falling, but this does not release the spindle from the control of the lever. In other words, the same relative position of the lever to the drill point is maintained, thereby avoiding the necessity of resetting it for each hole, when a number of holes are being drilled in the same plane. By pushing the lever slightly beyond this first position of the locking latch, into another notch, the spindle is released from the control of the lever so that it can be moved up or down by the handwheel. The counterweight directly connected to the top of the spindle makes the lever feed extremely sensitive.

The weight of the column is taken by a conical roller bearing, and the column is clamped by a quick-acting cam-lever, which, by the aid of a hexagon nut and draw-bolt, can be made to clamp in any position found convenient by the operator. The arm is very rigid, being made in D-section and strongly webbed. It is raised and lowered by a crank at the side of the column which connects, through bevel gears, with an elevating screw that engages a stationary nut bolted to the arm. The thrust of this screw is taken by a ball-thrust bearing. The arm is clamped by the ball-lever shown. The head or saddle is moved on the arm by a handwheel operating through a rack and pinion, and it can be securely clamped in any position.

This machine is also furnished with a tapping attachment shown in detail in Fig. 2. Like the drive of the machine proper, no gears are used in connection with this attachment, the spindle being reversed by a narrow belt located above the spindle pulley. This belt is driven from the idler pulleys on the head (which revolve in an opposite direction to the main driving pulley), and it drives a pulley supported on a plate directly above the main pulley. Between these upper and lower spindle pulleys there is a cone-clutch operated by

the bent lever seen to the right of the spindle. This clutch is normally held in engagement with the forward or lower pulley, by a powerful self-contained spring, thus causing the spindle to run forward. When a reverse movement is desired, the clutch is disengaged from the lower pulley and engaged with the upper or reversing pulley, by the lever referred to. As soon as this lever is released, the spring automatically withdraws the chuck from the reversing pulley, and engages it with the forward pulley. An adjustable idler is provided for taking up any slack in the belt due to stretching.

The salient features claimed for this tapping attachment are as follows: It operates without shock or jar at speeds as high as 1170 revolutions per minute; it reverses instantly; is absolutely noiseless in operation; and the spindle alone reverses so that the machine is equally sensitive for both drilling and tapping operations. The tension of the belt can also be readily adjusted so that it will just pull any size tap, thus permitting the tap to be driven into a "blind" hole and to strike the bottom, without danger of breaking it

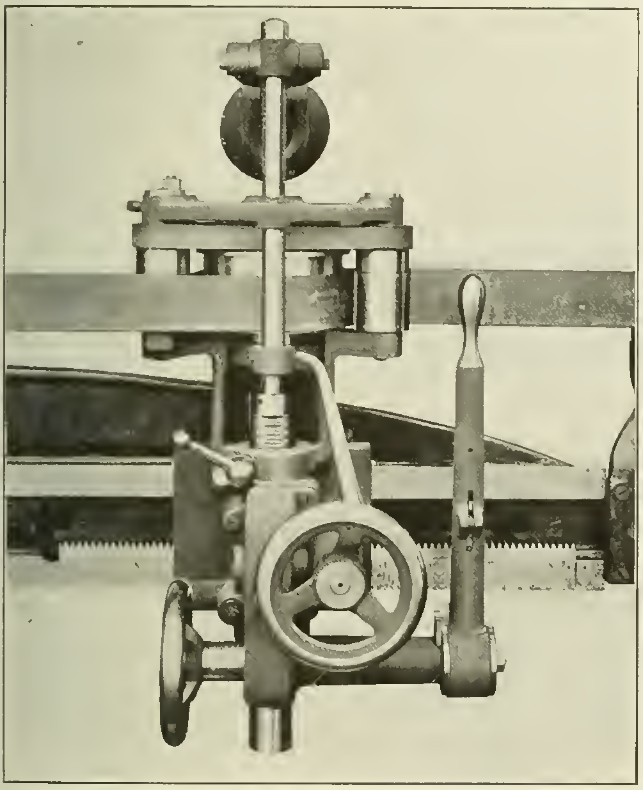


Fig. 2. Tapping Attachment for Gang Radial Drill

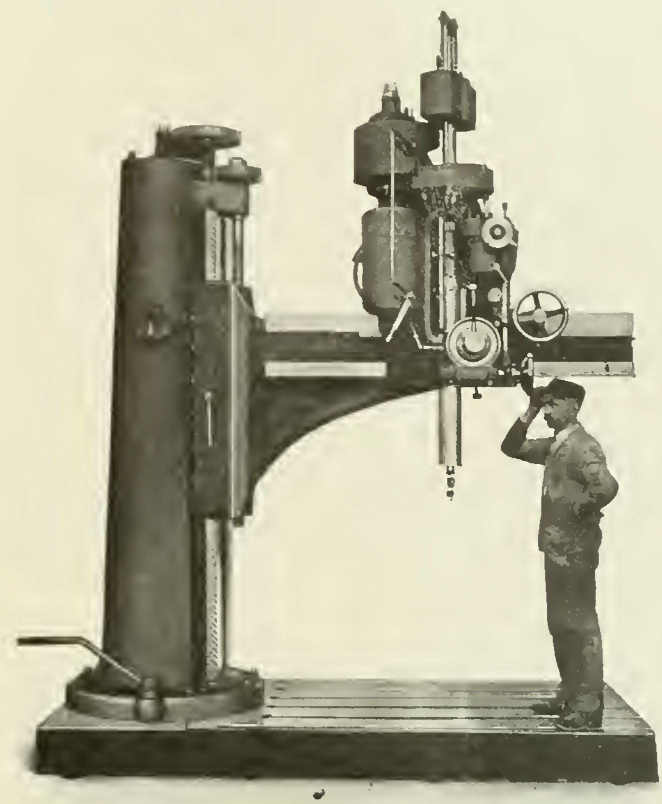
or injuring the machine. This machine will pull U. S. standard taps up to and including ¾ inch. The arms are made in 2½-, 3- and 3½-foot sizes. The standard equipment includes belts and a plain round table, as illustrated. Other styles of tables can also be furnished.

ELECTRICALLY-DRIVEN RADIAL DRILLING MACHINE

The large radial drilling machine shown in the accompanying view is a recent design built by the James Clark, Jr., Electric Co., 520 West Main St., Louisville, Ky. This machine has a maximum distance of 72 inches between the spindle and base of the column, and it weighs, complete, 19,000 pounds. It is electrically driven, and the driving motors are incorporated in the design, making the machine compact and substantial.

The motor for driving the spindle is a variable-speed type, having a 4 to 1 speed variation, and it will develop a maximum of fifteen horsepower. Twenty spindle speeds are obtained through one back-gear and the motor changes. The friction back-gears can be changed without stopping the machine, and all operating handles are conveniently located. The driving and feed gears are all of steel. The spindle has a vertical traverse of 19 inches, and its smallest diameter is 3 inches.

The hoist motor for the arm is mounted on top of the column, and either upward or downward movements are obtained by throwing the controller handle shown on the side of the column, to the right or left. The column turns on ball and roller bearings, and when the clamping lever is tightened, the large flange at the base of the column is drawn down into contact with the bed, thus binding it rigidly. The arm has long gibbed bearing surfaces on the column, as the illustration shows. When adjusting the arm vertically, the



Radial Drilling Machine, built by the James Clark, Jr., Electric Co.

hoisting motor shows no difference in the power consumed with the head close to the column or at the extreme end of its traverse.

While this machine was being tested, thirty-five holes were drilled with a 1⅞-inch high-speed drill in twenty-five minutes through two steel condenser heads clamped together and having a total thickness of 2 inches. The actual drilling time for each hole was thirty-five seconds. This machine has a total height of 114 inches, and the bed measures 117 by 54 inches.

NEW MACHINERY AND TOOLS NOTES

Forging Machine: Ajax Mfg. Co., Cleveland, Ohio. Upsetting and forging machine which is said to be the largest ever constructed. The construction of this machine, which is a 7-inch size, is similar to the standard line of forging machines built by this company.

Drill: A. C. Vauclain, 401 North 33rd St., Philadelphia, Pa. New type of twisted drill with cutting edges which meet in the center thus eliminating the scraping action common to the web point of a regular twist drill. Tests are said to show a very low power consumption.

Pipe Cutting and Threading Machine: Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. Electrically-driven pipe cutting and threading machine. The die cutting head is of the Forbes pattern and has a range of from 1 to 8 inches. The machine has a cabinet base which contains the driving motor.

Duplex Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. This machine is of the Lincoln type, the table of which has a working surface of 11 by 40 inches. The spindle heads are independent and have micrometer adjustment. The spindle speeds range from 15 to 38 revolutions per minute.

Combination Drill: Standard Tool Works, Standish, Maine. Combination drill having a small pilot drill to relieve a center of larger size, the same as when a small hole is first drilled for this purpose. The pilot drill has a taper shank which is inserted in the end of the large drill, the latter acting as a socket.

Combination Screw Driver: J. C. Barrett Co., Hartford, Conn. Combination screw driver set with blades that fold within the handle similar to a jack-knife and are retained by a knurled sleeve at one end. These blades are of different sizes and a quarter turn of the retaining sleeve enables any one to be quickly brought into the working position.

Quick Return for Horizontal Boring Mill: Cleveland Machine Tool Works, Cleveland, Ohio. Quick return for horizontal boring mill cutter bars which is effected by operating a pilot wheel on the head after pulling out a knob conveniently located in its center. This arrangement facilitates the operation of the machine and will be applied to the line built by this company.

Castellating Fixture: Hendey Machine Co., Torrington, Conn. Nut castellating fixture consisting of a circular plate having projections that prevent the nuts from turning while slots are being milled. Three passes of the gang cutters are necessary to castellate a plateful of hexagonal nuts. The work-holding plate is attached to a base by swinging bolts and it can be quickly indexed.

Steel Clamp: Adell Bros. Mfg. Co., Orange, Mass. Pressed steel clamp made from sheet steel and designed for the use of machinists, toolmakers, etc. The screws are long and have special U. S. standard threads that are fine enough to insure a powerful clamping action. The standard sizes have 6-inch jaws with a 4½-inch opening; 7⅜-inch jaws with a 5½-inch opening; and 8¾-inch jaws with 6½-inch opening.

Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. Vertical belt-driven milling machine designed for doing an average line of work without the use of spindle gears. The machine is driven by a 5-inch double belt and has sufficient power with the open belt drive to take cuts ranging from 1/16 to 3/32 inch deep in cast iron, with a table feed of 8 inches per minute, using surface mills 10 to 12 inches in diameter.

Cold Saw: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Cold sawing machine having an annular disk blade with internal teeth. The saw has a positive direct-geared drive, and the power is furnished by a 20-horsepower motor. Nine changes of feed are obtained through a gear box, and there is a reversing rapid power traverse. This saw is rated as a 5-inch machine, but it will clear diameters up to 7 inches.

Cutting-Off Machine: Hurlbut-Rogers Machine Co., South Sudbury, Mass. Five-inch self-contained motor-driven cutting-off and centering machine of the accelerated-speed type. The centering attachment is driven from a short shaft under the main spindle, having a sliding gear at one end which meshes with one of the driving gears of the machine. This attachment is mounted on a sliding base aud can be moved out of the way when not in use.

Circular Milling Attachment: Hendey Machine Co., Torrington, Conn. Circular attachment applicable to the No. 3 and 4 milling machines built by this company. The table has a power feed in either direction controlled by a lever which may be placed in a neutral position when it is desired to turn the table by the handwheel provided. The diameter of the table is 20 inches and it is graduated in degrees. The attachment can be quickly removed, when not in use.

Test Indicator: E. M. Erb Mfg. Co., Jersey City, N. J. Dial test indicator adapted to general shop and tool-room work. The dial face is covered with celluloid, and the indicator spindle has a shoulder which prevents accidentally forcing it in too far and injuring the mechanism. These indicators are subjected to rigorous tests for accuracy, and the mechanism is compact and simple. A means of adjustment is provided, if for any cause this should be necessary.

Chuck Mechanism: Adolph Muehlmatt, Cincinnati, Ohio. Chucking mechanism for engine and turret lathes, bench lathes, etc. The arrangement is such that the work can be gripped by the chuck, machined and removed without stopping the spindle. The chuck is actuated by a closing tube inside the spindle which derives its movement from a lever located at the front or rear of the head, the position depending on the type of machine. These chucks are made for gripping work either internally or externally.

Planimeter: W. L. Durand, 929 K St., N. W., Washington, D. C. Radial planimeter designed to give the mean value of the ordinates of circular charts, such as are used for recording pressure, temperature, etc. The instrument is graduated to give the mean ordinate in linear inches, so that by applying the appropriate scale factor, it may be used for all diagrams, regardless of the character of the quantity recorded. The tracing point of the instrument will cover circles ranging in diameter from 1½ inch to 10½ inches.

Gasoline Engines: Trump Bros. Machine Co., Wilmington, Del. This company has placed on the market a line of two-cycle marine gasoline engines. In designing these engines it was the aim of the builders to make a simple, reliable and efficient motor. All parts are easy of access and special attention has been given to the matter of lubrication. The cylinders, crankshaft, and all inside moving parts are positively oiled from one source. These engines are made with single or double cylinders and in sizes ranging from 3 to 12 horsepower.

Special Turret Machine: Pottstown Machine Co., Pottstown, Pa. Multiple-operation turret machine built specially for the production of globe valves. This machine can, however, be used for a variety of work by changing some of the equipment. It will handle globe valves varying from ½ inch to 2 inches inclusive, and will finish ½-inch brass valve bodies at the rate of six per minute and 2-inch bodies at the rate of four per minute. The machine is so arranged that it is impossible for the operator to move the turret until the automatic gripping device is released.

Precision Lathe: Rivett Lathe Mfg. Co., Brighton, Mass. Precision bench lathe equipped with a device for correcting any errors in the lead-screw when it is desired to cut very accurate threads. This device consists of a bar that is mounted in bearings at the back of the lathe bed and connected with the lead-screw at the front. This bar has an arm attached to it engaging an adjustable slide, which, by its angular positiou, governs the compensating movement of the lead-screw. This attachment is also useful for giving slight variations in the pitch of threads when necessary.

Automatic Metal Saw: Covel Mfg. Co., Benton Harbor, Mich. Automatic circular, metal saw sharpener that can be used to retooth or punch heavy circular saws without retempering. This machine is provided with a patented crosshead which enables the center of a saw to be adjusted to coincide with the grinding wheel center at all times. The machine can be used for grinding new teeth in saws where the old ones have been broken, and the work can be fed to the emery wheel by an index plate. All adjustments of rods or connections are controlled by handwheels and screws, and adjustments can be made with the machine running.

Bending Machine: Wallace Supply Co., 108 North Jefferson St., Chicago, Ill. Hand-operated bar bender, especially designed for bending the reinforcing bars used in concrete work. Stock 1¼ inch in diameter can be bent cold without difficulty. Either round or flat material can be handled, and by substituting higher dies, flat stock 4 inches or more in width can be formed. The power is obtained by a 36-inch ratchet lever which operates a small pinion meshing with a stationary segment gear. By turning the pinion along this gear, a radial member carrying the bending jaws is given the required movement. This machine is furnished with or without a stand.

Boring and Turning Mill: Betts Machine Co., Wilmington, Del. Boring and turning mill designed for heavy duty. The faceplate is driven by two pinions located on opposite sides which tends to give smooth operation. The machine swings 20 feet 3 inches and will take work 12 feet in height under the tools. A fine tool adjustment on the saddles enables the operator to adjust the tools either vertically or horizontally to the exact position required after they have first been located approximately by the rapid traverse. The tool spindles are balanced directly on the swivels by means of cast-iron rings which slide on tubes attached to the swivels. The total weight of the machine is 373,000 pounds and it is driven by a 50-horsepower variable-speed motor.

Multiple Injector Sand Blast: J. M. Betton, 178 Washington St., New York. Multiple injector sand blast designed particularly for foundries having a large output. The sand is contained in a vertical tank capable of withstanding a pressure of 80 pounds per square inch. The outlets are attached to the bottom of the tank and the flow of sand is regulated by a valve so designed that it will not jam under the sand pressure. The sand is thoroughly mixed with the air in the sand blast apparatus and it is discharged through a rubber hose and nozzle. The flow of sand through each outlet can be regulated or stopped independently of the others. These sand blasts are made in capacities varying from 2000 to 16,000 pounds of sand, and with from one to four outlets.

Multiple Drilling Machine: Moline Tool Co., Moline, Ill. This machine is of the independent spindle feed type and can be equipped with any number of heads desired. It has six changes of speed by 3-step cone and back-gears. The drive is the company's standard double spiral type, the main spirals in the rail being of steel and the spindle spirals of phosphor-bronze. The spirals and the spindles are all equipped with ball thrust bearings. The spindle feed is by Sellers' motion, a bronze spiral working in rack teeth cut in the steel quills, which are bronze bushed. The bronze spiral mounted on the inclined shaft which also carries the quick-traverse handwheel, is driven by bronze and hardened steel worm-gearing. This shaft is pivoted so that the worm-wheels may be dropped out of mesh with the worms either by the hand latch or by the automatic stop. The spindles do not run directly in the heads, but in revolving sleeves on which the spindle spirals

are mounted. The lower bearings of these sleeves are adjustable for wear. The spindles are counterbalanced. The closest adjustment of the spindles is 6 inches, and the travel 10 inches. They have a No. 5 Morse taper and the capacity is up to 2 inches.

* * *

THE OXY-ACETYLENE PROCESS AND THE STEEL CAR

It is not so many years since the first steel freight car was built; to-day, it is the highest type of construction and is in general use on the best railroads. The steel passenger coach is still a novelty, although it is evident that it has come to stay. Three principal problems have arisen in connection with these developments: (1) the making of a strong joint;

Fig. 1. Welding the Lower Deck Roof by the Oxy-acetylene Process

(2) making this joint invisible; and (3) the performance of the work by a method which would involve only the parts in the immediate neighborhood of the joint. The great strength of the riveted joint has made it a favorite in many locations on the steel car; but the riveted joint is not invisible. Brazing is sometimes used with success, but it has two great objections: (1) weakness of the metal united; and (2) a different coefficient of expansion.

The new process of "welding" by the oxy-acetylene process seems to afford a very practical and economical solution, for the joint has from 80 to 85 per cent of the strength of the steel, can be made invisible, and the effects of its application are local. On coaches for one railroad, the joints of the roof plates, Fig. 1, usually made of from 1/16- to 3/32-inch metal,

Fig. 2. Lamp Supports located between Head Lining and Roof. Formerly made in Six Operations on the Power Press

are being closed by the oxy-acetylene torch. On a standard car, the roof joints have a tendency to bend downward and form a groove with the joint at the bottom. This tendency is successfully dealt with by using a little T-bar, to the web of which the plates are riveted, the oxy-acetylene process effecting a waterproof closure. The T-bar so increases the capacity for heat absorption that a heavy 1/8-inch wire is used, but it is not necessary in butt welding such thin sheets to chamfer the edges. Conditions vary on different parts of the roof, but a flat labor rate of 4 cents per lineal foot is paid, while the gas expense is about 1½ cent, making a total for the entire roof of about $12.75.

Another example of welding on steel coaches is found in the joints of the flat longitudinal panel frieze along the side of the car molding above and below, made in three sections of 1/16-inch metal. The separate pieces are straight, but the joints are so arranged as to give the center an arch of ⅜ inch in the 60-foot length, to provide for spring when under load. This severely tests the joints. Formerly the joint was made by brazing, which is not only quite expensive but also gives a weak joint. By the oxy-acetylene process, a much better job is produced at about half the cost. In making the weld, work is begun at a point one-third its width from the side which is to be uppermost when located, welding this upper third which forms the camber in the wrong direction. However, by beginning at the same point and welding the remaining two-thirds, this negative camber is eliminated and the correct one introduced. The plates are held together by the weld alone and the joint on the completed car is practically invisible.

Diamond-shaped window frames used on some coaches, which are made of 3/32-inch plate and have four mortised joints each, are jointed by oxy-acetylene welding. Similar joints in the rectangular deck frames of other cars are also welded by the same process; in a single car, there are upward of 176 such joints, or about 30 lineal feet of welding. In a certain construction, the ventilator frames have a cast-iron fitting which is attached interiorly to each upright. A bolt and nut do not insure a solid attachment, but with the

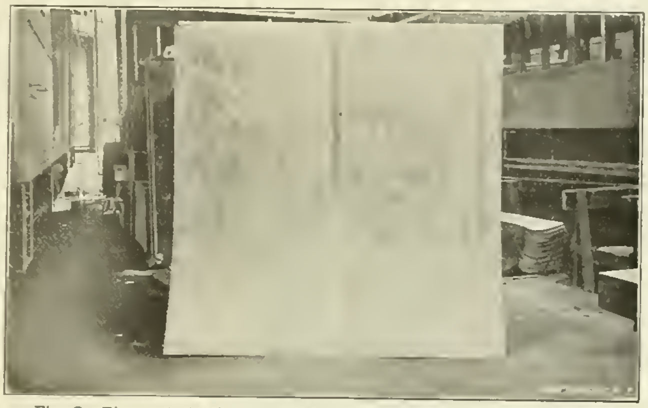


Fig. 3. Piece of Head Lining made of Patent Level Stock, Joined by Oxy-acetylene Welding

oxy-acetylene welding process, the gray cast iron and the hot rolled plate are readily and firmly bound together.

Another example of welding as a finishing procedure is in connection with the grab handles, which consist of a steel tube and two fittings. The fitting when in position has a vertical projection which is enveloped by the tube end, a countersunk pin holding the two firmly together. The welding process is used to efface the joint where the end of the tube comes in contact with the shoulder on the fitting, the labor cost of setting and welding these fittings being 1½ cent each, or 3 cents per handle.

An interesting application is the making of a kind of support, Fig. 2, used on certain coaches. In these cars, the roof sheets and the steel head lining are about 1⅞ inch distant, and are strengthened at the chandeliers by inserting the box-like support shown, two for each lamp. Each piece is of a rather complicated sheet-metal form, and was formerly made by pressing, in six operations, but as there was a large percentage of failures through radial cracking at the bends, they are now formed from three pieces of 3/32-inch sheeting through the oxy-acetylene process. The estimated saving is 50 per cent, with practically no failures.

It is practically impossible to form the complicated depression at the bottom of the recess for the water cooler used for drinking purposes, in conjunction with the bottom of one piece by the use of the press, although the depressed piece apart from the bottom of the alcove can be so formed. The

welding process is used to unite the pressed piece and the bottom, also uniting the bottom to the vertical part of the alcove.

Perhaps the most interesting piece of work is the welding together of sheets to form the seven-foot square units of head lining, shown in Fig. 3. This patent level stock is not obtainable in sufficient width, so, by the use of the oxy-acetylene welding process, two strips are so united as to produce the desired piece without destroying the required flatness. The stock used is about 1/16 inch thick and no reinforcing strip is employed. In carrying out this operation, the two half-sheets are secured edge to edge on a suitable table by heavy bars properly clamped. The edges of the sheets are not prepared, but they are placed in contact on one side and perhaps ¾ inch apart on the other. The operator begins on the side where there is contact, using a No. 4 tip and 1/16-inch wire. At first, the separation of the opposite edges tends to increase, but as the work advances, they press toward each other. Two or three times during the operation the clamps on the open side are loosened and the edges permitted to approach a little. As the operator works across the 82-inch seam, a buckle follows, but this disappears as the weld is finished. Straight ends may readily be obtained by trimming, and the rough surface of the weld is remedied by filing. The expense for the labor, including the filing, is 4 cents per lineal foot, and the gas expense may be taken at 1½ cent, so that the weld costs, altogether, about 38.5 cents.

The Davis-Bournonville Co., 97 West St., New York, manufactures the apparatus used in the operation referred to; this includes torches and the generators of oxygen and acetylene.

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DISK GRINDING ALUMINUM CHAIN-CASE CASTINGS

During a recent test in the experimental department of the Gardner Machine Co., Beloit, Wis., on the grinding of aluminum, the four castings which form the aluminum chain-case

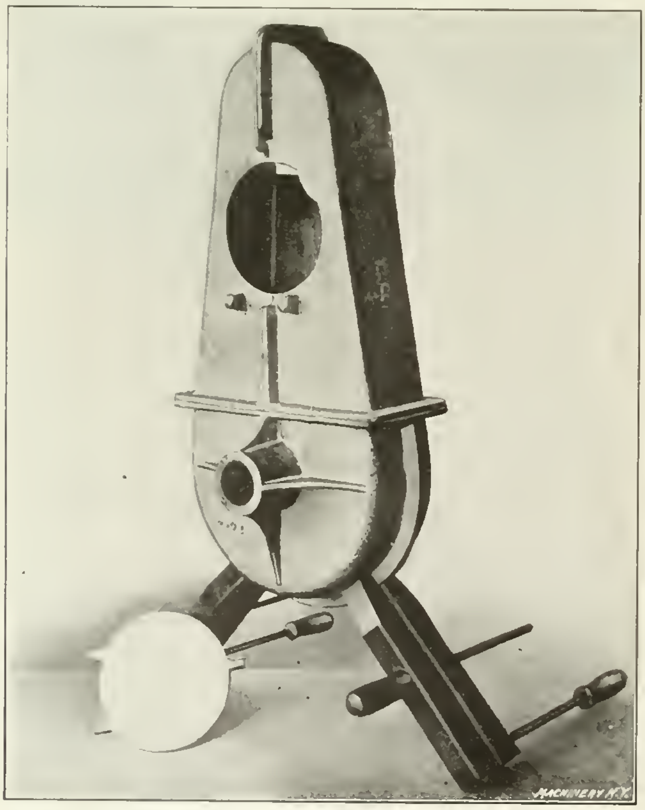


Fig. 1. Aluminum Case, the Joints of which are finished on a Disk Grinder in about Twenty Minutes

illustrated in Fig. 1, were finished complete in a little less than twenty minutes. The assembled case measures approximately 24 inches long; the maximum width is 11 inches, and the depth about 6 inches. Each of the four castings has two faces which must be ground flat, to size, and at 90 degrees to each other. The two adjoining faces of the bottom half of the case were first ground; they were then clamped together with patternmaker's clamps, and the top surface of this bottom half was finished. The two adjoining faces of the top half were next ground, and, after being clamped together, the bottom surface of the top half was ground.

In finishing these three joints in the time specified, it will, of course, be understood that the grinding was done from the rough casting. The time required for grinding the round cover shown in Fig. 1, was less than one minute. The re-

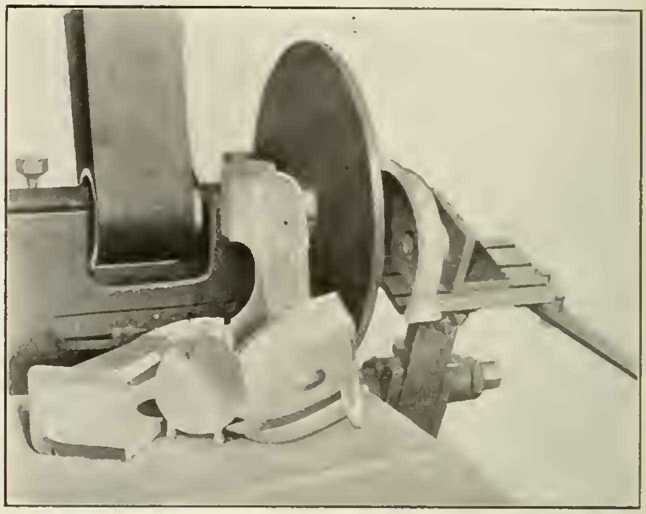


Fig. 2. Grinding the Sections of the Aluminum Case

sults of this test are particularly interesting, as these castings were formerly finished on milling machines and about ⅛ inch stock was left for machining. When the disk grinder is employed, from 1/64 to 1/32 inch has been found sufficient for finishing. It has been estimated that this difference in weight would pay for the grinding, making the finished case, when disk ground, cost less than the rough casting when the required stock is left for any other method of finishing.

It is the practice of this company when disk grinding aluminum, to use soft metal wax in connection with the abrasive disk. When this is not done, the chips have a tendency to clog the disk which, of course, would in a short time lose its cutting efficiency.

* * *

COMMERCIAL SECRETIVENESS

At the recent "Congress of Technology," held in Boston to celebrate the fiftieth anniversary of the Massachusetts Institute of Technology, Prof. William H. Walker made a strong appeal to manufacturers for a more generous publication of the results obtained in modern industrial research laboratories, the reasons for his contention as to its desirability being given in the following:

"There is a heavy moral obligation on the part of large industrial organizations having fully equipped research laboratories to contribute their share to the advance of the world's knowledge. There is in every laboratory much work which could be published and yet conserve the interests of the corporation. First—there are the results which may not have proved valuable to the laboratory in which they were obtained, but which would be of immense value to some one else working in an entirely different field. Second—there are those results of value to the laboratory possessing them, but which could be published in an unapplied or 'pure' form, and which would be an important contribution to science, without causing the least injury to the company or corporation most interested. And finally there are those results of operations and processes, machines and apparatus, which, if the truth were known, are possessed by a number of concerns, but are held as valuable secrets by each. Every one would profit and no one be the loser by so far-sighted and generous a policy. It requires no extensive mathematical calculation to prove that the manufacturers themselves would be the ones to profit by such a liberal treatment of the results of scientific work. Of one hundred manufacturing concerns, each one would give but 1 per cent to the whole fund of information, while it would receive the remaining 99 per cent. It could not in the long run be the loser."

* * *

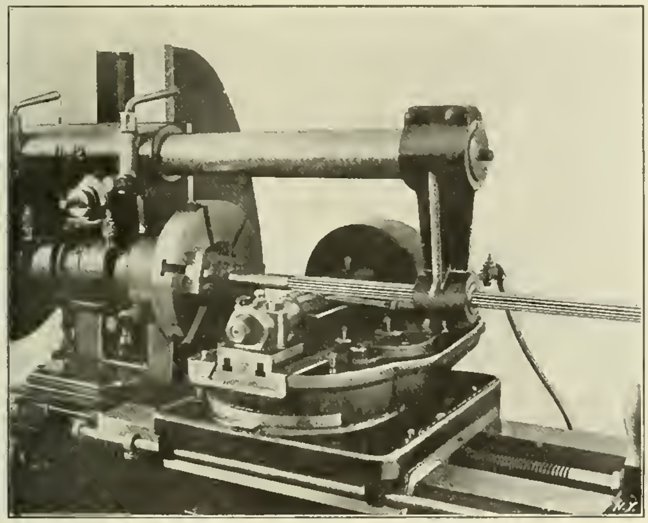
According to the *Scientific American* there is a movement on foot in France to have poles carrying high-tension current electric cables painted with some distinctive color, so as to act as a warning.

AN UNUSUAL GEAR-HOBBING SITUATION

By A WESTERN FOREMAN

One of those out-of-the-ordinary problems that are the spice of life in the humdrum of ordinary machine shop operations recently presented itself in an unusual gear-cutting proposition. The work in question was a 16-tooth pinion, 6 feet long and 1⅛-inch outside diameter, as shown in the halftone. Just how this pinion was to be cut seemed to be a problem impossible of solution, and about the only suggestions that were made were along the line of how the draftsman should have made his design so as to avoid this seemingly impractical pinion. However, work had progressed too far on the other parts of the machine of which it was a member, to allow of any change in the design, even if desirable.

The milling machine was first considered, but the largest machine at hand would not take work longer than 3 feet between centers, so that it could not be cut on the centers of the index head. The only feasible suggestion gleaned from a canvass of the practical heads of the plant was to rig up a planer with index centers and plane the teeth with a form tool. It was decided that this was the only way out of the difficulty, but it so happened that the planers were, at that time, very busy, so the job was laid aside until an opening would occur. The job became the pet problem among the boys, all trying to think up a good scheme.



Cutting a Long Pinion on a Barber-Colman Gear-hobbing Machine, using a Special Chuck and Bushing

A Barber-Colman hobbing machine had recently been installed, and the new operator became so enthusiastic over the hobbing process, and was so much "taken up" with the possibilities of the machine that he naturally could see no other way of cutting gears. He also was interested in this job, and after careful consideration, offered to cut the pinion on his machine. The offer was finally accepted, and the manner in which he succeeded is the object of this article.

The machine is of the horizontal spindle type, with a 1⅛-inch hole through the work spindle, making it possible to run the pinion blank through the spindle, which was obviously necessary on account of the great length. The possible length of cut was about 12 inches, so that the work required shifting at least six times. To maintain the relation with the hob when shifting, the pinion blank was splined the whole length, with a 16-pitch gear-cutter on a milling machine, in the usual manner, shifting once or twice as necessary. In this way a straight guide was obtained by which the blank could be shifted and still maintain an accurate relation with the index wheel of the hobbing machine. To facilitate this, and also to act as a driver, a block about 3 by 1½ by 10 inches was made, with a reamed hole through the center of the flat side to fit the pinion blank, fitted with a key, the latter being made to fit the spline in the blank so as to allow of no play. A set-screw was provided to securely hold the blank after setting. The illustration shows the whole clamped to the faceplate as when used. The outer support was provided with a bushing in which the blank fitted snugly. To complete the work including the fixtures necessary, less than one day's time was required.

The horizontal arrangement of the machine was what made it possible to do this job, as in this way a pinion of any length could be cut if sufficiently small to pass through the spindle, the outer bearing providing a good support. The success with which this pinion was cut brought out a number of schemes for attachments that would automatically shift the blank or provide a continuous feed to the blank so that shifting would be unnecessary.

* * *

STANDARDIZATION OF AUTOMOBILE PARTS

The Society of Automobile Engineers, with a membership of about 800 engineers and experts connected with the automobile industries, has within a year accomplished results that will be found to have made engineering history, for it has made a very extensive forward movement in the standardization of automobile parts. That standardization is a good thing is realized by many, but the necessity of it would strike many more if the situation were thoroughly understood.

Few realize the multiplicity of designs that there are for some of the simplest details around automobiles; for example, there are from three to four hundred more dimensions and designs than there ought to be for lock washers between the sizes of 3/16 and ½ inch. The explanation of this unnecessary situation is very simple: it is due to the draftsman exercising his own judgment with regard to the various details, not having any standards from which to design the new part. He may choose a tubing for the steering cross-rod, for example, that does not exist in stock, or if there is not a table of tubing sizes before him, it is made to suit his own fancy so long as it will satisfactorily perform its functions. The same condition exists for the shapes of the heads of screws and bolts, and for the size of the holes, for the spring clips, and for many other details.

The errors due to the designer selecting non-standard parts cannot be checked until it is too late to do so, for when the drawing is completed, if the figures correspond and the design be a good-looking one, the checker passes it and it goes to the purchasing department, the parts being ordered. Here is where the trouble arises. The company from which the parts are ordered will have to perform special work in producing parts that are not standard, and in this way the cost is in many cases doubled. The worst feature of it is that the next time a new model is designed it may be desirable to incorporate this axle, or parts of it, to save tools and fixtures. This process is repeated, and it may be several years before the extra expense due to obtaining special parts is eliminated. All this arises, not from necessity, but from the unguided idea of the draftsman.

Standardization will not be an attempt to throttle original design, for there is not the slightest danger that this would ever be accomplished, even if attempted; the parts proposed to be standardized, such as screws, lock washers, spring parts, bearing parts, water connections, and many other small pieces too numerous to mention, would have no possible gain in originality if designed to meet the individual requirements, so that this useless multiplication of parts might well be minimized.

The aim of the society will be to put into the hands of every designing draftsman an engineer's pocket-book or a series of sheets which will show him what is available in these minor parts which have been standardized. This system already exists in constructional work, such as bridge building, and has been brought about by the large companies who furnish the materials. The handbooks which they publish show all the standard sections of structural shapes and the draftsman has formed a habit of going to such books to find out which size of any particular shape he can obtain having a regular section. He thus manages to incorporate such a standard piece in his design, with the result that no special rolls have to be made. The Society of Automobile Engineers stands ready to assist in manufacturing-difficulties in any of the many competent engineering fields of automobile production.

N. M. T. A. ANNUAL CONVENTION

The thirteenth annual convention of the National Metal Trades Association was held at the Hotel Astor, April 12-13. The presiding officers were Messrs. J. H. Schwacke, president, F. C. Caldwell, vice-president, and Robert Wuest, commissioner. Nearly two hundred and forty members and visitors were registered in attendance. The meeting was notable for the interest and enthusiasm expressed for industrial education, workmen's insurance, accident compensation on an equitable basis, and labor efficiency betterment generally. Though the program lacked, perhaps, some of the novelty characterizing that of last year, it nevertheless included papers and discussions of much value. A commendable feature of the papers and discussions on the relations of labor and capital was the absence of a bullying militant spirit. Although the policy of resistance to unwarranted aggressions and interferences with the rights of employers is upheld as strongly as ever, conciliation and cooperation are being recognized as more and more important factors in smoothing out industrial difficulties. The program included the following reports and papers:

"Industrial Education," F. A. Geier, chairman;
"Apprenticeship," E. P. Bullard, Jr., chairman;
"The Employer and Prevention of Accidents," by John Calder;
"Labor Efficiency Betterment," by H. F. J. Porter;
"Mutuality," by W. A. Grieves;
"Employers' Liability Insurance," Wm. Butterworth, Jr.;
"German Thoroughness," by H. L. Gantt;
"Impressions Regarding Foreign Shop Methods," by Oberlin Smith;
"The St. Louis Method of Technical Education," by Lewis Gustafson;
"Sanitary, Safe and Comfortable Working Conditions," by George Brown.

The following officers were elected:

President, F. C. Caldwell, of the H. W. Caldwell & Son Co., Chicago, Ill.;
First Vice-President, Henry D. Sharpe, of the Brown & Sharpe Mfg. Co., Providence, R. I.;
Second Vice-President, W. A. Layman, of the Wagner Electric Mfg. Co., St. Louis, Mo.;
Treasurer, Howard P. Eells, of the Bucyrus Co., South Milwaukee, Wis.

* * *

NEW STORE OF PETER A. FRASSE & CO.

Peter A. Frasse & Co. have moved into their new store and warehouse at 417-421 Canal St., corner of Sullivan St., New York, where the main office, steel and steel tube departments, and wholesale and retail machinery and metal supply departments are now located. This firm, which was established in 1816, is one of the oldest supply houses in the city, and its move further north from the Fulton St. district, where many of the machinery supply houses have been located for years, is significant of the up town trend of mercantile business generally. The move takes the company into an excellent location in the heart of the steel district, Canal St. being one of the few through cross town streets in the lower part of the city.

The new structure, named the "Brion Bldg." by the directors as a mark of appreciation for the services rendered by the president, Mr. A. E. Brion, has eight stories and a basement. The frontage is 65 feet on Canal St. and 100 feet on Sullivan St. The front of the main floor is the retail supply department and the rear, the wareroom for Shelby steel tubing. The tubing is stored in compartments on sheet metal shelving, the shelving having an advantage over racks in that both long and short lengths can be stacked on it with efficient utilization of space. A 3000-pound capacity traveling crane serves the tube wareroom, transporting material from a side entrance at which trucks are unloaded, clear through to the front, if required.

The executive offices are at the front of the second floor and the wholesale supply department at the rear. The offices of the department managers are on the mezzanine floor, the retail supply manager's office being at the front where the retail floor can be seen.

The basement is the storeroom for Poldi tool steels. Ten racks are provided in which there are 1000 vertical bins for storing the bars on end. The bins are formed with long screw studs projecting from horizontal channels about five feet above the floor. A steel rib is laid in the floor to keep the bars in place. An overhead track and trolley serves the basement floor, connecting with the three elevators. The street elevator is of ample capacity to carry steel stock lying flat. An inclined chute from the street level is provided for handling cases.

The building is fireproof throughout and has been planned for efficiently carrying on the business—so efficiently, in fact, that the management expects to do a larger business than heretofore with no increase of employes.

* * *

MACHINERY SALESMEN

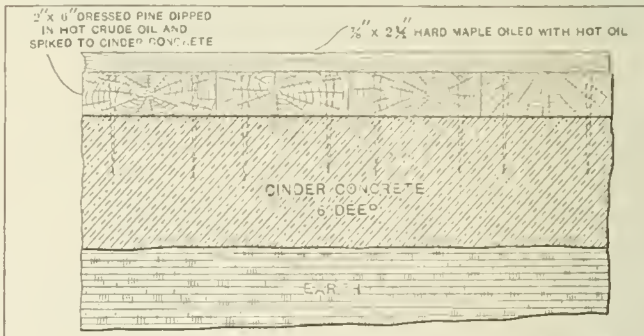
A well-known machinery sales manager and a machine tool expert declares that successful machine salesmen must be caught young and trained exclusively for selling machines. "A salesman who can sell iron, steel, brass tacks or any staple line is no good for machine tool selling, nor can he be trained to it in most cases."

The reason is that the buyers of machine tools are critical men who select tool equipment not as a commodity, but as one selects a piano, a house or a carpet—with a lively sense of the fitness of the article to individual needs. The machine tool buyer is the "man from Missouri"—who must be shown how the machines are built and how used. The seller must combine the intelligence and skill of the designer, the mechanic and the salesman. "Guff" and "hot air" do not sell machines to intelligent customers, and the most desirable customers are those who insist on knowing what they get and on getting what they bargain for.

* * *

BAKER BROS. MACHINE SHOP FLOOR

The machine shop floor of Baker Bros., Toledo, Ohio, was recently rebuilt, the construction being as indicated in the accompanying illustration, showing a cross-section. Six inches of cinder concrete was thoroughly tamped, and allowed to stand for a week. The concrete was then mopped with hot tar, and while the tar was hot 2-inch by 6-inch dressed pine planks, which had been dipped in hot crude oil,



Cross-section of Baker Bros. Machine Shop Floor

were spiked to the concrete. On top of the planks hard maple flooring, 7/8 inch by 2½ inches, was laid. This was thoroughly oiled with hot oil after laying.

The hot tar on top of the concrete makes it thoroughly waterproof, thus protecting the pine planking from dampness. No trouble whatever was experienced in driving spikes into the concrete. The construction should prove very durable and generally satisfactory.

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PERSONALS

Robert S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, sailed from New York for Europe, March 25, on a pleasure trip.

E. A. Moore, formerly with the Bullard Machine Tool Co., has taken the position of traveling salesman with the Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt.

Herman Gill has resigned his position with the Fiberloid Co., Springfield, Mass., to take charge of the cost department of the Hendey Machine Co., Torrington, Conn.

E. Thielicke of C. Thielicke, Berlin, Germany, is visiting the United States to secure selling rights for American machine tools. His address is Bullard Machine Tool Co., Bridgeport, Conn.

Lewis R. Gilbert, formerly engineer with Charles Schmidt of the Peerless Motor Car Co., Cleveland, Ohio, announces that he is no longer connected with the company in any capacity.

Frank J. McCarty, Springfield, Mass., has resigned as draftsman for the Gilbert & Barker Mfg. Co. to take charge of the designing and construction work of the Tate & Jones Co., Pittsburg, Pa.

C. H. Pearson, formerly with the Noera Mfg. Co., Waterbury, Conn., has taken a position with the hoist department of the Yale & Towne Mfg. Co. Mr. Pearson's field of operations will be in the West.

David E. Jackman of E. S. Jackman & Co., Chicago, Cleveland and Pittsburg, has withdrawn to become treasurer of the Firth-Sterling Steel Co., McKeesport, Pa. Mr. Jackman assumed his new responsibilities April 1.

J. Frank Duryea, vice-president, and William M. Remington, mechanical engineer, of the Stevens-Duryea Co., Chicopee Falls, Mass., are making a six weeks' trip through Italy, France and Scotland in the interests of their company.

Rodman Gilder, secretary of the Crocker-Wheeler Co., manufacturer of electrical machinery, Ampere, N. J., has resigned to become associated with the brokerage house of Dick Bros. & Co., New York. Mr. Gilder was with the Crocker-Wheeler Co. seven years.

F. Charles Scribner, for the past three and a half years general foreman of the gage and tool departments of the Wells Bros. Co., Greenfield, Mass., has resigned to become inspector of gages with the Colt's Patent Firearms Mfg. Co., Hartford, Conn.

Erik Oberg, associate editor of MACHINERY, will sail for Europe May 6, on a two months' trip through England, Holland, Belgium, Germany and Sweden. Mr. Oberg expects to attend the graduation exercises of his alma mater, the Government Technical College at Boras, Sweden. He will observe industrial conditions, especially in Belgium and Sweden.

John R. Ide has resigned his position in the sales department of the Hyatt Roller Bearing Co. and has engaged with the New Departure Mfg. Co., Bristol, Conn., maker of New Departure ball bearings. Mr. Ide will continue to reside in Detroit and will be connected with the western branch of the New Departure Mfg. Co. which is shortly to be opened in that city.

Henry Morris, manager and treasurer of the Western Tool & Mfg. Co., Springfield, Ohio, sailed for Europe April 8, on the *Frederick der Grosse*. Mr. Morris will visit the Turin Exposition, where the company has an exhibition, and several countries of Europe, returning through England. While abroad, Mr. Morris expects to close contracts with some of the large European dealers.

E. Ronceray has been elected vice-president of the Committee of Admission and Installation, Group IV., Classes 23 to 27, of the Turin Exposition, Italy, which includes various machine tools, heating processes and forging tools, machine tools and small tools, machines for various work, and machines for building materials. Mr. Ronceray is a partner of the firm of Ph. Bonvillain & E. Ronceray, Paris, France.

Dr. Robert Bosch of Stuttgart, Germany, designer and inventor of the Bosch magneto and other Bosch products, is on a business trip in the United States. Dr. Bosch is much interested in our manufacturing industries, and with Mr. Otto Heins, president of the Bosch Magneto Co., New York, is making an extended tour of the country with the object of visiting some of the larger industries as well as the natural points of interest.

A. H. Tuechter, president of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, sails for Europe on May 17, on the *President Lincoln* of the Hamburg-American Line, for a four months' trip through Europe, combining business with pleasure. The combination of the Cincinnati and Bickford plants, and the labor of moving them both into their large new works at Oakley have kept Mr. Tuechter close to business for a long time, and he is entitled to more rest than he will probably get on this trip, if there is any chance to talk machine tools.

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OBITUARIES

Lieut-Col. Frank E. Hobbs, commandant of the Rock Island Arsenal, Rock Island, Ill., died at the Army and Navy Hospital, Hot Springs, Ark., April 11, aged fifty-six years.

Alonzo H. Johnson, who for over forty years worked as an armorer at the United States Armory, Springfield, Mass., died at his home in that city March 30, aged eighty-three years.

Chas. E. Mitchell, president of the Stanley Rule & Level Co., New Britain, Conn., died at his home March 17, aged seventy-three years. Mr. Mitchell was Commissioner of Patents under President Harrison.

Charles W. Hunt

Charles G. Thaxter, master mechanic of the Dennison Mfg. Co., South Framingham, Mass., died from Bright's disease at Orlando, Florida, March 31. Mr. Thaxter had been in the employ of the Dennison Mfg. Co., for forty years, entering the service of the concern when a boy and rising to the position of master mechanic. He worked with Mr. Dennison for years perfecting the company's machines, and had recently, alone, done much to forward the interests of the company.

George A. Barnes, secretary of the Whitman & Barnes Mfg. Co., Akron, Ohio, died at Akron, March 22, in his fifty-fourth year. Mr. Barnes was born in Cincinnati, Ohio. He began his long service with the Whitman & Barnes Mfg. Co. at the company's Syracuse factory in 1876. In 1879 he was transferred to the Canton, Ohio, works of the company, remaining there as manager until 1895, when he removed to Akron, where he resided until his death, with the exception of the years 1902 and 1904, during which time he was located at the company's offices in Chicago. At the time of his death Mr. Barnes was secretary of the company, and a director and member of the executive board. He is survived by a widow and one son, H. L. Barnes, who is superintendent of the Whitman & Barnes Mfg. Co.'s Chicago works.

CHARLES W. HUNT

Charles W. Hunt, president of the C. W. Hunt Co., West New Brighton, Staten Island, N. Y., died suddenly at his home, Grymes Hill, Staten Island, March 27, aged seventy years. He had been suffering from asthma for several months, but had been able to attend to business up to two weeks prior to his death. Mr. Hunt established a retail coal business at West New Brighton in the late '60s. Observing the need of an economical and expeditious method of unloading coal barges and carrying coal, he invented a conveyor system and installed it in his yard. The success of the system brought orders from other coal yards for similar apparatus, and this was the beginning of the manufacture of coal-carrying machinery at West New Brighton. The business became one of the largest in that line in the United States, and is to-day one of Staten Island's largest and most prosperous manufacturing enterprises. The handling and conveying machinery produced is in use in almost all parts of the world. During his lifetime Mr. Hunt took out one hundred and forty-seven patents, largely on machinery for handling materials, but including many other devices also. Mr. Hunt was a prominent figure in mechanical engineering circles, and a member of many clubs and societies. He was a life member of the American Society of Mechanical Engineers; vice-president of the society in 1892-94, and president 1897-98.

WILLIAM S. GORTON

William S. Gorton, secretary and general manager of the Standard Welding Co., of Cleveland, Ohio, was killed at the railroad crossing close to his factory on April 17. Mr. Gorton with his chauffeur was just returning from a ride, when the car was struck by the locomotive of a passenger train on the Lake Shore road, and his body was thrown almost against the fence of his own factory, both he and the chauffeur being instantly killed.

Mr. Gorton was born in Waterford, Conn., February 12, 1859, and educated in the common schools of New London, Conn. He was for four years with the Marine Department of the United States Coast Survey, and had considerable experience

William S. Gorton

as an engineer on cable road construction in Eastern cities. Later he became connected with the Standard Tool Co. of Cleveland in mechanical and executive capacities, and in 1899 he organized the Standard Welding Co., which for some time occupied a small plant in the rear of the Standard Tool Co.'s present buildings. Mr. Gorton was a man of tremendous energy and of high executive ability, and the welding business expanded under his management until it became necessary to build the present extensive plant which it occupies at the junction of West 76th St. and L. S. & M. S. R. R. in Cleveland. Mr. Gorton leaves a widow and four children.

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COMING EVENTS

May 9-10.—Annual meeting of the American Association of Refrigeration, La Salle Hotel, Chicago, Ill. J. F. Nickerson, secretary, Chicago.

May 15-17.—Sixteenth annual convention of the National Association of Manufacturers at the Waldorf-Astoria Hotel, New York. John Kirby, Jr., president; J. Philip Bird, general manager; and George S. Boudinot, secretary, 30 Church St., New York.

May 18-19.—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J. Marlborough-Blenheim Hotel, headquarters. Charles L. Hildreth, secretary, Worcester, Mass.

May 18-19.—Semi-annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, Youngstown, Ohio. Prof. Frank E. Sanborn, Columbus, Ohio, secretary-treasurer.

May 30-June 2.—Spring meeting of the American Society of Mechanical Engineers at Pittsburg, Pa., headquarters, Hotel Schenley. Local committee, E. M. Herr, chairman; Elmer K. Niles, secretary; office of local committee, 2511 Oliver Bldg., Pittsburg. The professional sessions will be held in the lecture hall of the Carnegie Institute, near the headquarters, Wednesday morning and evening, and Thursday and Friday morning. A number of inspection trips to various industrial plants in the vicinity have been planned. Calvin W. Rice, secretary, 29 West 39th St., New York.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics' and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 15-17.—Mid-summer meeting of the Society of Automobile Engineers at Dayton, Ohio. Coker F. Clarkson, general manager, 1451 Broadway, New York.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 20-23.—National Gas and Gasoline Engine Trades Association convention, Hotel Pontchartrain, Detroit, Mich. Albert Stritmatter, secretary, Cincinnati, Ohio.

NEW BOOKS AND PAMPHLETS

Electricity in the Development of the South. By George Westinghouse. 19 pages, 6 by 9 inches.

An address given before the Southern Commercial Congress at Atlanta, Ga., March 10, 1911.

Practical Silo Construction. By A. A. Houghton. 69 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

This is No. 3 of a series entitled "Concrete Workers' Reference Books," and has to deal with the construction of monolithic and block silos.

Record of Transportation Lines Owned and Operated and Associated with the Pennsylvania Railroad, for the Year Ending December 31, 1910. 49 pages, 9½ by 12 inches.

Detailed account of the trackage and location of the integral lines of the Pennsylvania System, compiled from data on file in the office of the chief engineer of maintenance.

Metal Work and Etching. By John D. Adams. 96 pages, 5 by 7 inches. 49 illustrations. Published by the Popular Mechanics Co., Chicago, Ill. Price 25 cents.

This is one of the latest of the Popular Mechanics 25-cent series of industrial handbooks, and is a manual for art metal workers, giving the necessary details for the production of many interesting articles in sheet metal.

Molding Concrete Chimneys, Slate and Roof Tiles. By A. A. Houghton. 61 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

No. 4 of the concrete workers' reference series is a practical treatise explanatory of the construction of block and monolithic type of concrete chimneys, monolithic roofs and the molding of concrete slate, tiles and slabs.

Molding and Curing Ornamental Concrete. By A. A. Houghton. 58 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

In this book, No. 5 of the series, practical methods covering the various methods of preparing the molds and filling with the concrete mixture are treated, as well as methods of remedying defects in the cast, surface treatment of various effects, and proper proportion and preparation of the concrete.

The Flow of Heat Through Furnace Walls. By Walter T. Ray and Henry Kreisinger. 32 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 8.

This bulletin contains a statement of the results obtained in a series of tests on the furnace which forms a part of the government fuel-testing plant at Pittsburg, Pa., to determine the heat losses through the walls. Some instructive deductions were drawn from these tests, which should prove of especial interest to power-plant engineers.

The Mechanic, 1911. H. W. Sherlock, editor-in-chief. 178 pages, 10 by 8 inches. Illustrated. Published by the senior class of Williamson Free School of Mechanical Trades, Williamson School P. O., Pa.

The board of editors of the seventh volume of "The Mechanic" deserve commendation for the excellent year-book which they have produced this Spring. All the write-ups and the descriptive matter are of a high order, while a good deal of ingenuity is displayed in the character skits, etc., contained in the book. Many original departures from the customary college year-book are embodied, improving the book materially.

Inventors and Inventions. By H. Robinson. 95 pages, 6½ by 10 inches, paper. Illustrated. Published by H. Robinson, 41 West 33d St., New York. Price 25 cents.

The method in which Mr. Robinson treats the subject is unique, the unusual treatment carrying out the object of the author in writing the book, which is to awaken the public conscience to the great injustice continually being done to a numerous and worthy class of intellectual toilers, and the evil to the general public resulting therefrom. A strong feature is made of the comparatively negligible protection that the government affords the poor inventor against infringement by powerful corporations.

Machine Shop Mechanics. By Fred H. Colvin. 177 pages, 5 by 7 inches. 116 illustrations. Published by the McGraw-Hill Book Co., 239 West 39th St., New York. Price $1.

This book has for its object the explaining of the principles of common things seen daily in shop work; the underlying reasons are explained in common language. The chapters are as follows: Levers; The Screw and Wedge; Inclined Planes; Gravity; Friction; Heat; Inertia; Belts and Pulleys; Block and Tackle; Gearing; Centrifugal Force; Hydraulics; Steam Pressure; The Force of a Blow; Strength of Materials; Shafting; Action and Reaction; Beams; Measuring Moments; and Force Diagrams.

Plumbing and Household Sanitation. By J. Pickering Putnam. 718 pages, 5½ by 8 inches. 649 illustrations. Published by Doubleday, Page & Co., Garden City, N. Y. Price $3.75.

It would take one well versed in the details of sanitary engineering to find the omissions in this large work, the subject seeming to have been exhaustively treated. The volume embodies the results of more than a quarter of a century's study and research in sanitary plumbing from both the theoretical and practical standpoint, and is the immediate outcome of a course of lectures delivered before the plumbing school of the North End Union, Boston. The book is voluminous, containing forty-four chapters, and a mere enumeration of the chapter heads would fill much space. It is a work that should be of interest and value to the layman as well as to the sanitary engineer.

Increase the Crop per Acre. Issued by the Pennsylvania Railroad, Philadelphia, Pa. 112 pages, 6 by 9 inches. Illustrated with 36 full-page and 17 part-page engravings.

"Increase the Crop per Acre" is the title of a booklet issued by the Pennsylvania Railroad, which is to be distributed throughout the territory traversed by its lines. This pamphlet deals with the application of dynamite on the farm, and illustrates with half-tones the blasting of stumps, forming of ditches, road building, plowing, etc., and gives a final chapter on the "Principal of Explosives," which should be of interest to the average reader as well as to the farmer. With this latest addition to its agricultural literature the Pennsylvania Railroad has now on hand, for distribution eleven pamphlets including: "Potato Culture," "Alfalfa," "Use of Lime on Land," "Seed Grain Suggestions," "Orchard Primers—Planting, Pruning, Spraying, and Cultivation," "The Pennsylvania Railroad and the Farmer," and "Good Roads at Low Cost."

Chemistry for Beginners; Inorganic. By Edward Hart. 207 pages, 5¼ by 6¾ inches. 80 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price $1.

This is No. 1 of a set of three volumes:—"Chemistry for Beginners"—the other two dealing with organic chemistry and experiments. That this book has met with appreciation is evidenced by its appearance in the fifth edition since the first publication in 1896. The strong feature of the book is its simplicity and practicability; the author realized that but a few of those who study chemistry ever become professional chemists, and hence the common subjects of everyday life are those whose chemical aspects are enlarged upon. The aim was to make the book utilitarian; anyone who has studied complete works on the subject will realize that this is a simple treatment. An objectionable feature in our estimation of the work is the "new spelling" which so changes many of the older chemical terms that in several instances the average reader does not immediately realize what is meant.

Principles of Machine Work. By Robert H. Smith. 388 pages, 5 by 8 inches. 434 illustrations. Published by the Industrial Education Book Co., Boston, Mass. Price $3.

With the companion book, "Elements of Machine Work," by the same author, a thorough treatment of the elements and principles of machine work is presented in a style adapted to the needs of students in technical, manual training and trade schools, and apprentices in the shop. These books represent a great deal of painstaking work on the part of the author, and his endeavors should be crowned with success, for they meet the requirements of the class noted thoroughly, being expressed in a clear, intelligible manner. The subjects treated are too numerous to enumerate, but the main features dealt with are engine and speed lathes, drilling and grinding machines, carbon and high-speed steel cutting tools, measuring, turning, fitting, threading, chucking, drilling, reaming, jigs, fixtures and cylindrical grinding. The illustrations, for the most part in line perspective, make the description clear and useful, especially to the beginner in the mechanical field.

THICKNESS OF BOILER SHELL PLATES—I

Formula: Thickness of Plate = Gage Pressure in Pounds × Diameter in Inches ÷ 24,000

Inside Diameter	Gage Pressure, Pounds per Square Inch																	
Ft. Ins.	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
2 0	0.080	0.090	0.100	0.110	0.120	0.130	0.140	0.150	0.160	0.170	0.180	0.190	0.200	0.210	0.220	0.230	0.240	0.250
2 2	0.087	0.097	0.108	0.119	0.130	0.141	0.152	0.162	0.173	0.184	0.195	0.206	0.217	0.227	0.238	0.249	0.260	0.271
2 4	0.093	0.105	0.116	0.128	0.140	0.152	0.163	0.175	0.187	0.198	0.210	0.222	0.233	0.245	0.257	0.268	0.280	0.292
2 6	0.100	0.112	0.125	0.137	0.150	0.162	0.175	0.187	0.200	0.212	0.225	0.237	0.250	0.262	0.275	0.287	0.300	0.312
2 8	0.107	0.120	0.133	0.147	0.160	0.173	0.187	0.200	0.213	0.227	0.240	0.253	0.267	0.280	0.293	0.307	0.320	0.333
2 10	0.113	0.127	0.142	0.156	0.170	0.184	0.198	0.212	0.227	0.241	0.255	0.269	0.283	0.297	0.312	0.326	0.340	0.354
3 0	0.120	0.135	0.150	0.165	0.180	0.195	0.210	0.225	0.240	0.255	0.270	0.285	0.300	0.315	0.330	0.345	0.360	0.375
3 2	0.127	0.142	0.158	0.174	0.190	0.206	0.222	0.237	0.253	0.269	0.285	0.301	0.317	0.332	0.348	0.364	0.380	0.396
3 4	0.133	0.150	0.166	0.183	0.200	0.217	0.233	0.250	0.267	0.283	0.300	0.317	0.333	0.350	0.367	0.383	0.400	0.417
3 6	0.140	0.157	0.175	0.192	0.210	0.227	0.245	0.262	0.280	0.297	0.315	0.332	0.350	0.367	0.385	0.402	0.420	0.437
3 8	0.147	0.165	0.183	0.202	0.220	0.238	0.257	0.275	0.293	0.312	0.330	0.348	0.367	0.385	0.403	0.421	0.440	0.458
3 10	0.153	0.172	0.191	0.210	0.230	0.249	0.268	0.287	0.307	0.326	0.345	0.364	0.383	0.402	0.422	0.441	0.460	0.479
4 0	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300	0.320	0.340	0.360	0.380	0.400	0.420	0.440	0.460	0.480	0.500
4 6	0.180	0.202	0.225	0.247	0.270	0.292	0.315	0.337	0.360	0.382	0.405	0.427	0.450	0.472	0.495	0.517	0.540	0.562
5 0	0.200	0.225	0.250	0.275	0.300	0.325	0.350	0.375	0.400	0.425	0.450	0.475	0.500	0.525	0.550	0.575	0.600	0.625
5 6	0.220	0.247	0.275	0.302	0.330	0.357	0.385	0.412	0.440	0.467	0.495	0.522	0.550	0.577	0.605	0.632	0.660	0.687
6 0	0.240	0.270	0.300	0.330	0.360	0.390	0.420	0.450	0.480	0.510	0.540	0.570	0.600	0.630	0.660	0.690	0.720	0.750
6 6	0.260	0.292	0.325	0.357	0.390	0.422	0.455	0.487	0.520	0.552	0.585	0.617	0.650	0.682	0.715	0.747	0.780	0.812
7 0	0.280	0.315	0.350	0.385	0.420	0.455	0.490	0.525	0.560	0.595	0.630	0.665	0.700	0.735	0.770	0.805	0.840	0.875
7 6	0.300	0.337	0.375	0.412	0.450	0.487	0.525	0.562	0.600	0.637	0.675	0.712	0.750	0.787	0.825	0.862	0.900	0.937
8 0	0.320	0.360	0.400	0.440	0.480	0.520	0.560	0.600	0.640	0.680	0.720	0.760	0.800	0.840	0.880	0.920	0.960	1.000
8 6	0.340	0.382	0.425	0.467	0.510	0.552	0.595	0.637	0.680	0.722	0.765	0.807	0.850	0.892	0.935	0.977	1.020	1.062
9 0	0.360	0.405	0.450	0.495	0.540	0.585	0.630	0.675	0.720	0.765	0.810	0.855	0.900	0.945	0.990	1.035	1.080	1.125
9 6	0.380	0.427	0.475	0.522	0.570	0.617	0.665	0.712	0.760	0.807	0.855	0.902	0.950	0.997	1.045	1.092	1.140	1.187
10 0	0.400	0.450	0.500	0.550	0.600	0.650	0.700	0.750	0.800	0.850	0.900	0.950	1.000	1.050	1.100	1.150	1.200	1.250
10 6	0.420	0.472	0.525	0.577	0.630	0.682	0.735	0.787	0.840	0.892	0.945	0.997	1.050	1.102	1.155	1.207	1.260	1.312
11 0	0.440	0.495	0.550	0.605	0.660	0.715	0.770	0.825	0.880	0.935	0.990	1.045	1.100	1.155	1.210	1.265	1.320	1.375
11 6	0.460	0.517	0.575	0.632	0.690	0.747	0.805	0.862	0.920	0.977	1.035	1.092	1.150	1.207	1.265	1.322	1.380	1.437
12 0	0.480	0.540	0.600	0.660	0.720	0.780	0.840	0.900	0.960	1.020	1.080	1.140	1.200	1.260	1.320	1.380	1.440	1.500
12 6	0.500	0.562	0.625	0.687	0.750	0.812	0.875	0.937	1.000	1.062	1.125	1.187	1.250	1.312	1.375	1.437	1.500	1.562
13 0	0.520	0.585	0.650	0.715	0.780	0.845	0.910	0.975	1.040	1.105	1.170	1.235	1.300	1.365	1.430	1.495	1.560	1.625
13 6	0.540	0.607	0.675	0.742	0.810	0.877	0.945	1.012	1.080	1.147	1.215	1.282	1.350	1.417	1.485	1.552	1.620	1.687
14 0	0.560	0.630	0.700	0.770	0.840	0.910	0.980	1.050	1.120	1.190	1.260	1.330	1.400	1.470	1.540	1.610	1.680	1.750
14 6	0.580	0.652	0.725	0.797	0.870	0.942	1.015	1.087	1.160	1.232	1.305	1.377	1.450	1.522	1.595	1.667	1.740	1.812
15 0	0.600	0.675	0.750	0.825	0.900	0.975	1.050	1.125	1.200	1.275	1.350	1.425	1.500	1.575	1.650	1.725	1.800	1.875
15 6	0.620	0.697	0.775	0.852	0.930	1.007	1.085	1.162	1.240	1.317	1.395	1.472	1.550	1.627	1.705	1.782	1.860	1.937
16 0	0.640	0.720	0.800	0.889	0.960	1.040	1.120	1.200	1.280	1.360	1.440	1.520	1.600	1.680	1.760	1.840	1.920	2.000

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STANDARD BOILER STAY-BOLTS—II

EFFECTIVE DIAMETER AND AREA, AND TENSILE STRENGTH OF BOILER STAY-BOLTS WITH 12 SHARP V-THREADS PER INCH

The tensile strength is calculated for a permissible stress of 6000 pounds per square inch

Diameter of Stay-bolt, Inches	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Effective diameter, ins.	0.6057	0.7307	0.8557	0.9807	1.1057	1.2307	1.3557
Effective area, sq. ins.	0.2882	0.4193	0.5754	0.755	0.960	1.190	1.443
Tens. strength of stay-bolt, pounds	1729	2516	3452	4530	5760	7140	8658

TABLE OF MAXIMUM AREA IN SQUARE INCHES WHICH CAN BE SUPPORTED BY STAY-BOLTS OF DIFFERENT SIZES, AT VARYING STEAM PRESSURES

Stress in stay-bolts, 6000 pounds per square inch

Gage Pressure, Pounds per Square Inch	Size of Stay-bolts, Inches						
	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
80	21.62	31.45	43.15	56.62	72.00	89.25	108.22
90	19.22	27.95	38.36	50.33	64.00	79.33	96.20
100	17.30	25.16	34.52	45.30	57.60	71.40	86.58
110	15.73	22.87	31.38	41.18	52.36	64.91	78.71
120	14.42	20.96	28.77	37.75	48.00	59.50	72.15
130	13.31	19.35	26.56	34.85	44.31	54.92	66.60
140	12.35	17.97	24.66	32.36	41.14	51.00	61.84
150	11.53	16.77	23.01	30.20	38.40	47.60	57.72
160	10.81	15.73	21.57	28.31	36.00	44.62	54.11
170	10.17	14.80	20.31	26.65	33.88	42.00	50.93
180	9.61	13.98	19.18	25.17	32.00	39.67	48.10
190	9.11	13.24	18.17	23.84	30.32	37.58	45.57
200	8.65	12.58	17.26	22.65	28.80	35.70	43.29
210	8.24	11.98	16.44	21.57	27.43	34.00	41.23
220	7.86	11.43	15.69	20.59	26.18	32.45	39.35
230	7.52	10.94	15.01	19.69	25.01	31.04	37.64
240	7.21	10.48	14.38	18.87	24 00	29.75	36.07
250	6.92	10.06	13.81	18.12	23.04	28.56	34.63

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MAXIMUM PITCH OF STAY-BOLTS—III

For fire-boxes, furnaces and back-connections:

$$p = \sqrt{\frac{T^2 \times 112}{P}} \text{ for } \tfrac{7}{16}\text{-inch plate and less,}$$

$$p = \sqrt{\frac{T^2 \times 120}{P}} \text{ for plate over } \tfrac{7}{16}\text{-inch thick.}$$

In these formulas, p = pitch or spacing of stay-bolts in inches; T = thickness of boiler plate expressed in sixteenths of an inch—for example, if plate thickness is $\frac{7}{8}$-inch, $T = 14$; P = gage pressure in pounds per square inch.

The table below is calculated from these formulas, with some modifications.

For boiler heads the formula is $p = \sqrt{\dfrac{T^2 \times 140}{P}}$.

When the stay-bolts in the boiler heads are provided with a washer riveted to the head, having a thickness of at least one-half of the thickness of the head-plate, and a size equal to at least seven-eighths of the spacing of the stay-bolts, or when the heads have a reinforcing plate riveted either on the inside or outside, covering the area stayed and equal in thickness to at least one-half of the head-plate, then

$$p = \sqrt{\frac{(T + t \times 0.8)^2 \times 200}{P}},$$

in which t = thickness of washer or reinforcing plate in sixteenths of an inch. This formula can also be used when the head is fitted with angle iron, riveted to the head, the thickness of the angle iron being at least two-thirds of the thickness of the head-plate, and the depth of angle at least equal to one-quarter of stay-bolt spacing, t being thickness of angle iron in 16ths inch.

FIRE-BOXES, FURNACES AND BACK-CONNECTIONS — Thickness of Plate, Inches

Gage Pressure	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16
80	7 1/8	8 1/4	9 3/4	10 1/2	10 1/2	10 1/2	10 1/2	10 1/2	10 1/2	10 1/2
90	6 5/8	7 13/16	9 5/16	10 3/8	10 1/2					
100	6 5/16	7 3/8	8 3/4	9 13/16	10 1/2					
110	6	7 1/16	8 5/16	9 3/8	10 7/16	10 1/2				
120	5 3/4	6 3/4	8	9	10	10 1/2				
130	5 1/2	6 7/16	7 5/8	8 5/8	9 9/16	10 1/2				
140	5 5/16	6 1/4	7 3/8	8 5/16	9 1/4	10 1/4	10 1/2			
150	5 1/8	6	7 1/8	8	8 15/16	9 13/16	10 1/2			
160	5	5 13/16	6 7/8	7 3/4	8 5/8	9 1/2	10 3/8	10 1/2		
170	4 13/16	5 11/16	6 11/16	7 9/16	8 3/8	9 3/16	10 1/16	10 1/2		
180	4 11/16	5 1/2	6 1/2	7 5/16	8 1/8	8 15/16	9 3/4	10 1/2		
190	4 1/2	5 3/8	6 5/16	7 1/8	7 15/16	8 11/16	9 1/2	10 5/16	10 1/2	
200	4 7/16	5 3/16	6 3/16	6 15/16	7 3/4	8 1/2	9 1/4	10 1/16	10 1/2	
210	4 3/8	5 1/16	6	6 3/4	7 9/16	8 5/16	9 1/16	9 13/16	10 1/2	
220	4 1/4	4 15/16	5 7/8	6 5/8	7 3/8	8 1/4	8 13/16	9 9/16	10 5/16	10 1/2
230	4 3/16	4 7/8	5 3/4	6 1/2	7 3/16	7 15/16	8 5/8	9 3/8	10 1/8	10 1/2
240	4 1/16	4 3/4	5 5/8	6 5/16	7 1/16	7 3/4	8 7/16	9 3/16	9 7/8	10 1/2
250	4	4 5/8	5 1/2	6 3/16	6 7/8	7 5/8	8 5/16	9	9 11/16	10 3/8

BOILER HEADS — Thickness of Plate, Inches

Gage Pressure	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4
80	7 15/16	9 1/4	10 3/16	11 7/8	13 3/16	14 1/2	15 7/8	16	16	16	16	16	16	16	16
90	7 7/16	8 11/16	9 15/16	11 3/16	12 7/16	13 11/16	14 15/16	16							
100	7 1/16	8 1/4	9 7/16	10 5/8	11 15/16	13	14 3/16	15 3/8	16						
110	6 3/4	7 7/8	9	10 1/8	11 1/4	12 3/8	13 1/2	14 5/8	15 3/4	16					
120	6 7/16	7 9/16	8 5/8	9 11/16	10 3/4	11 7/8	12 15/16	14	15 1/16	16					
130	6 3/16	7 1/4	8 1/4	9 5/16	10 3/8	11 3/8	12 7/16	13 7/16	14 1/2	15 9/16	16				
140	6	7	8	9	10	11	12	13	14	15	16	16			
150	5 3/4	6 3/4	7 11/16	8 11/16	9 5/8	10 5/8	11 9/16	12 9/16	13 1/2	14 7/16	15 7/16	16			
160	5 9/16	6 1/2	7 7/16	8 3/8	9 5/16	10 1/4	11 3/16	12 1/8	13 1/16	14	14 15/16	15 7/8	16		
170	5 7/16	6 5/16	7 1/4	8 1/8	9 1/16	9 15/16	10 13/16	11 3/4	12 11/16	13 9/16	14 1/2	15 3/8	16		
180	5 1/4	6 1/8	7 1/16	7 15/16	8 13/16	9 11/16	10 9/16	11 7/16	12 5/16	13 3/16	14 1/16	14 15/16	15 7/8	16	
190	5 1/8	6	6 7/8	7 11/16	8 9/16	9 7/16	10 1/4	11 1/8	12	12 7/8	13 11/16	14 9/16	15 7/16	16	
200	5	5 13/16	6 11/16	7 1/2	8 5/16	9 1/8	10	10 13/16	11 11/16	12 1/2	13 3/8	14 3/16	15 1/16	15 7/8	16
210	4 7/8	5 11/16	6 1/2	7 5/16	8 1/8	8 15/16	9 3/4	10 9/16	11 3/8	12 1/4	13 1/16	13 7/8	14 11/16	15 7/16	16
220	4 3/4	5 9/16	6 3/8	7 1/8	7 15/16	8 3/4	9 9/16	10 5/16	11 3/16	11 15/16	12 3/4	13 9/16	14 5/16	15 1/8	15 15/16
230	4 5/8	5 7/16	6 3/16	7	7 3/4	8 9/16	9 5/16	10 1/8	10 7/8	11 11/16	12 7/16	13 1/4	14	14 13/16	15 9/16
240	4 9/16	5 5/16	6 1/16	6 7/8	7 5/8	8 3/8	9 1/8	9 7/8	10 11/16	11 7/16	12 3/16	12 15/16	13 3/4	14 7/16	15 1/4
250	4 7/16	5 3/16	5 15/16	6 11/16	7 7/16	8 3/16	8 15/16	9 11/16	10 7/16	11 3/16	11 15/16	12 11/16	13 7/16	14 3/16	15

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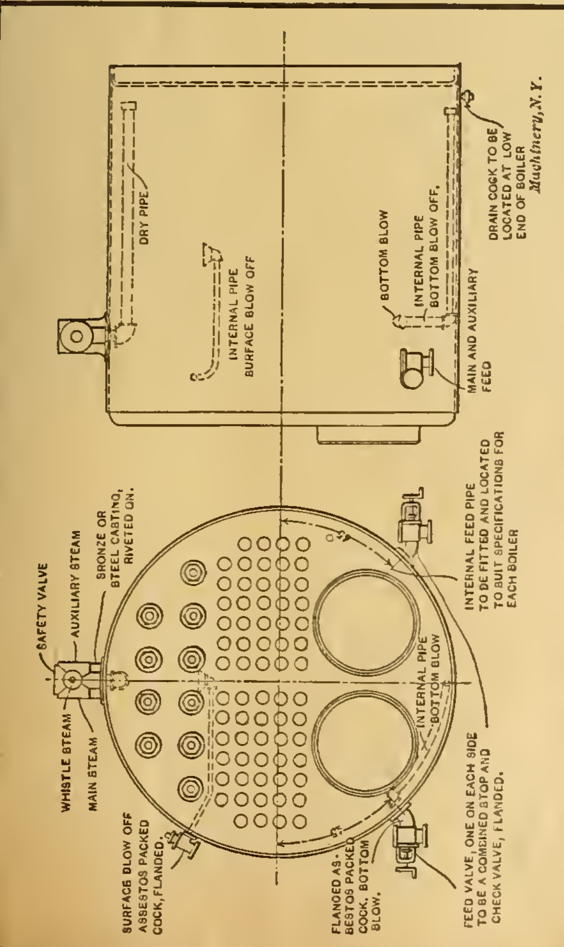
STANDARD BOILER ACCESSORIES—IV



PROPORTIONS PER SQUARE FOOT OF GRATE AREA

Grates to have about 45 per cent clear opening unless otherwise directed

Safety valve .... $\frac{1}{3}$ square inch Main steam .... $\frac{1}{3}$ square inch
Auxiliary steam .... $\frac{1}{6}$ square inch Main and auxiliary feed $\frac{1}{10}$ square inch
Bottom blow-off .... $\frac{1}{10}$ square inch Surface blow-off....... $\frac{3}{4}$ bottom blow area

Area of smokestack............. = $\frac{1}{8}$ grate surface
Area over bridge walls......... = $\frac{1}{7}$ grate surface
Least area through tubes........ = $\frac{1}{7}$ grate surface
Ratio heating surface to grate area = 30 or 35 to 1

TABLE OF DIMENSIONS

Grate area given in square feet. Other dimensions given in inches diameter

Grate area............	2 1/4	3 1/4	5 1/4	9 1/4	14 1/4	17 1/2	21	28 3/4	31	37 1/2	47 1/2	58	70
Safety valve..........	1	1 1/4	1 1/2	2	2 1/2	3	3	3 1/2	4	4	4 1/2	5	5 1/2
Main steam............	1	1 1/4	1 1/2	2	2 1/2	3	3	3 1/2	4	4	4 1/2	5	5 1/2
Auxiliary steam.......	3/4	1	1 1/4	1 1/2	2	2	2	2 1/2	2 1/2	3	3 1/2	3 1/2	4
Feed pipes............	3/4	3/4	1	1 1/4	1 1/2	1 1/2	2	2	2	2 1/2	2 1/2	3	3
Bottom blow	3/4	3/4	1	1 1/4	1 1/2	1 1/2	2	2	2	2 1/2	2 1/2	3	3
Surface blow..........	3/4	3/4	3/4	1	1	1	1 1/2	1 1/2	1 1/2	2	2	2 1/2	2 1/2
Smoke stack...........	10	12	14	19	24	26	28	33	34	38	42	46	52

Contributed by Walter B. Beebe

MACHINERY
June, 1911

GOLD AND SILVER SPINNING*

By CHESTER L. LUCAS†

THE spinning of metals is popularly supposed to be an out-of-date method of forming sheet metal; at least it is considered to be a decadent art. It is true that spinning is a much slower method of production than press work, but there are many special cases and classes of work in which spinning is the more economical method to employ, everything considered. Especially is this true in the manufacture of sterling silverware of the highest class, such as is the product of the Gorham Mfg. Co., of Providence, R. I.

Through the courtesy of Mr. Fred C. Lawton, superintendent, and Mr. Whipp, assistant superintendent of this company, the writer was allowed to photograph and record some of the interesting features of a model gold and silver spinning department and some of the machinery of the press and die departments. The main factory buildings are shown in Fig. 1, and even in the general appearance of the grounds and buildings there crops out that artistic touch that characterizes the entire product of the Gorham Co. The work of this company includes everything from the making of a sterling teaspoon to the casting of a life-size equestrian statue.


Fig. 1. Factory of the Gorham Mfg. Co., Providence, R. I.

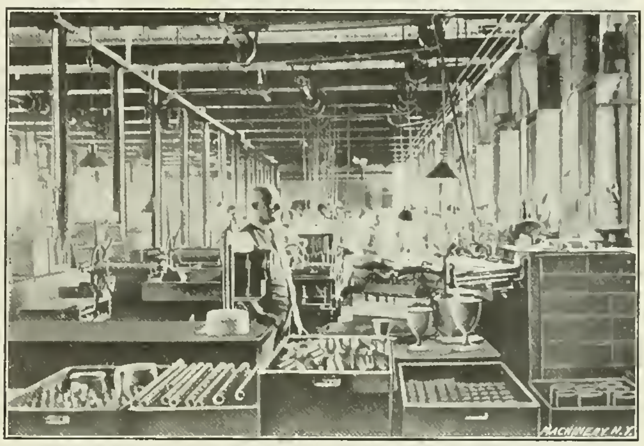


Fig. 2. General View of the Spinning Department


Fig. 3. Some Representative Work of the Spinning Department

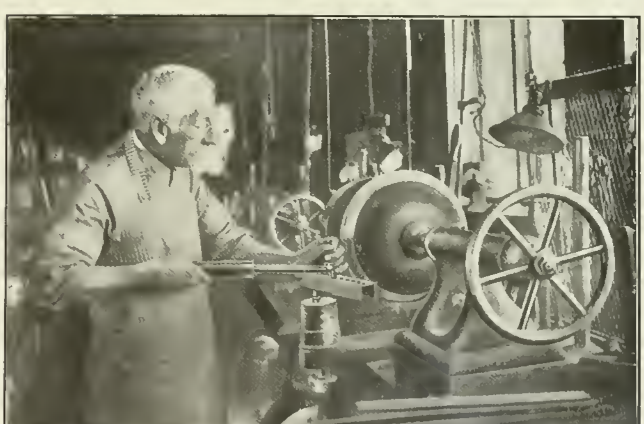


Fig. 4. A Spinner of Fifty Years' Service finishing a Silver Waiter

The Spinning Department

The gold and silver spinning department is located in a well-lighted building, as the illustration Fig. 2 shows. This department, giving employment to from 50 to 75 men, is in charge of Mr. E. W. Crocker. Fig. 3 shows a few specimens of the work produced by this department. Fully half of the work is the finishing up of shells after they have been partially drawn up in a drawing press, and includes smoothing out the wrinkles, trimming the edges, rolling beads and making accurate fits. A good idea of this class of finishing may be had from the illustration Fig. 3, which shows some of the every-day work of the department. In the rear are a number of water pitchers that have been fitted with silver tops; in the tray at the center are twenty candlestick bases that have been spun, and the square tray in the foreground is a piece of spun and pierced work that has been beaded at the edges and formed into a square shape as shown. The other articles are similar in character.

At the office of this department there is an interesting system in vogue for keeping the job records. Index cards are kept with the number of each job, the dates received and completed, the number of pieces, the weight per piece, the time consumed and a list of the operations necessary. On the reverse side of the card is pasted a photograph of the finished article—the most important feature of the record. No piecework is done in this factory, for the quality of the work performed is considered to be of far more importance than the quantity.

Spinning a Silver Waiter

The work of spinning sterling silver does not differ materially from the spinning of brass and aluminum, except that the work is of a higher grade and more care must be taken to prevent spoiling the stock. As with other classes of spinning, the point and ball tool is the one most often used. Common brown soap is used for a lubricant.

Fig. 4 shows a spinner putting the finishing touches on a silver waiter. This particular spinner is over seventy years of age and has been in the employ of the company for fifty years; in this same department there is another spinner

* For information previously published on metal spinning, see "Metal Spinning" 1 and 2 in the March and April, 1910, issues of MACHINERY, engineering edition, and accompanying reference.
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who has worked for forty-eight years. With such records of service, it is obvious that relations must be pleasant between employer and employe.

Oval Spinning

One of the most interesting spinning operations in the Gorham factory, and a branch of spinning that is followed in but few shops, is oval, or more properly speaking elliptical, spinning. In Fig. 5, the spinning lathe is shown set up with an oval chuck for medallion frames, and the spinner has just made some changes in the form before starting the spinning. As this illustration shows, the chuck is provided with a threaded spindle upon which different sizes and snapes of ovals may be mounted. It is obvious that the chuck is an important featnre of oval spinning, and as its operation is somewhat novel, it may be interesting to consider the construction and working principles of one of the latest models of elliptic (or oval) chucks.

This chuck is called a "self-balancing" elliptic chuck and is made by the P. Pryibil Co., New York; it is so balanced that it may be run at a much higher speed than the ordinary oval chuck. Essentially it consists of a circular frame casting, in

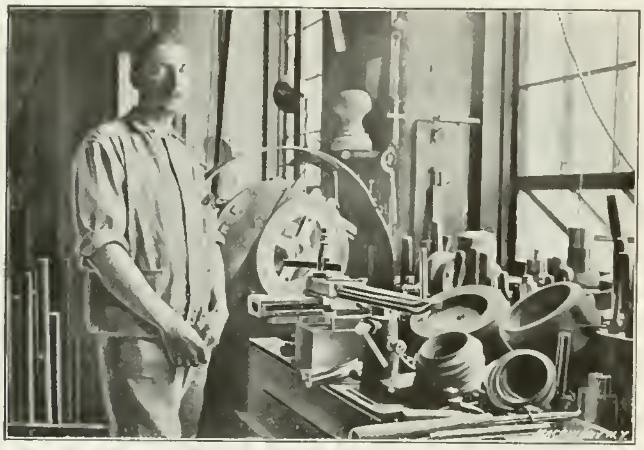

Fig. 5. The Oval Chuck and a Form for Flanging Ovals

which are fitted two diametrically opposed slides. These slides are geared to a central idler gear in such a manner that they reciprocate in opposite directions in unison. The amount of travel given these slides may be regulated at will by means of a hand crank that, with the aid of a scale and indicator, may be set to turn ovals of any proportion, for the amount of travel in the slides governs the shape of the oval.

Upon one of these two slides the work-holding spindle is mounted, while the function of the other slide is to balance the movements of the work slide. Thus the chuck is self-balancing, for as one slide leaves the center to make the

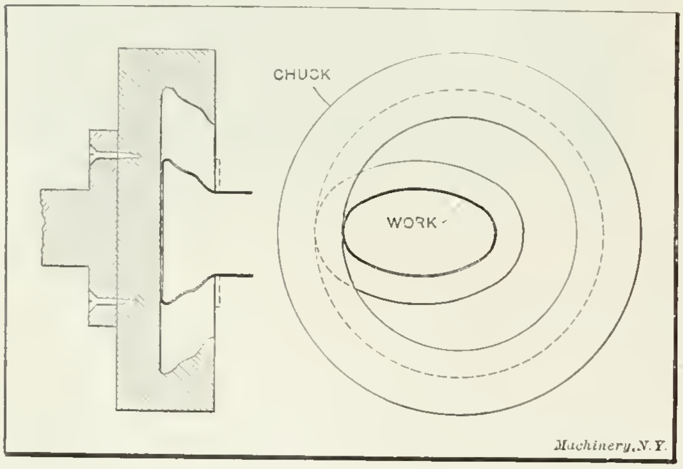

Fig. 6. Diagrammatic View of Circular Chuck for Spinning Ovals

ellipse, the opposite slide travels the same distance from the other side of the center.

With such a chuck, ovals or ellipses may be turned or spun of any size and of any proportion from a straight line to a perfect circle. The proportions of the ellipse may be varied at will without stopping the lathe, by means of the adjusting crank. The principal points of superiority that this design of chuck has over other elliptic chucks lie in the fact that there are two slides whose opposite movements balance each other, and in the fact that the proportions of the oval being turned or spinned may be changed without stopping the lathe.

Flanging Ovals in a Circular Form

A little kink in oval spinning that is of interest is the method used in flanging the oval frames shown on the lathe

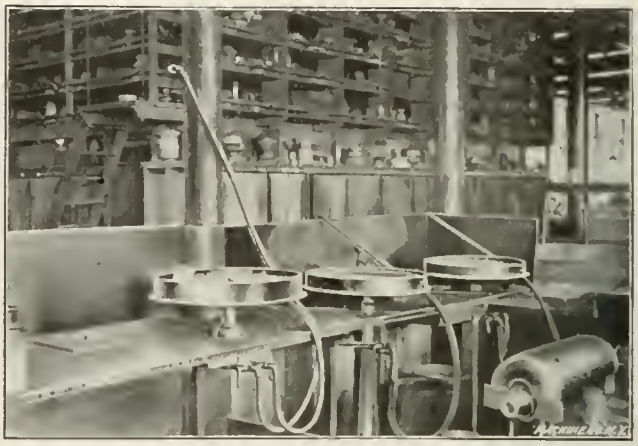

Fig. 7. The Annealing Bench and Collection of Forms

in Fig. 5, and diagrammatically in Fig. 6. The frames are first spun up, leaving the flanged part out straight. Next, a wooden form is mounted on the spindle; this form is turned out a little larger than the greatest diameter of the oval and so recessed that the frame sets within the form except for the edge that is to be flanged. The form is shown beyond the pile of frames on the lathe. The lathe is then started and with the aid of the spinning tools, the flange is turned over against the form. The surprising part of the operation is

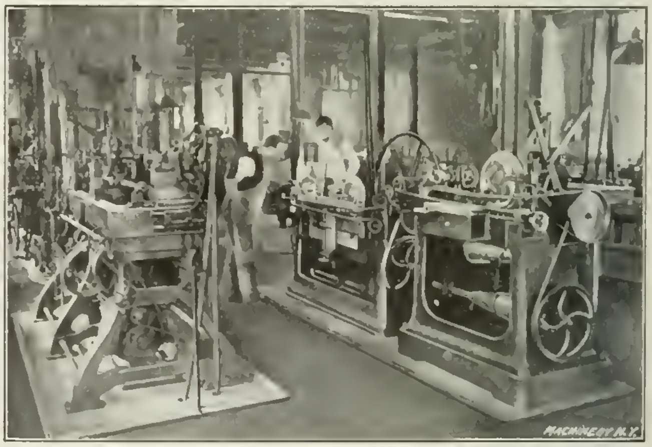

Fig. 8. Sinking Dies by Machinery

that an oval shell is flanged in a circular form, but it is more readily understood when it is explained that the pressure of the spinning tool causes the shell to bear against the form at the point where the spinning tool is held. This method gives a good flange without the use of a sectional chuck, and it should be applicable to similar flanging on ovals and circular shells in other lines of mannfacturing.

Annealing Bench—Forms—Vault

Annealing is an important operation connected with spinning, and unless the half completed shells are properly annealed, there is danger from seams and cracks that may develop. In order to properly and conveniently anneal the silver shells, the spinning department is equipped with an annealing bench consisting of three turntables, filled with pumice, as shown in Fig. 7. The shells are placed on the tnrntables and slowly turned while the torch is directed upon the work. Thus, all parts of the work are easily reached by the flame and a good even anneal is readily obtained. The torches are fed by gas and air piped from beneath the bench. Close at hand are the pickle baths and potash tanks for removing scale and cleaning.

Above the annealing bench in this illustration may be seen the storage racks where the spinning forms are kept. In nearly every case there is the prospect of a duplicate order so that this collection represents the work of many years. Each night, shortly before closing time, the silver and gold work in process of completion is stored in a fire-proof vault, as a precaution against both fire and theft. In this vault the stock from which the product is spun is also kept.

The Spinning of Gold

Gold is a difficult metal to spin; in fact, there are few metals that resist the spinner's tool as strenuously. Unlike

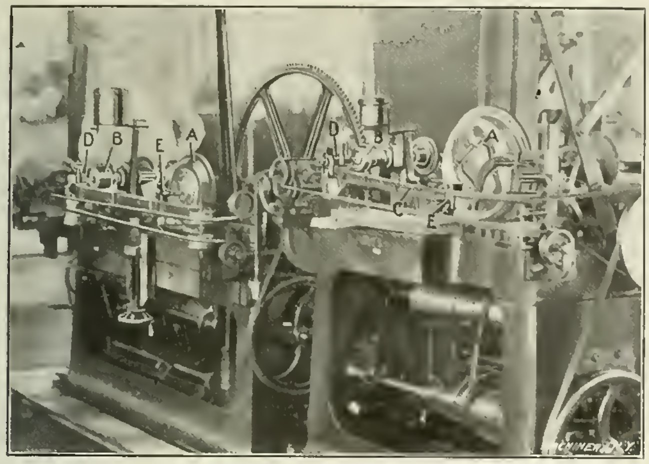

Fig. 9. Salient Features of the Janvier Engraving Machine

zinc, which is more easily spun than drawn in dies, gold is much more easily worked in dies than by spinning. For this reason it is always best to rough gold down by presswork or by swaging when possible and after the approximate shape has been reached, place the shell on an iron form and bring it to the exact size and shape required, by spinning. Iron forms are always used in spinning gold. The metal of which the shells are made is usually very thin and the pressure required is very heavy, making necessary an unyielding surface upon which to spin the gold.

The formation of grooves, ridges and other similar shapes in the work is best accomplished by "roller spinning." Roller spinning is very similar to knurling in operation, except that the rollers are plain faced, shaped to fit the forms being used. The reason for this roller spinning lies in the fact that the gold is more easily shaped this way than with a stationary spinning tool. In spinning gold, the lubricant used is a cheap grade of animal fat known as "horse grease." The rolls for spinning gold are kept on pegs in a cabinet, and when a particular roll is needed by one of the spinners, he hangs his check on the peg until the roll is returned, so that it will be easy to locate it should it be needed while in his possession. Great care is taken to prevent the loss of any of the gold while in the spinning department. At such times as they are not being worked upon, the gold shells are kept in a locked case under the care of the assistant foreman, and of course the weights of the rough stock and of the finished articles and scrap are carefully checked.

Fig. 10. Striking-up Silver Waiters under a 2000-pound Drop-hammer

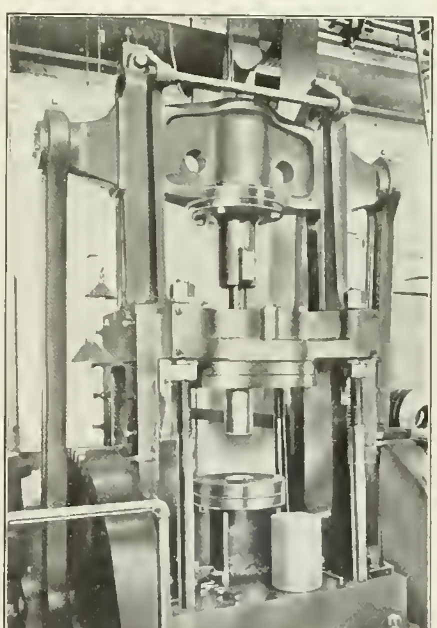

Fig. 11. The "Jumbo" Drawing Press built Fifty Years ago

The Die-sinking Machines

Another interesting part of the Gorham Mfg. Co.'s factory is the die-sinking department. In this room are located four automatic machines for cutting the embossing dies used in the press department for striking up flat and hollow ware as well as other silver articles that require embossing. In the illustration Fig. 8 the two machines at the right are of the Janvier make; the one in the left foreground is an American machine made by the Keller people; and the machine in the background is a Janvier, but larger than the other two.

Of these machines, the Janviers are the better, both in their construction and in the quality of the work turned out. It is the opinion of the writer that if the workmanship put on the American machine was as good as on the Janvier machine, the result would excel either of the present machines, for the principles of the Keller machine are good.

Owing to the location of the large Janvier machine, it was impossible to get a close-range photograph. Only two of these machines have ever been built, as there are so few concerns making large dies in sufficient quantities to warrant the installation of such a machine. The other machine of this type is in Germany. The one here is used principally for dies for embossing large silver platters and hollow ware and it is designed so that it will reproduce the same size as the master pattern if necessary; it is impossible to do this on the other machines. In addition to these machines, there are about 30 men in this department finishing up the dies after they leave the machines. These die-sinkers also cut many dies entirely by hand.

From the illustration Fig. 9 a good idea may be had of the principles upon which the Janvier die-sinking machine operates. Briefly, the operation of the machine is as follows: A brass pattern of the design is made, enlarged several times, and is attached to the copy-holding table *A*, while in the chuck on the work-holding table *B*, the die is held. These two tables turn at the same speed, which gradually increases and decreases according to the position of the cutter in relation to the center. Lever *C* is pivoted at its left-hand end and carries the cutter *D* and the style or tracer, *E*. Tracer *E* rides upon the pattern and as it is moved in and out by the irregularities of the design, it transmits the motion to the cutter *D* that is mounted on the same lever *C*. This movement is transmitted in a lesser degree, however, as the position of the cutter is nearer the fulcrum of the lever *C*. The lever *C* also has a lateral motion parallel with the faces of the die and pattern. The die and pattern revolve in unison and, actuated by the cone pulleys beneath the machine, move more rapidly as the cutter and tracer approach the centers of the die and pattern, respectively. Thus, as the tracer moves slowly in and out of the various parts of the design, it guides the revolving cutter over the die in precisely the same proportion, slowly cutting out the steel as it does so. It takes from 6 to 20 hours to cut a die, varying with the intricacy of the design and the size and depth of the die.

Striking Up Large Silverware

The large drop press shown in Fig. 10 is for striking up large articles of silver, such as waiters, platters and similar

tableware. This press, which was built in the shops of the Gorham Co., is very heavy and of a size that is seldom met with except in drop-forging plants. The weight of the hammer is 2000 pounds, and it is raised by a roller lift which requires two men to handle. The total weight of the press is ten tons. On account of its weight, the foundation for this press was made by excavating to the depth of ten feet and placing therein three large blocks of granite. These blocks, three feet square and three feet thick, were placed one above the other and a thick layer of cement beneath the three and around the sides. This foundation has withstood the test of time well.

The dies for plain waiters are made from cast iron and the forces, or male dies, are cast of tin. Of course a cast-iron die would not do for embossing designs, but for shaping up a plain silver waiter it answers very well. The tin forces are made by lowering the hammer to within a few inches of the die and after building a wall around the die and hammer, pouring molten tin into the intervening space. In getting out a dozen waiters, the force has to be renewed once.

In striking up a lot of waiters, the die is set up and the force made as described. Within the die are placed two brass sheets, 1/16-inch thick, that lie closely over the die, following every detail of its shape. These pieces are used for "breaking down" the silver. With both of these pieces in the die, all of the blank sheets of silver are struck, this operation forming the blanks to somewhere near the shape of the die. Next, the upper of these sheets is taken out and the half-formed pieces run through again. Finally, the lower sheet is removed and the silver pieces are struck directly into the die, which operation sharpens up the form and finishes the striking operations on the waiters.

The "Jumbo" Drawing Press

In an old-established shop like the Gorham Co.'s there are a great many sidelights on mechanical history; the drawing press shown in Fig. 11 affords one good example. This press, known throughout the factory as the "Jumbo" press, was made in the days "before the war," and it is in use at the present time; one of the shells made in it is shown standing on the bed. This shell is of silver, ten inches diameter and fourteen inches deep, and was drawn up in seven operations. The press will take blanks up to 30 inches in diameter. Crankshafts at either side of the press actuate the ram, being connected with geared driving wheels that extend beneath the flooring. This press is not to be compared with the modern metal-working machinery of to-day, being neither powerful nor quick, but it is interesting in that it illustrates the work of the machine designers and builders of fifty years ago.

* * *

LARD OIL AS A CUTTING LUBRICANT

There is a difference of opinion as to the relative merits of pure lard oil and other cutting lubricants on the market. While some of the lubricants are useful for certain classes of work, they do not give as good results when cutting steel as can be obtained by a good grade of lard oil. After being used for a considerable time, lard oil seems to lose some of its good qualities as a cooling compound. There are several reasons for this: Some manufacturers use the same oil over and over again on different materials, such as brass, steel, etc. This is objectionable, for when lard oil has been used on brass it is practically impossible to get the fine dust separated from it in any centrifugal separater. When this oil is used on steel, especially where high-speed steels are employed, it does not give satisfactory results, owing to the fact that when the cutting tool becomes dull it generates sufficient heat to "melt" these small brass "chips," so that they freeze to the cutting tool and thus produce rough work. The best results are obtained from lard oil by keeping it thin, and by using it on the same materials—that is, not transferring the oil from a machine in which brass is being cut to one where it would be employed on steel. If the oil is always used on the same class of material it will be found that it does not lose any of its good qualities.

BLANKING AND SHAVING DIES FOR TYPE-SETTER FORK

By A. C. LINDHOLM*

In order to reduce the cost of manufacturing the sheet metal piece shown in Fig. 1, the sub-press dies shown in Figs. 2 and 3 were designed and carefully made. Previous to the new method, the piece, which is called a type-setter fork, was roughly blanked. Then the holes *A* were punched, and the metal removed from the inside of the fork to allow a formed cutter to enter and mill the teeth *B* and the edge *C*. The edge *C* was milled so that it would present a smooth working face for a roller. The final operation consisted in placing the piece on pins in vise jaws and milling the working point from *D* to *E* with a formed cutter. The percentage of pieces spoiled through errors in machining by this method

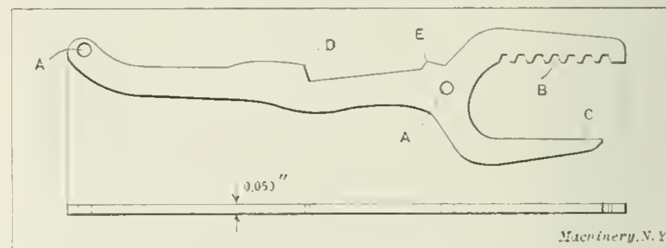

Fig. 1. Type-setter Fork

was excessive and, therefore, the parts passing inspection came high, as every piece required a thorough test.

The dies shown in Figs. 2 and 3 eliminated all the trouble, and as for inspection, the burr was about all that was necessary to look out for. As a rule a piece is generally O. K. if cut clean. Fig. 2 is the blanking die which is of the follow-type, placed in a sub-press or post construction. The die *A* has a section *B* fastened to it by means of screws *C* and dowel-pins *D* and *E*. The pin *E* also acts as a stop-pin for the stock, when taking the first blank from the sheet. The

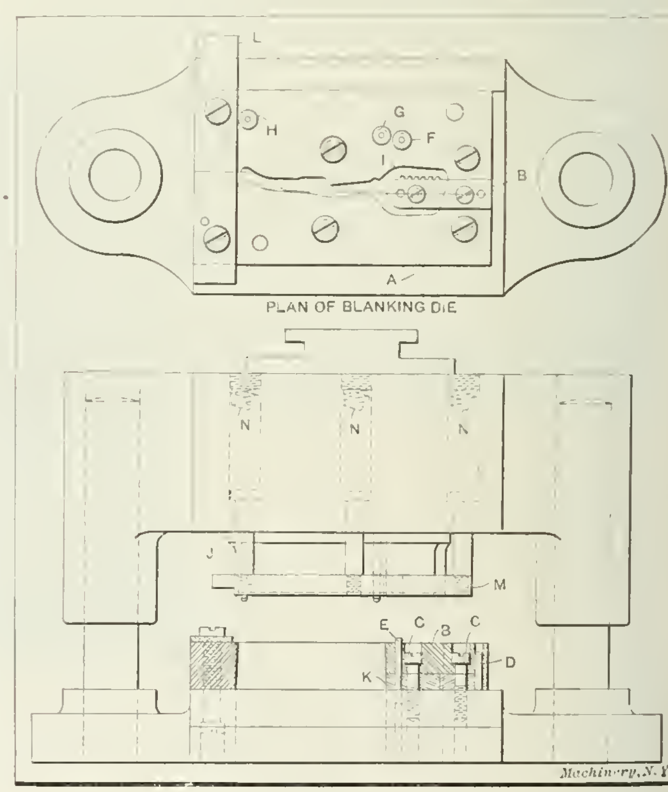

Fig. 2. The Blanking Punch and Die

locating hole in the sheet is punched in the inserted bushing *F* at the same time as the pilot holes *G* and *H*. In starting a sheet, the edge of the strip is placed near the edge of the opening in the die at *I*. The ram then descends and the pilot holes and the locating hole in the blank are pierced. To make the first and the successive blanks, the locating hole in the sheet is placed over the pin *E*. Of course, the pin *E*

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is small enough to allow the pilots on the punch *J* to locate the work properly. The cross-sectional view illustrates the construction of the die with regard to the sectional or inserted piece *B*. As will be seen, one end of *B* rests on part of the die which is cut out to receive it, while the other end is supported by the piece *K*. *L* is the guide-plate, and *M* is the stripper, which in this case is fastened to the upper member of the sub-frame, and is actuated by the six springs *N*, three of which are shown.

The small punches (not shown) for piercing the holes in the blank are supported in bushings located in the stripper, thereby assuring rigid support, and thus avoiding breaking the punches. It will be noted that the die is not "nested"—that is, that there is no groove cut to fit the two sides of the die. This practice is rapidly proving to be preferable to that of nesting, owing to the fact that it is more economical in making the die, and also in placing it in the desired position. Good substantial screws and dowel pins should be used. The same method applies to the punch. Instead of nesting or inserting the shanks, as the case may be, the punch has a shoulder or flange. Although this may seem more expensive to make, it is in reality cheaper considering the advantage over the inserted method; as for instance, when shearing the punch in the die, the upper member is utilized for the purpose and when the punch has been hardened it can be placed to advantage to fit the die. If it has warped so that it is not square with flange or base, it can be speedily corrected. Of course, as in the case of the die, substantial screws and dowels should be used.

Fig. 3 shows the die used for the second operation, which consists in shaving the blank. The same pattern of sub-press

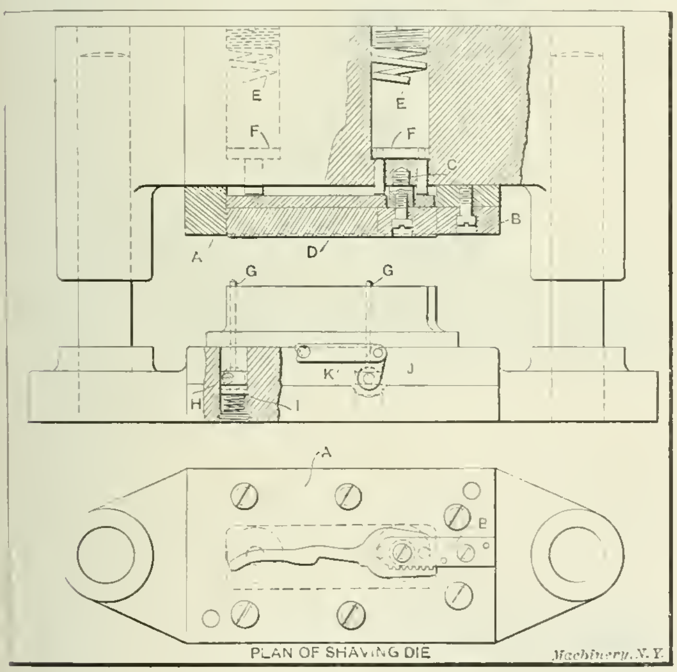


Fig. 3. The Shaving Punch and Die

frame is used, and the same method of fastening the die and punch to their respective members is followed, as in the preceding case. The die, however, is fastened to the upper member and the punch to the lower. The die is practically a copy of the blanking die, except that more care is exercised in machining, as the product from this tool must fit the gage. Referring to the die *A*, the support under the inserted part *B* is a stud *C* screwed into the cast-iron holder, one end being tapped for the fillister-head screw which fastens the inserted member to the stud. The shedder or ejector *D* is made in two parts. When making the punch, sufficient length is allowed and cut off for this member. A flat plate is fastened to it by screws or rivets as the case may be. A hole is drilled for clearance to allow the plate freedom in working.

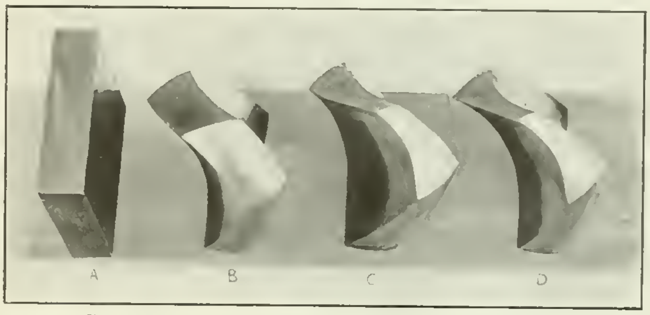
Two spiral springs *E* actuate the shedder through the plungers *F*. In order to release the work from the gage-pins *G*, a contrivance shown in the cross-section is used, and consists of two rods with eccentrics *H* turned on one end. The eccentric operates in a slot in the plunger *I*. The eccentric rods have cranks *J* fastened to one end which are joined together by the link *K*, the latter having a small handle attached to it, to assist in operating it.

The amount of stock shaved from each edge is about 0.004 inch. This leaves a smooth cut, and with proper care in reference to keeping the die sharp, good work free from burrs is obtained. In shaving dies the same rule applies as in gear-cutters—that is, keep them sharp; if used in a dull state the edges become rounded very quickly and require much more grinding, whereas, if taken in time all that is necessary is to grind off from three to five thousandths inch.

* * *

EVOLUTION OF A FLAT TWISTED DRILL POINT

The accompanying illustration shows four of the stages in the manufacture of a flat twisted drill. The illustration shows at *A* an end view of the rough flat stock from which the drill is made. At *B* is shown the end of the drill after having been twisted, but before it is ground or thinned down to the proper thickness for the drill point. It will be seen that the section at the point is entirely too thick to be used as a drill point, and that a great amount of grinding is required to reduce



Four Stages in the Manufacture of a Flat Twisted Drill

the point to a suitable width. In fact, the width of the point is even greater than the thickness of the flat stock from which the drill is twisted, on account of the angle that the line at the point makes with the original flat side of the stock. It will also be seen that the cutting edge or lip is not a straight line, as it should be for efficient action, but that it is decidedly curved. At *C* the point is shown partly ground to the correct thickness, the curve of the cutting lips being less pronounced; in fact, one part of the cutting edge has assumed a straight line form, while the remainder still has the original curved shape; the thickness of the point is also too great for the purpose of the tool. At *D* the finished drill point is shown, the cutting lip here being a straight line and the point reduced to the proper thickness.

It is apparent that the process of grinding or thinning the point of the drill and straightening the form of the cutting lips is a slow, difficult and costly one, on account of the fact that it must be done by hand. As this grinding is done only at the point when the drill is manufactured, the web being otherwise of the same thickness as shown at *B*, it is also evident that when the drill is later ground for sharpening after having been dulled, and it is shortened, it must be ground in the flute by the user in order to obtain a point of the proper width and straight cutting lips. It is evident that this is a difficult operation for the user, and this, in fact, is one of the disadvantages of the regular type of flat twisted drills, otherwise so efficient, and has been the cause of several attempts to improve the drill, by constructing it in such a manner as to make the grinding easier, and make the use of a machine for this purpose possible.

* * *

An analysis of the causes of all accidents to aeroplanes at the British meets last fall shows that out of 40 accidents, 13, or 32.5 per cent, were due to the failure of the engine; 10, or 25 per cent, were due to descents on bad ground; 6, or 15 per cent, were due to sudden gusts of wind which the stability of the machine was not able to resist; 5, or 12.5 per cent, were due to breakage of the propeller, and 6, or 15 per cent, were due to fire and miscellaneous causes.

METHODS USED IN MANUFACTURING THE STEPTOE SHAPER

By G. K. ATKINSON

Some time ago the line of shapers built by the John Steptoe Shaper Co., Cincinnati, Ohio, was redesigned, and since that time a great many of the methods used in the construction of these machines have also been changed. While some of the methods adopted are well known in modern shop practice, there are others which are novel, and which should arouse the interest of the mechanic. The accompanying halftones and line engraving illustrate some of the methods used, and it is the object of the present article to briefly describe some of the more interesting features.

In Fig. 1 is shown the back-gear lever *A*—a malleable iron casting—which is drilled, reamed, and faced to the required dimensions, at *B*, and is then clamped in the slotting fixture

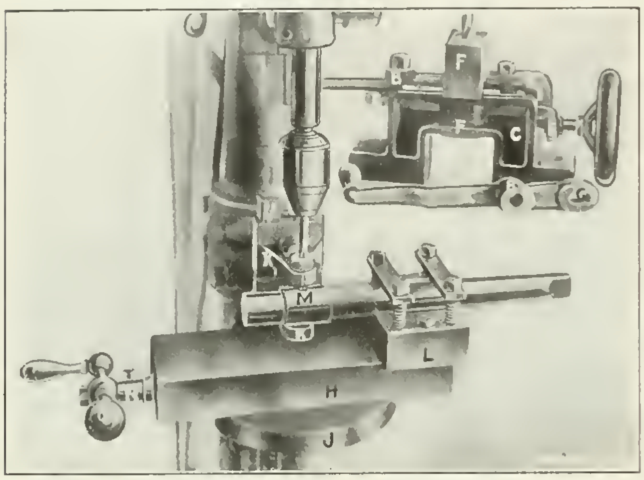


Fig. 1. Two Fixtures used for Cutting Elongated Holes

C, using the hole at *B* as the locating point. Clamp *D* holds it rigidly to the slide *E* on the fixture. The fixture is provided with two hardened bushings at *F*. The lower bushing receives and guides the drill after the lever has been drilled through at *G*, the drill being fed down and through the upper bushing. With the drill in this position the slide *E* carrying the lever *A* is fed by hand across the fixture until it comes in contact with a stop provided. The drill, being

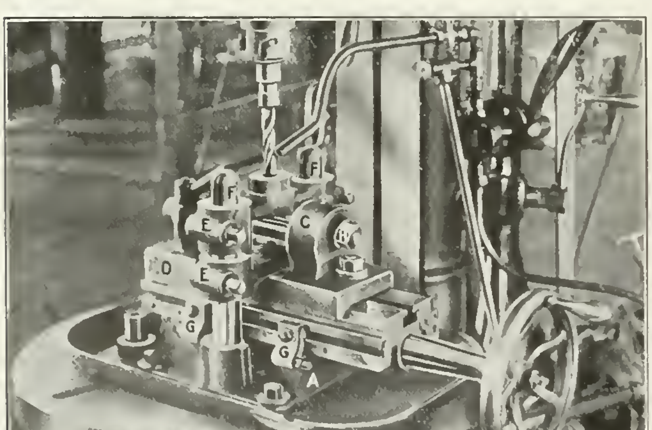


Fig. 2. Fixture for Cutting Slots in Toolposts

guided in the two bushings, makes an ideal spiral milling cutter and produces a good clean slot from the solid stock. The slot is one-half inch wide by one inch long, and one inch deep; the time required to drill and mill the slot is only two minutes.

This fixture suggested the one shown at *H* in the same illustration, which is mounted on the knee of a sensitive drill press, and which consists of a harp and harp-slide from one of the company's regular shaper heads. This fixture is used for cutting the slot in boring and facing bars, and is shown with a facing bar clamped in position for slotting. The vertical part *I* which is bolted and doweled to the back of the harp *J*, supports the two arms *K* and K_1, which carry the bushings for guiding the drill and reamer. The V-block *L* locates and holds the bar *M* in line with the drill spindle and bushings, while being drilled and slotted. The method of cutting the slot is as follows: Assume as an example that a slot 5/16 inch wide and 1¼ inch long is to be cut in a bar which is

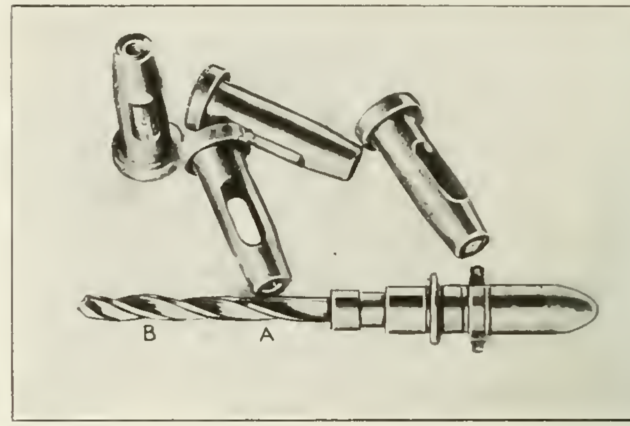


Fig. 3. Some of the Toolposts and the Drill used for Slotting them

clamped as shown. The bar is adjusted by means of the ball crank at the end of the slide until the drill is in position to drill the hole forming one end of the slot. The index collar *N* on the adjusting screw is now set at zero, and the first hole drilled; then the table *H* is fed over a distance equal to 5/16 inch and the second hole drilled, the same operation being

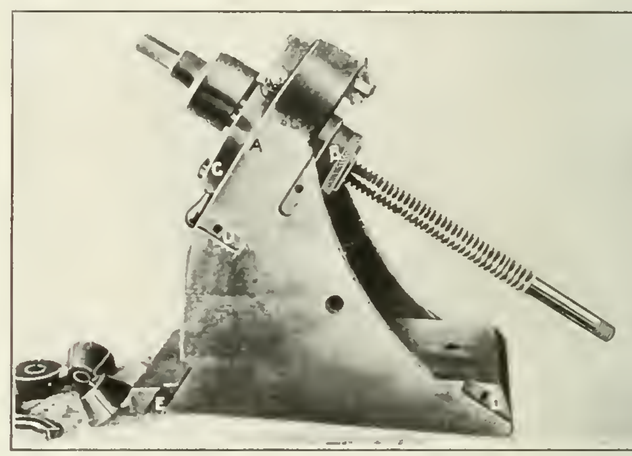


Fig. 4. Fixture for Milling Hexagon and Square Heads on Vise Screws, etc.

performed until four holes have been drilled through the bar. Now a drill having an almost flat or "square" cutting end is substituted, and by means of this the stock between the holes is drilled out. The stock which remains after this second drilling operation is removed by a hand reamer supported by the bushings in the brackets *K* and K_1 below and above the

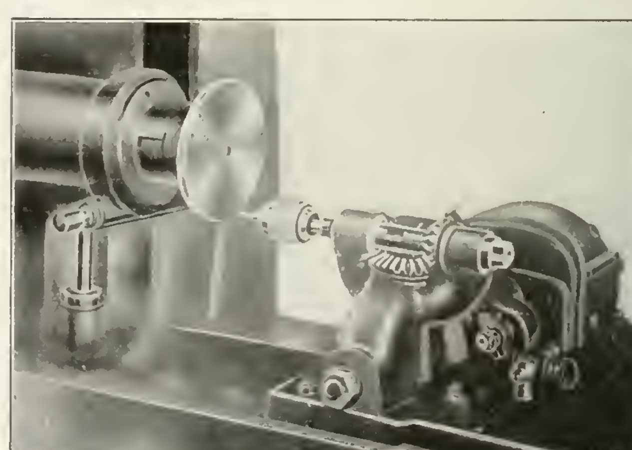


Fig. 5. Device for Drilling Index Plates in a Brown & Sharpe Automatic Gear-cutter

bar. After this operation nothing is left except to square the ends of the slot, which is done by hand.

In Fig. 2 is shown a fixture in which the same idea is carried out in a still more elaborate manner, this fixture being

used for drilling and milling the slot in the toolpost for the shaper. This fixture consists of a base A cast integral with an oil pan, a slide B, a headstock C, a tailstock D, drill bushing supports E, posts F, four stops G (two being shown in the illustration and two being placed on the opposite side of slide B), and the feed-screw and handwheel. The toolposts are turned, drilled and tapped for the binding screw, and cut off from the bar in a hand screw machine; they are then clamped

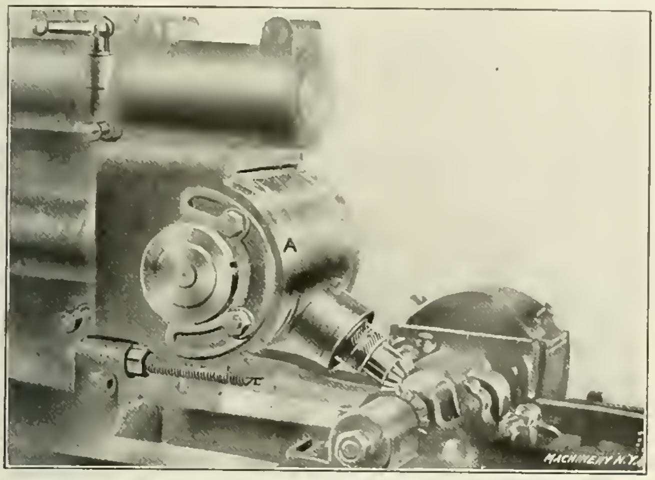
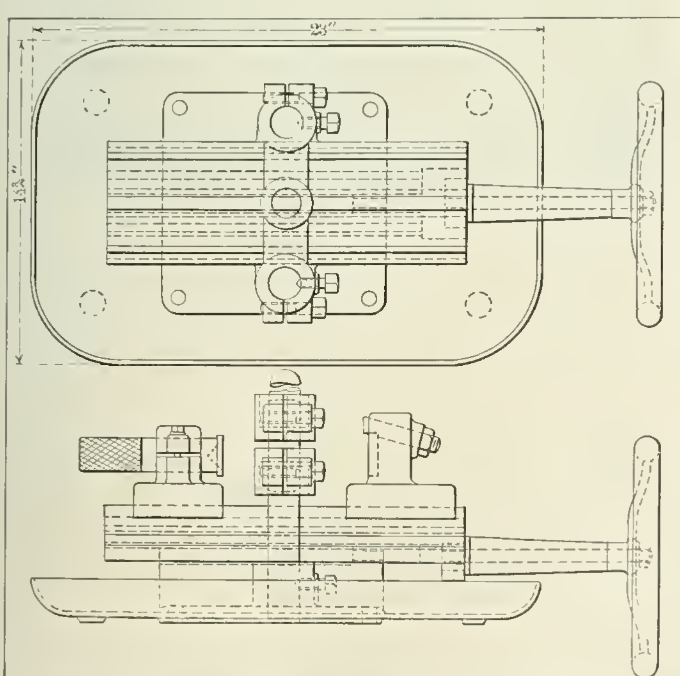


Fig. 6. A Bevel Gear and Face Clutch Milling Attachment for the Brown & Sharpe Automatic Gear-cutter

in the headstock C by means of a nut and wedge bolt H. The tailstock spindle, which is provided with a bell center, supports the small end of the toolpost. The slide is adjusted by means of a handwheel until the drill conforms to one end of the slot to be cut. The stops are then set for that end of the slot; the drill is fed through the toolpost and well into the lower guide bushing, after which the work is fed across the drill until the slot is cut to the required length, and then the stops at the other end are set for the length of the slot. The subsequent pieces require no measuring, as they are all clamped in the same manner, the stops insuring that they become exact duplicates.

The cutting lubricant is copiously supplied from a tank at the side of the drill press by a pump of the Brown & Sharpe design, bolted to the side of the column, thus permitting the drill to be run at a very high speed. At first, considerable trouble was experienced in finding a drill that would stand



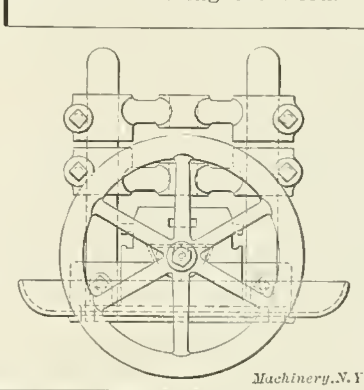


Fig. 7. Construction of Fixture shown in Fig. 2

the side pressure in milling this slot. The ordinary carbon steel drills did not permit of speeds high enough, and the milled high-speed drills would break between the guide bushings. The only drill that has so far been found to work satisfactorily is the Celfor three-fluted twisted high-speed steel drill.

The slot in the toolpost for the 20-inch shaper is 25/32 inch wide by 2 17/32 inch long, and the average time required for drilling and milling the slot complete in lots of 125, is 3.8 minutes for each; the drill mentioned requires only one sharpening for the entire lot without any apparent dulling of the cutting edges. Some of the finished toolposts, and the drill with which they were drilled and milled, are shown in Fig. 3. The drill is backed off so as to have a keen cutting edge between the points A and B. Fig. 7 shows the toolpost slotting jig. From the description already given with reference to Fig. 2, no difficulty should be experienced in understanding the design. The headstock and tailstock are not shown in position in Fig. 7, except in the side elevation.

The milling fixture shown in Fig. 4 is used for milling hexagon and square heads on vise screws, shafts, bolts, etc. The spindle is provided with a taper bearing, and with a clamping and take-up nut B, and is cast integral with the index plate A. The jig for holding the work to be milled is provided with a collet for each size piece to be milled. The index plate has ten holes drilled through it, the holes being reamed for a locking pin having a 15-degree included angle. Six of the holes are 60 degrees, and four of the holes 90 degrees apart. After the holes for the index pin have been reamed, they are tapped the remainder of the way through the index plate to permit of the insertion of the round-head cap-screws C, of which there are twelve, six of these being long enough to come flush with the back of the index plate and six being shorter. When milling a hexagon head, the short screws are put into the six holes marked "6," to prevent chips from getting in, and the long screws are put into the four holes marked "4," to prevent the locking pin from entering any of these holes, thus making it impossible to index incorrectly. When milling square heads the opposite course is pursued, so that under no circumstances can a mistake be made in indexing the work. The spindle is at an angle of 30 degrees to the base of the fixture, which facilitates the chucking and removing of long shafts or screws having a collar back of the square. The side of the fixture is finished parallel with the spindle, and grooves D and E are provided for locating-keys which permit the fixture to be turned over on the side and set with the spindle parallel to the milling machine table for milling collar-head screws and work of a similar nature with an end-mill. It is obvious from the location of the grooves D and E that the fixture may be set either with the spindle parallel with, or at right angles to, the milling machine spindle.

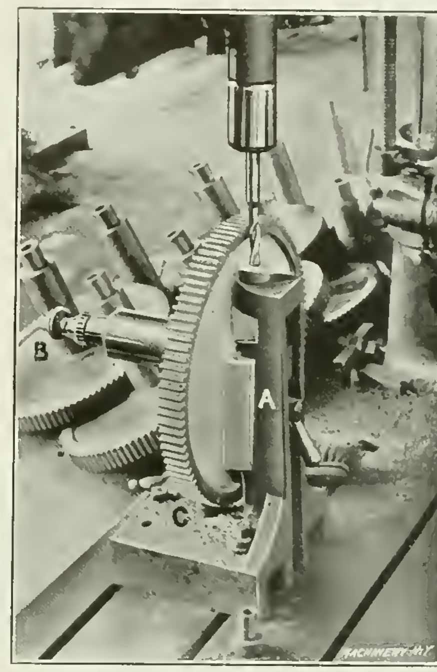


Fig. 8. Jig for Drilling and Reaming the Hole for the Stroke-adjusting Screw in the Bull-gear

In Fig. 5 is shown an interesting drilling fixture for drilling index plates for index centers. The fixture is mounted on the carriage of a Brown & Sharpe automatic gear-cutter, and the index plate is mounted on an expanding arbor in the spindle of the gear-cutter. The plates are made in lots of fifty, and in drilling these, the machine is first set to index the holes in the outer circle. The outer row of holes is drilled in all the plates in the lot, and the machine is then set to index the holes in the second row. All the holes in this row are drilled in all the plates, and so on until the index plate is finished. This method not only insures accurate results, but also eliminates the possibility of errors in indexing.

In Fig. 6 is shown a bevel gear and face clutch milling attachment for the Brown & Sharpe automatic gear-cutter. It will be seen that this attachment is rigidly supported by the overhanging arm, and also has a bearing on the nose of the spindle. It is graduated in degrees at *A* and can be rotated through an angle of 100 degrees, thus having ample range for bevel gears of any angle as well as for face clutches.

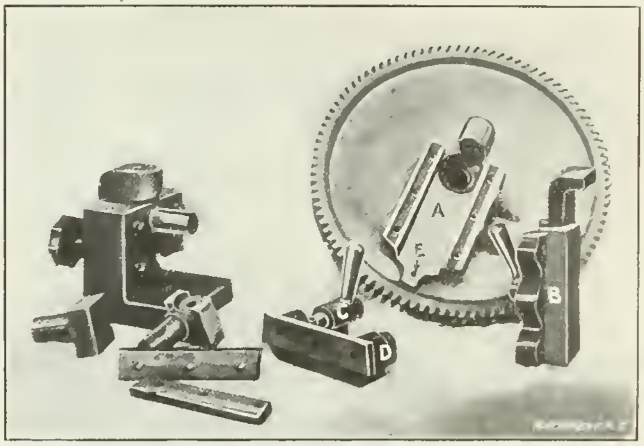


Fig. 9. Jigs for Bull-gear, Bull-gear Block and Slats

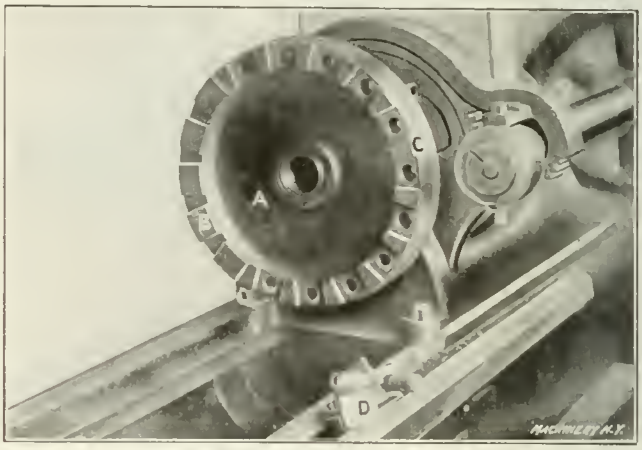


Fig. 10. Method of Turning Vise Swivel Bolts

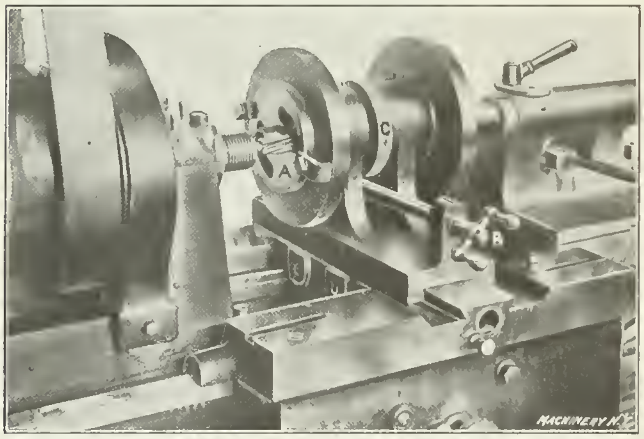


Fig. 11. Milling Belt Shifter Cams in a Lathe

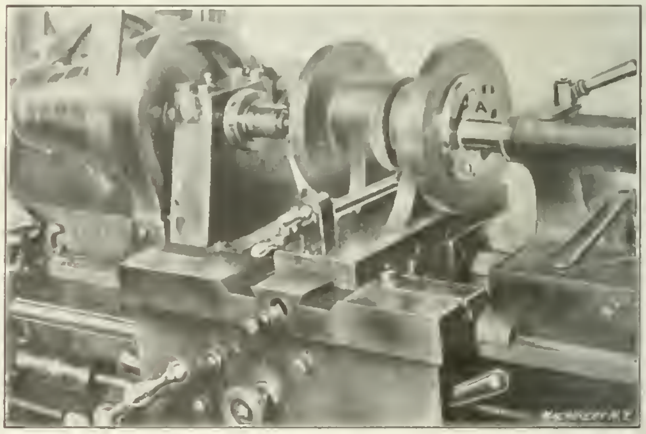


Fig. 12. Master Cam and Guide Roller used when Milling Belt Shifter Cams

In Fig. 8 is shown a jig for drilling and reaming the hole for the stroke-adjusting screw in the bull-gear of the shaper. The bull-gear is located by an eccentric stud *A* and clamped by bolt *B* and toe-clamp *C*, which insures all holes being drilled straight and true with the bearing *A* in Fig. 9. In this latter illustration are shown other drill jigs used for the bull-gear, the bull-gear block and slats. The jig *B* is for drilling the six tapped holes for the slats, and the pin hole shown at *E*. At *C* is shown a jig with an eccentric clamping arrangement for drilling the slat shown in position in the jig. Two more slats are shown in front of the jig and the locating-pin is shown at *D*. The jig is entirely open, thus permitting free access for cleaning.

In Fig. 10 is shown a lathe fixture which holds the vise swivel bolts while the radial portion is being turned on the bolt heads, this portion fitting the T-slot in the vise face. The bolts are slipped into the holes, as shown on the left side at *B*, and are held in place by nuts at the back. The rim *C* is of the same width as the finished bolt head, and serves as a gage for setting the lathe tool. As the fixture holds sixteen bolts at a time, this method of machining them is very rapid and effective. Some of the finished bolts are shown at *D* beneath the faceplate.

The method of milling the belt shifter cam for the triple-geared shaper is shown in Figs. 11 and 12. The cam-cutting fixture is mounted on the lathe carriage, as shown, and the master cam *A* in Fig. 12 is bolted and doweled to a faceplate and is actuated by a roller held in the tailstock spindle, as indicated. The belt shifter cam is mounted on a stud and clamped as shown at *A* in Fig. 11. It is then fed toward the end-mill by the tailstock screw, and revolved by the ball-crank *B* which operates the worm-gear *C*.

* * *

An attractive and convenient method for storing patterns is used in the shops of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Ordinarily, patterns are stored on permanent wooden shelves, which has several disadvantages. All the dirt and dust carried from the foundry with the patterns collects on the shelves. The store-room becomes very dark, and the fire risk is increased. Besides, as the shelves are permanently put in place, some patterns will be found to be too large to go into the space where they properly belong, while the space provided for other patterns is larger than required. In the shops of the above-mentioned company, however, the shelves are made of expanded metal, held in metal frames attached to brackets at the ends, which, in turn, are supported by upright pipes to which the brackets are held by means of set-screws. In this way the shelves can be moved up and down as required by the sizes of the patterns, and the sand and dust cannot collect on the shelves, but falls through the expanded metal to the floor, where it can be easily swept up and removed.

* * *

The working hours of the factories in Cleveland are from 6:30 to 11:30 and 12 to 5 Central standard time. There is a movement on foot to change to Eastern time and begin work at 7 o'clock and stop at 12 and 5:30. The change would mean that work would begin one-half hour earlier than now, and the men would have more daylight time after hours for recreation, etc.

EXTERNAL CUTTING TOOLS—5

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

This article, the concluding installment of the series on external cutting tools, treats of angular cutting tools, shaving tools, shaving-tool holders and feeds and speeds for shaving.

Angular Cutting Tools

When it is necessary to form the end of the work cone-shaped and produce a sharp point, a tool which is fed in similarly to an ordinary cut-off tool does not give satisfactory results. An example of this class of work and the attach-

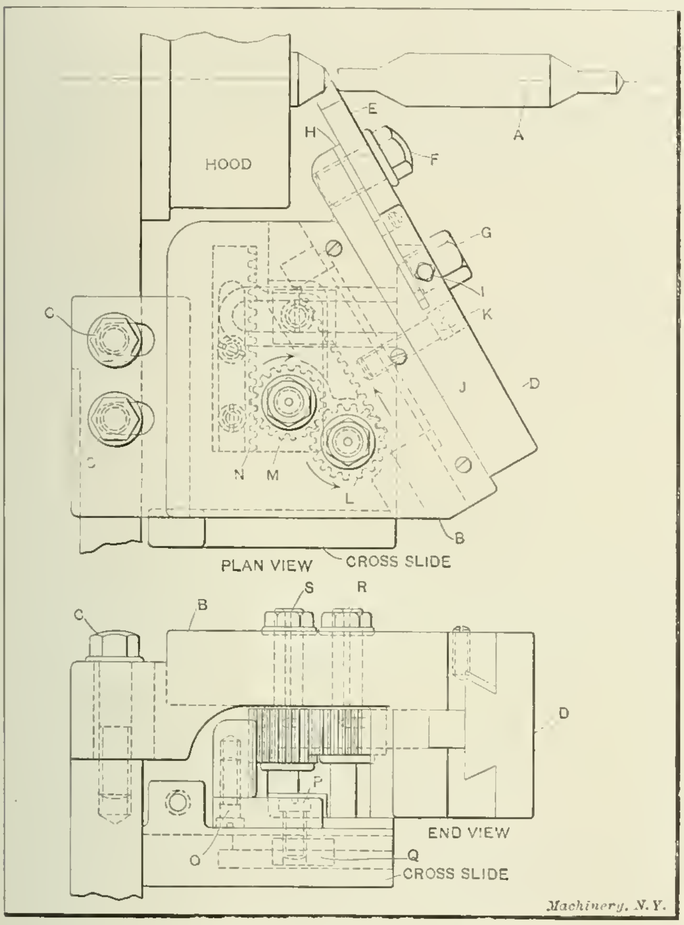


Fig. 20. Cross-slide Angular Cutting-off Tool

ment used for forming it are shown in Fig. 20. The work, which is shown at *A*, is a blank for a combination drill and countersink. The angular cutting-off attachment consists mainly of a bracket *B*, which is fastened to the machine by two cap-screws *C*. These screws are located in the holes which are used for fastening the slotting, cross-drilling and burring attachments to the machine. The sliding member *D*, fitting in dovetailed grooves cut in the bracket *B*, is used for holding an ordinary circular forming tool *E*, which is held to this sliding member by cap-screw *F*. The usual means for

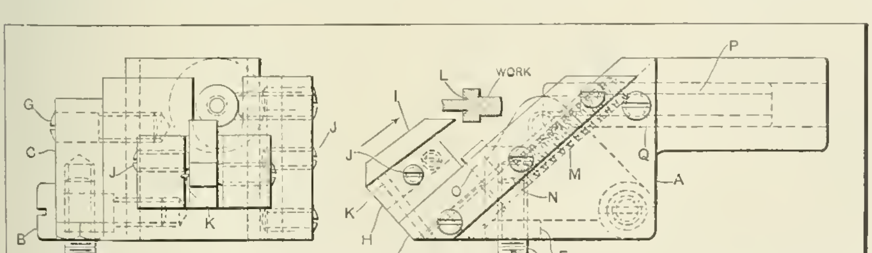


Fig. 21. Back Recessing Tool for Small Work

adjusting the circular tool is provided; this consists of an eccentric cap-screw *G* and a plate *H*. The eccentric screw *G* is locked by the screw *I*.

Attached to the sliding member *D* is a rack *J* held in a groove cut in the slide, by a fillister screw *K*. This rack meshes with gear *L* which, in turn, meshes with gear *M* in contact with the rack *N*. Rack *N* is attached to the cross-slide by means of a block *O* held in the T-slot cut in the cross-slide, by a block *Q* and two fillister screws *P*. The gears *L* and *M* are held on studs *R* and *S* fitted with bronze sleeves on which the gears rotate. These bronze sleeves are provided with oil grooves, and oil holes are drilled through the studs, so that a copious supply of oil is given to the bearings.

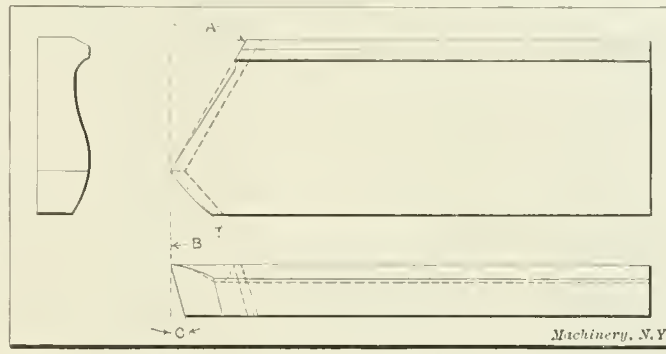


Fig. 22. Shaving Tool for Forming Long Work

The operation of this attachment is as follows: As the cross-slide advances, the rack *N* attached to it, rotates gear *M* which, in turn, through gear *L* and rack *J*, forces the slide *D* in as indicated. Slide *D* is returned to its former position in a similar manner, when the cross-slide drops back. The circular tool *E* follows a diagonal line of travel, so that the point on the work is turned to the correct angle. Thus a very fine point can be made on the work, as no pressure is brought to bear on the part being severed, the weight of the work alone breaking it off.

An angular turning tool which is constructed on a different principle from that shown in Fig. 20 is shown in Fig. 21. This tool is held in the turret, and is operated by a rising block held on the cross-slide. The construction of this tool

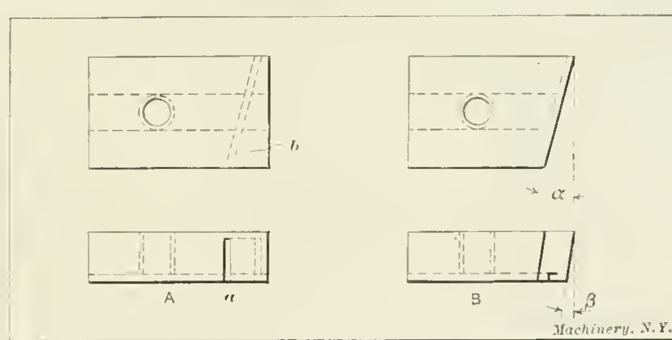


Fig. 23. Type of Shaving Tool used in the Shaving-tool Holder shown in Fig. 24

is as follows: Attached to the body *A* by a shouldered screw *B* is a plate *C*. Tapped into plate *C* is a screw *D*, checked by a nut *E*. The sliding member *F*, fitting over dovetailed ways formed on the angular face of the holder *A*, is attached to the block *C* by means of a screw *G*. The tool-holder *H* is made integral with the sliding member *F*, and holds the turning tool *I*, which is held in a slot cut in the holder, by two headless screws *J*, and rests on a pin *K*.

In operation, as the rising block presses on the screw *D* it swivels block *C* on screw *B*, and as block *C* is attached to slide *F* by screw *G*, it carries the slide along the face of the tool-holder, thus turning the recess in the work as shown at *L*. When the rising block drops back, the tool-slide *F* is returned by a coiled spring *M* held in the body *A*, through a spring plunger *N* pressing against a pin *O* held in the sliding member *F*. A gib and adjusting screws are also provided to make allowance for wear and the free movement of the slide. A bushing *P* held in the body of the holder by a screw *Q* supports the forward end of the work, while the recess is being turned. An angular

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cutting-off tool which is held in the turret and operated on by a rising block was illustrated and described in the June, 1908, number of MACHINERY.

Shaving Tools

When forming work of irregular contour, in the automatic screw machines, it is common practice to use a shaving tool, which is operated tangentially to the work and passes either under it or over it as conditions may require. It is customary, however, to place the shaving tool on the rear cross-slide, so that the shaving operation can be accomplished at the same time as the turret operations, when the spindle is running forward.

Shaving tools are made from tool steel containing a high

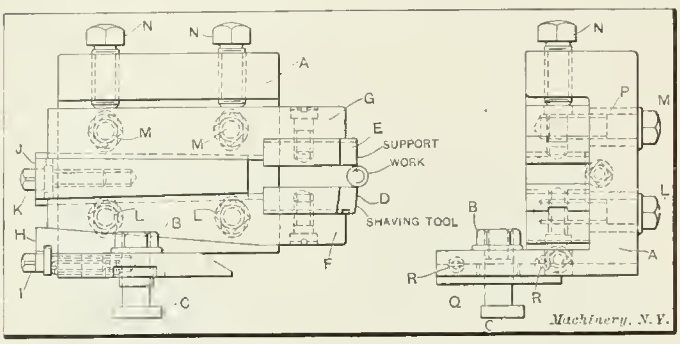

Fig. 24. Shaving-tool Holder which can be used for a Wide Range of Work

percentage of carbon, on the top face of which is formed the irregular contour to be reproduced on the work. High-speed steel, as a rule, does not give very satisfactory results, owing, no doubt, to the fact that to get the best results from this steel, high peripheral velocities must be used. When high peripheral velocities are used, the extreme cutting edge of a high-speed steel tool becomes ragged and will not produce a smooth finish. A brand of steel which has been found very satisfactory for shaving tools is Bohler's special Styrian steel. This steel is extremely fine-grained and produces a high finish on the work. The surface speed, of course, cannot be as great as if a tool made from high-speed steel were used; but this

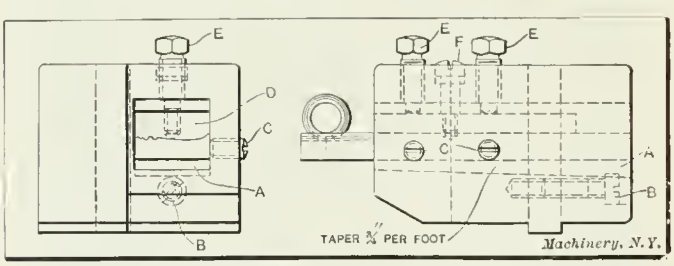

Fig. 25 Shaving-tool Holder of the Box Type

has very little effect on the production of the automatic screw machines where accurate and finished work is the chief requisite.

It is not necessary when applying a shaving tool to the work to incline it at an angle to the horizontal plane to any great extent. The best results are obtained by holding the tool practically parallel, so that when passing under the work the forward end of the tool is at approximately the same height as the rear part. This produces a smooth finish on the work, as the shaving tool burnishes it after removing the material. Holding a shaving tool practically in a parallel plane, obviates the needless and difficult calculations which would be necessary to obtain the shape of the tool if the tool were inclined at an angle.

Shaving tools are used to follow a circular forming tool and produce a smooth finish as well as to completely form the work, finishing it without having rough formed it with any other tool. Where the work has not been roughed down previous to shaving, a larger cutting angle is necessary, and if the work is long in proportion to its diameter the tool should be ground with two cutting angles A and B, as shown in Fig. 22, so that the extreme point of the tool will be where the greatest amount of material is to be removed. This produces a shearing cut and removes the material more easily. The angles on the type of shaving tool shown in Fig. 22 for cutting the materials specified are as follows:

Material	Cutting Angles in Degrees
Brass rod	$A = 20$, $B = 30$, $C = 10$;
Machine steel	$A = 30$, $B = 40$, $C = 15$;
Tool steel	$A = 40$, $B = 50$, $C = 15$;

While the shaving tool shown in Fig. 22 is used extensively on the automatic screw machines, it is difficult to harden because of its length. If sufficient care is not exercised it will be distorted, and where the contour is of such a shape that it is impossible to grind after hardening, this becomes an objectionable feature. A shaving tool which does not present the same difficulty in hardening is shown in Fig. 23. This shaving tool is a short block which is held in the holder shown in Fig. 24. A support is also provided so that the work need not be supported from the turret except when the length being shaved is long in proportion to the diameter. Owing to the rigidity of the support, the cutting angle can be less than the angle A shown in Fig. 22. The cutting angles on the shaving tool shown in Fig. 23 for cutting the various materials are as follows:

Material	Cutting Angles
Brass rod	$\alpha = 10$ deg. $\beta = 10$ deg.
Machine steel	$\alpha = 15$ deg. $\beta = 15$ deg.
Tool steel	$\alpha = 20$ deg. $\beta = 15$ deg.

The chief use of this tool is for finishing the work after it has been rough formed with a circular form or other external

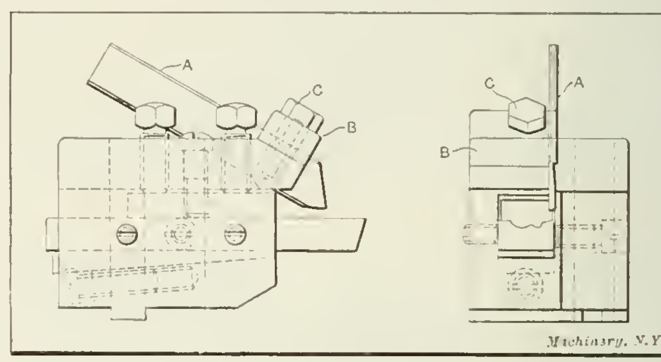

Fig. 26. Combination Cut-off and Shaving-tool Holder

cutting tool. As a support passes over the work after shaving, a burnished appearance is the result; of course, it is absolutely necessary to have the faces of the shaving tool and support polished if good results are to be expected. The first step in making the shaving tool shown in Fig. 23 is to form it into a block as shown at A. A saw slot a is cut at the desired angle, so that the part b can be broken off after the shape required is milled on the top face and the tool hardened and polished. The polishing can be accomplished in a milling

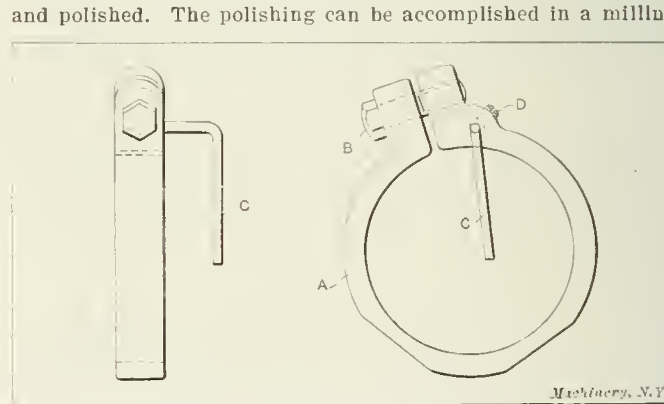

Fig. 27. Ejector used in Connection with the Shaving-tool Holder shown in Fig. 26

machine by holding a piece of brass or copper in a chuck, the outer end of the brass being formed to the contour of the tool. Emery is applied to this lap, and by running the carriage back and forth with the shaving tool held in the vise, a very smooth finish can be obtained. After the tool is polished the part b is broken off and the tool ground as shown at B. By leaving the part b on until the tool is polished, the cutting edge will not be rounded and the tool can be more easily polished.

For cutting machine or tool steel it is preferable to make the shaving tool thinner at the rear end to provide for clearance. Making the tool from 0.001 to 0.0025 inch thinner at the rear than at the front end, gives the desired result. This can be accomplished by packing up the rear end when milling the form on the tool. This type of shaving tool when used on steel should not be used for rough forming, but for finishing only—that is, the work should be rough formed before shaving. Fly-cutters are used in making this tool when

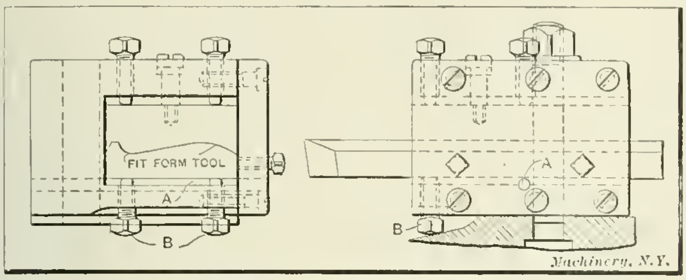

Fig. 28. Shaving-tool Holder for Long Work

the contour is very irregular; but when a large number of tools is to be made it might be advisable to make a formed milling cutter.

When the work is rough formed before shaving and the shaving tool is only used for finishing, the amounts to be removed from the diameters are as follows:

Diameter	Amount to Remove in Inches
1/16 – 1/8	0.0050
1/8 – 3/8	0.0075
3/8 – 5/8	0.0100
5/8 – 7/8	0.0150

Shaving-tool Holders

It is necessary to hold a shaving tool rigidly if good results are to be expected, and if the work is small in diameter in proportion to the length being shaved, it is also necessary to use a support. A shaving-tool holder which will be found satisfactory for this class of work is shown in Fig. 24. This holder is held on the rear cross-slide and consists of a machine-steel body *A*, which is held to the cross-slide by means of the nut and bolt *B* and *C*, the latter fitting in the groove in the cross-slide. The shaving-tool block and support *D* and *E* are held to the two members *F* and *G* by fillister screws as shown. A tongue is formed on members *F* and *G* which fits in grooves cut in the shaving block and support.

The gib *H* is provided for raising the shaving tool *D* to the correct height, being operated on by the collar-screw *I*, fitting into a slot in the gib and screwed into the base of the holder *A*. The gib *J* is provided for increasing and diminishing the distance between the shaving tool *D* and the support *E*, thus governing the diameter of the work. A collar-screw *K*, fitting in a slot cut in the gib *J* and tapped into the holder, is used for adjusting the gib. When members *F* and *G* are set correctly, they are held in the body *A* by means of screws *L*, *M* and *N*. Elongated slots *P* are provided in holder *A*, so as to allow screws *L* and *M* to be moved up and down, which provides for adjustment for different diameters.

The ordinary adjustable block provided in the toolposts for holding circular tools is also provided in this holder. This block *Q* is adjusted by the screws *R*, and is used for setting the side of the shaving tool parallel with the face of the chuck. The front edge of the support *E* should have the same face angle as the shaving tool *D*, but should be set a distance equal to 1/40 of the diameter of the work back from the face of the shaving tool.

It is obvious that a shaving-tool holder of the type shown in Fig. 24 can be used for a wide range of work. The only parts to be made when using it for a different piece of work are the shaving tool and support. The wide range of adjustment also provides for the shaving of different diameters. By making the blocks *D* and *E* of various thicknesses to suit the diameter of the work, a still greater increase in the different diameters that can be shaved is possible.

In Fig. 25 is shown a shaving-tool holder for holding a shaving tool of the type shown in Fig. 22, which is operated from the rear cross-slide. This holder is of the box type, and a tapered gib *A* is provided for adjusting the tool for various heights, which is actuated by the fillister screw *B*, fitting in a slot cut in the gib and screwed into the holder. Set-screws *C* are used to prevent lateral movement of the shaving tool, and a pad *D* operated on by two set-screws *E* is used to hold the shaving tool down on the adjustable gib. This pad *D* is made with the same contour on its lower face as the shaving tool, so that it will hold the latter rigidly. Where the contour of the tool is of a difficult shape to make, it is customary to have the pad bear only on two or three points, which obviates the necessity of putting any more time on the pad than is really necessary. A screw *F* is provided for holding the pad when the shaving tool is removed. The shaving-tool holder is held to the cross-slide in the same manner as the circular-tool holder.

A shaving-tool and cut-off-tool holder combined are shown in Fig. 26. This type of holder is used when the other cross-slide is occupied by a forming tool. The construction is similar to that shown in Fig. 25, except for the additional provision for holding the cut-off tool blade *A*. This is held in a groove cut in the holder, by a block *B* which, in turn, is held by the cap-screw *C*. When using a combination shaving and cut-off tool of this kind, provision has to be made so that the work when cut off will not stay on the shaving tool. A simple

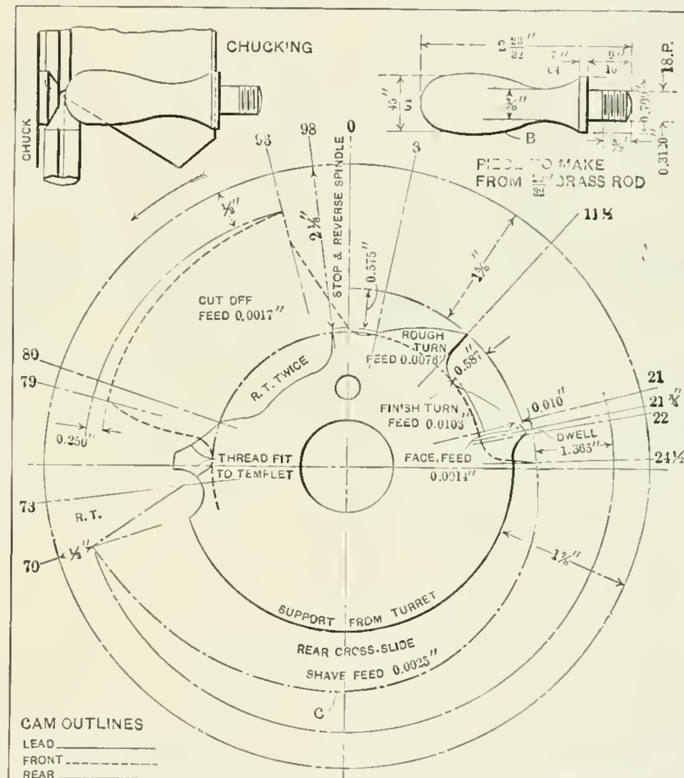

Fig. 29. Cams for making a Handle which is formed by a Shaving Tool

device for overcoming this difficulty is shown in Fig. 27. This consists simply of a split ring *A* which is held on the hood over the chuck by the cap-screw *B*. A wire rod *C*, which is so located that it will remove the work from the shaving tool when the cross-slide drops back, is held in the ring *A* by a headless screw *D*.

In Fig. 28 is shown the holder which was used for holding the shaving tool shown in Fig. 22. This holder differs somewhat from those previously described in that provision is made for raising the front end of the shaving tool. The shaving tool rests on a pin *A* and is adjusted by two set-screws *B*. The object in making this adjustment is to provide for clearance, which is necessary on account of the wide bearing surface. The work for which this shaving-tool holder was designed is shown at *B* in Fig. 29, where the cams for making the piece are also shown. The piece *B* is made from brass and the irregular-shaped part is completely formed by the shaving tool. The lobe which operates the shaving tool is shown at *C* on the rear cross-slide cam. Numerous other designs of shaving tools could be shown, but those described illustrate the types generally used for this class of work.

Speeds and Feeds for Shaving

As a rule, shaving tools can be operated at the same speed as circular form tools, the speeds for which were given in the article entitled "Circular Form and Cut-off Tools" in the March and April, 1910, numbers of MACHINERY. However, as there is more cutting surface in contact with the work, extra precaution should be taken to see that the tool is copiously supplied with lard oil. Provision should also be made for removing the chips, thus avoiding the rough work, which would result should chips become lodged on the face of the shaving tool.

The feed at which a shaving tool can be operated satisfactorily is governed largely by the following conditions:

1. Amount of material to be removed from the diameter.
2. Character of the material.
3. Angle of the cutting edge.
4. Length of the work in proportion to the diameter.

The amount of material to be removed from the diameter should, to a large extent, govern the angle of the cutting edge, and is a more important factor than is the nature of the material. Owing also to the extra amount of cutting surface and insufficient clearance, a shaving tool cannot be fed at the same rate of feed as a circular form tool can. That is to say, to remove the same amount of material from the diameter requires a greater number of revolutions with a shaving tool than with a circular form tool. Where the length of the work is more than three and one-half times its diameter, a support should be used. Provision is made for this in Table VI, and it should be understood that the feeds given under the heavy lines should be used only when the work is supported.

TABLE VI. FEED PER REVOLUTION FOR SHAVING TOOLS

Width of Shaving Tool, in Inches	Smallest Diameter to be Shaved, in Inches										
	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8
1/4	0.0025	0.0030	0.0035	0.0040	0.0045	0.0050	0.0060	0.0080	0.0100	0.0120	0.0150
5/16	0.0020	0.0025	0.0030	0.0035	0.0040	0.0045	0.0055	0.0075	0.0095	0.0115	0.0145
3/8	0.0015	0.0020	0.0025	0.0030	0.0035	0.0040	0.0050	0.0070	0.0090	0.0110	0.0140
7/16	0.0010	0.0015	0.0020	0.0025	0.0030	0.0035	0.0045	0.0065	0.0085	0.0105	0.0135
1/2	0.0025	0.0010	0.0015	0.0020	0.0025	0.0030	0.0040	0.0060	0.0080	0.0100	0.0130
5/8	0.0020	0.0008	0.0010	0.0015	0.0020	0.0025	0.0035	0.0055	0.0075	0.0095	0.0125
3/4	0.0015	0.0030	0.0035	0.0010	0.0015	0.0020	0.0030	0.0050	0.0070	0.0090	0.0120
7/8	0.0010	0.0025	0.0030	0.0040	0.0010	0.0015	0.0025	0.0045	0.0065	0.0085	0.0115
1	0.0008	0.0020	0.0025	0.0035	0.0045	0.0010	0.0020	0.0040	0.0060	0.0080	0.0110
1 1/8		0.0015	0.0020	0.0030	0.0040	0.0008	0.0015	0.0035	0.0055	0.0075	0.0105
1 1/4		0.0010	0.0015	0.0025	0.0035	0.0050	0.0010	0.0030	0.0050	0.0070	0.0100
1 3/8		0.0008	0.0010	0.0020	0.0030	0.0045	0.0060	0.0025	0.0045	0.0065	0.0095
1 1/2			0.0008	0.0015	0.0025	0.0040	0.0055	0.0020	0.0040	0.0060	0.0090
1 5/8				0.0010	0.0020	0.0035	0.0050	0.0015	0.0035	0.0055	0.0085
1 3/4				0.0008	0.0015	0.0030	0.0045	0.0010	0.0030	0.0050	0.0080
1 7/8					0.0010	0.0025	0.0040	0.0080	0.0025	0.0045	0.0075
2					0.0008	0.0020	0.0035	0.0075	0.0020	0.0040	0.0070
2 1/8						0.0015	0.0030	0.0070	0.0015	0.0035	0.0065
2 1/4						0.0010	0.0025	0.0065	0.0010	0.0030	0.0060
2 3/8						0.0008	0.0020	0.0060	0.0100	0.0025	0.0055
2 1/2							0.0015	0.0055	0.0095	0.0020	0.0050

It is obvious from the foregoing that the feed should be decreased when the cutting angle is decreased and, on the other hand, the feed should be increased when the cutting angle is increased. The feeds given above the heavy lines in Table VI are applicable to shaving tools having the angles given in reference to Fig. 22, while the feeds below the heavy lines are for shaving tools having the angles given in reference to Fig. 23, and also for the angles given in reference to Fig. 22 when a support is used. When a shaving tool and support of the type shown in Fig. 24 are used, the feeds above the heavy lines in Table VI can be increased 50 per cent with satisfactory results.

* * *

We all respond more or less to the rhythm of motion and sound. So, it is hard to find a laggard in a hustling shop and impossible to keep a spirit of hustle in a draggy one.

TAPS AND TAPPING*

By "A"

Two or three years ago the readers of MACHINERY were treated to some interesting and ably-written articles on taps, their use, and the methods of making them; the contributor of these interesting articles must have thought that he imparted in them all the knowledge it is good for us to have regarding these all-important tools, as we have since been looking in vain for some more such material. It was, therefore, with all the more interest that the writer read the article in the May number of MACHINERY entitled "Square-threaded Taps," dealing with the troubles encountered when using them, and the elimination of some of these difficulties.

The object of the writer in presenting this article to the readers of MACHINERY is to suggest further means and methods for making not only square-threaded taps, but taps with any form of thread, whereby the ultimate object—a straight-threaded hole and a smooth and correctly formed thread—may be obtained. When a smooth and straight-threaded hole is of minor importance and is not necessary, one tap made as outlined by the former contributor will meet the requirements, and is, of course, most economical, as far as the making of the square-threaded tap is concerned. When, however, the threaded hole must be straight and smooth, a different type of tap is required, and where the pitch and lead are coarse, more than one tap is necessary.

Fig. 1 shows a set of taps (1½ inch diameter, 2 square threads per inch) made as the writer would recommend, whereas Fig. 2 shows a set of these taps as generally made. Fig. 5 illustrates the action of the two kinds of taps, and shows the portion of metal that each tap in the set cuts away in the nut. A set of taps made as shown in Fig. 1, with the first tap in the set made as outlined by the contributor in the May number (not indicated in this engraving) will, if otherwise well and properly made, produce the desired results mentioned above. It will be noted that each succeeding tap in the set is cut with a narrower tool, the finishing tap being cut with a tool of the correct width, thus making the teeth

* For additional information on taps and tapping, see the following articles previously published in MACHINERY: "Square-Threaded Taps," May 1911; "Squares on the Ends of Taps and Reamers," April 1909; "Stove-Bolt Taps," March 1909; "The Manufacture of Taps," January and February 1909; "Special and Adjustable Taps," July 1908; "Taper Taps," March and April 1908; "Testing the Lead of Taps and Screws," January 1908; "Acme and Square Thread Taps in Sets," November 1907; "Oversize Limits of Taps," August 1907; "Adjustable Reamers and Taps with Inserted Blades," July 1907; "Remarks on the Making of Hand Taps," June and July 1907 (and the articles there referred to); "Hobs and Die Taps," March 1907; "Machine Taps," February 1907; "Formulas for Determining the Proportions of Taps," January 1907; "Tapper Taps," December 1906; and "Hand Taps with Standard Threads," July 1905.

of each succeeding tap in the set wider, so that each tap will finish the sides of the thread in the nut as well as the bottom. As the amount cut on the sides is not great—merely sufficient to remove any irregularities left by preceding taps and at the same time to smooth up the sides—a hole will be tapped which will leave very little to be desired. Taps as regularly made, as shown in Fig. 2, will invariably produce holes with threads as indicated to the right in Fig. 5; hence, they should not be used when accuracy and smoothness of action between screw and nut are desired, as the bearing surfaces between the screw and nut are but a couple of ridges.

The difficulties encountered when trying to obtain a good square-threaded hole will also be encountered, in a somewhat

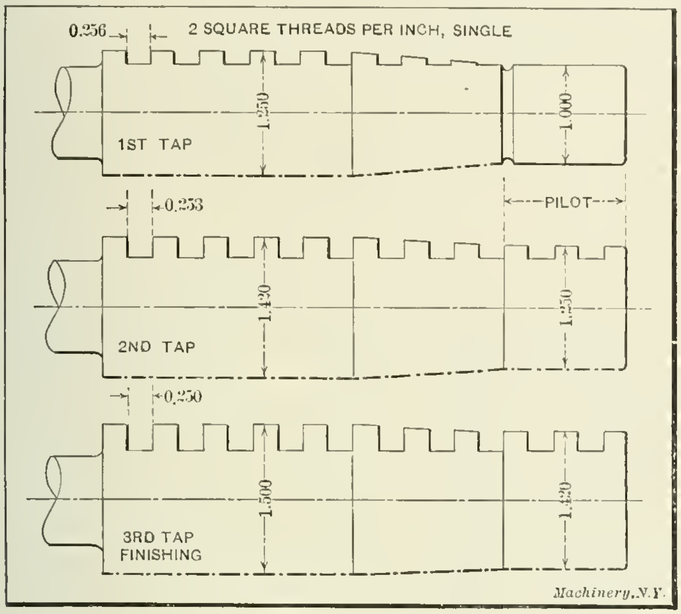

Fig. 1. Set of Square-threaded Taps made as recommended

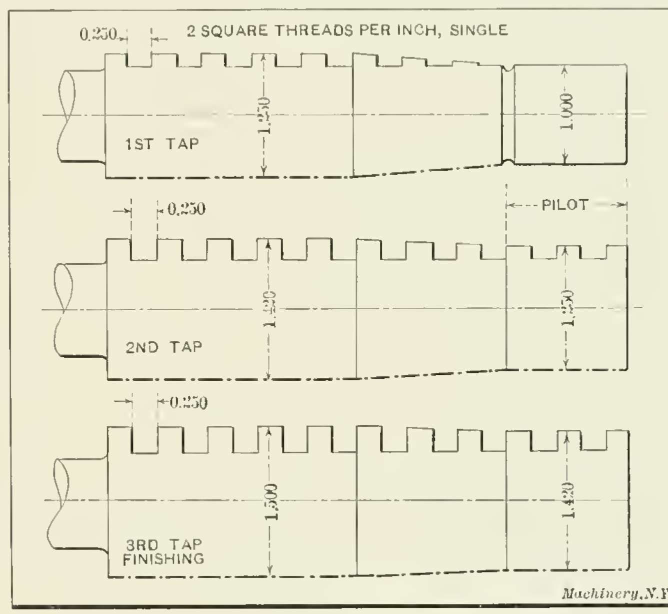

Fig. 2. Set of Square-threaded Taps as ordinarily made

less degree, when trying to produce, with a tap, a good hole with any form and shape of thread. The writer will endeavor to point out in the following some of the defects of taps as generally made, and the means for eliminating these defects, special reference being made to the production of good taps, even if at present they would cost more than taps as now made or manufactured. The makers of taps, however, finding that the remedies suggested actually will cure the defects in the taps and tapped holes, will soon find a way of making the

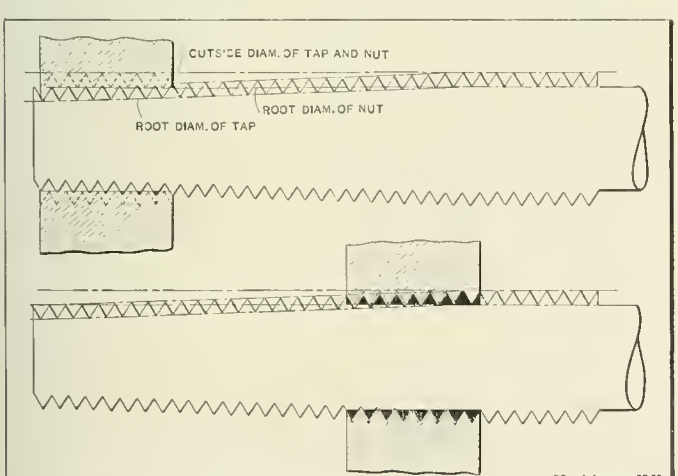

Fig. 3. Tap Threaded with Taper in Bottom of Thread so as to require no Additional Chamfer on the Top of the Thread

more perfect taps with little or no increase in cost over taps as now manufactured.

One of the most commonly found defects in nearly all kinds of taps (hand taps, nut or tapper taps, machine taps, taper die taps, stay-bolt taps, etc.) is the large amount of reaming they are called upon to do when entering the hole to be tapped, and before "taking hold." Any tap user knows that it requires more or less pressure on the tap to make it grip, the amount of this pressure being dependent upon the way in which the tap is made at its small end or point, that is, at the end of the tapered or chamfered portion. It will always be found that the more pressure required to make the tap take hold, the more reaming will be done, and the larger will be the end of the hole being tapped; the result will always be a hole tapered not only at the root of the thread, but in most cases in the angle of the thread as well. Figs. 3 and 6 show the two extreme ways in which taps can be chamfered or tapered, and in Fig. 4 is shown a method embodying a happy medium between the two. When considering the "taking-hold" property of taps and the amount of reaming they do before taking hold, it will be understood and seen at a glance when referring to the illustrations, that a tap made like that in Fig. 6 must do a great deal of reaming before taking hold in the nut, owing to the wide points on the top of the thread at the end of the tap. It is equally clear that a tap made like that in Fig. 4 will do much less reaming than will a tap made like that in Fig. 6, owing to the fact that the top of the thread at the end of the tap is considerably narrower. A tap made like that in Fig. 3 will have no opportunity whatever of reaming, as the sharp points of the thread immediately take hold in the hole. It must be admitted that a tap made like

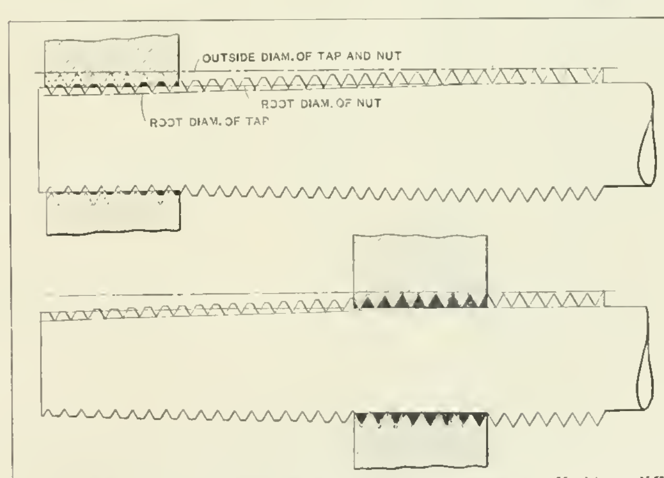

Fig. 4. Recommended Method of Making Taps

that in Fig. 3 is the ideal one to use if the securing of a straight-threaded hole were the only requirement. As, however, a straight hole is not the only thing required—the finish being an equally important factor—a tap made like that in Fig. 3 is not an ideal one, when all conditions are considered; before giving the reason, however, let us look into how the three different kinds of taps have been made.

To more clearly illustrate the conditions, a nut has been shown at the end of each of the three taps, indicating the

amount of metal cut away in the nut when the whole width of the nut has been engaged by the small end of the tap. All the taps must necessarily be small enough on the point to enter the hole in the nut, which, for the sake of convenience, will be considered as being the exact root-diameter. It will be found that taps like that in Fig. 6, are exactly identical with the first or taper taps in a set of hand taps as generally made; that is, the thread is not tapered in the angle, but has the same root diameter the whole length of the threaded portion, and all the cutting is done by the outside of the chamfered portion. Taps made like that in Fig. 3 have been tapered in the angle of the thread an amount equal to the double depth of the thread (when considering the diameter), making a full thread all the way up on the chamfered portion. Taps such as shown in Fig. 4 are made in a similar manner, but the taper in the angle of the thread is equal to the single depth of the thread only. As this tap, as will be explained later, is the ideal one to use when all conditions are taken into account, the writer has prepared the accompanying table, for obtaining the angle and root diameter at the point of taps so made; this table gives the constants to deduct from the standard diameter (on the straight part) to get the angle and root diameter at the point for different pitches and forms of thread.

As was mentioned before, straightness is not the only requirement for a well threaded hole, because the finish of the thread is of equal importance. It is evident that the less metal the tapered portion of the tap nearest to the straight part is required to remove, especially if the metal to be removed is distributed all around the thread as shown by the lower views in Figs. 3 and 4, the smoother and better will the finish of the thread be. The lower views in Figs. 3, 4 and 6, of the same taps as are shown in the upper views of the same illustrations, indicate the exact relation between tap and nut, when the nut is ready to engage the straight portion of the thread. From the amount of metal left to be cut away, shown by dotted lines in the illustrations, it may readily be seen that a tap made as shown in Fig. 6 has a very much smaller amount of metal to cut away than have taps made like those shown in Figs. 3 and 4, but it will also be noticed that the metal left to be cut away is on top of the thread only, exactly the same condition existing as that shown to the right in Fig. 5; the thread is thus likely to be left "ragged" on the sides. Taps like those shown in Figs. 3 and 4, as will be seen from the illustrations, have metal left to cut away all around the thread (shown by dotted lines). The amount left, however, for a tap made as shown in Fig. 3, is too great, and a tap so made will invariably produce a poorly finished thread in the hole. The best tap to use when considering smoothness and finish, is that in Fig. 4; this tap, as will be seen, has metal to cut away all around the thread, the same as the tap in Fig. 3, but the amount left to be cut away is not excessive and, therefore, not detrimental to the finish of the thread. A tap so made is the best one to use, even if it does not take hold in the hole as readily as will a tap made as shown in Fig. 3. The amount of reaming done by a tap thus made is also so small as to be scarcely perceptible.

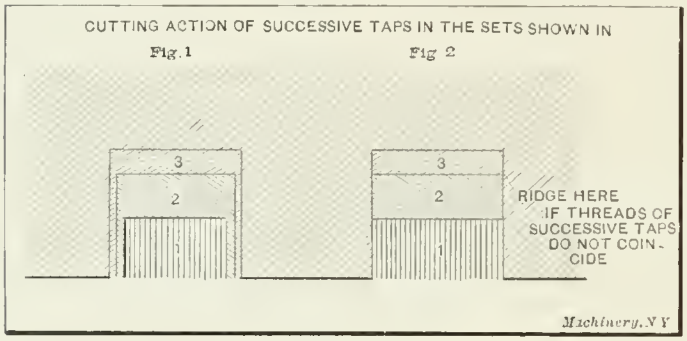

Fig. 5. Action of Taps shown in Figs. 1 and 2

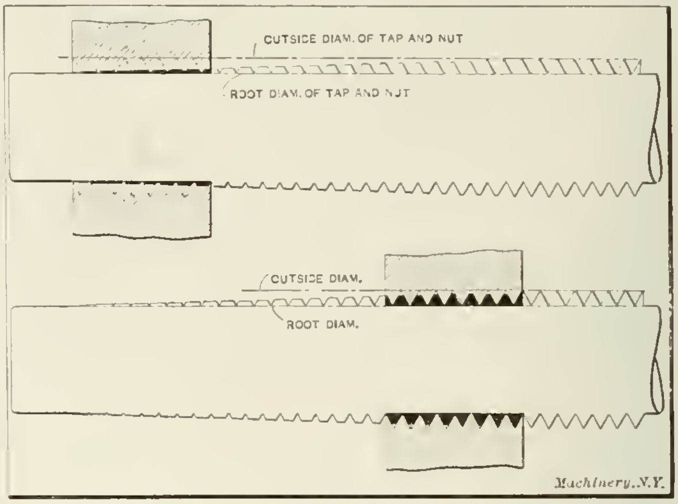

Fig. 6. Tap Chamfered on Top of Thread, having no Taper at Root of Thread

While the writer has seen and used taps made as outlined in Fig. 4, he has sometimes found that they produced poorly threaded holes; the reason for this was not, however, to be found in any incorrect principle of the taps, but was an entirely different one. As it is very simple, but produces a great deal of trouble, it should be mentioned and a remedy suggested, for even prominent tap makers have failed to take notice of it in such taps as machine taps, long taper die taps, etc. The tap shown in Fig. 4 is generally first threaded straight after having been chamfered; the taper attachment is then set over to the proper taper, and the thread-tool matched in with the straight threads. As this "matching" is done by the eye, it may readily be seen that no matter how carefully the tool is matched in, there is sure to be some

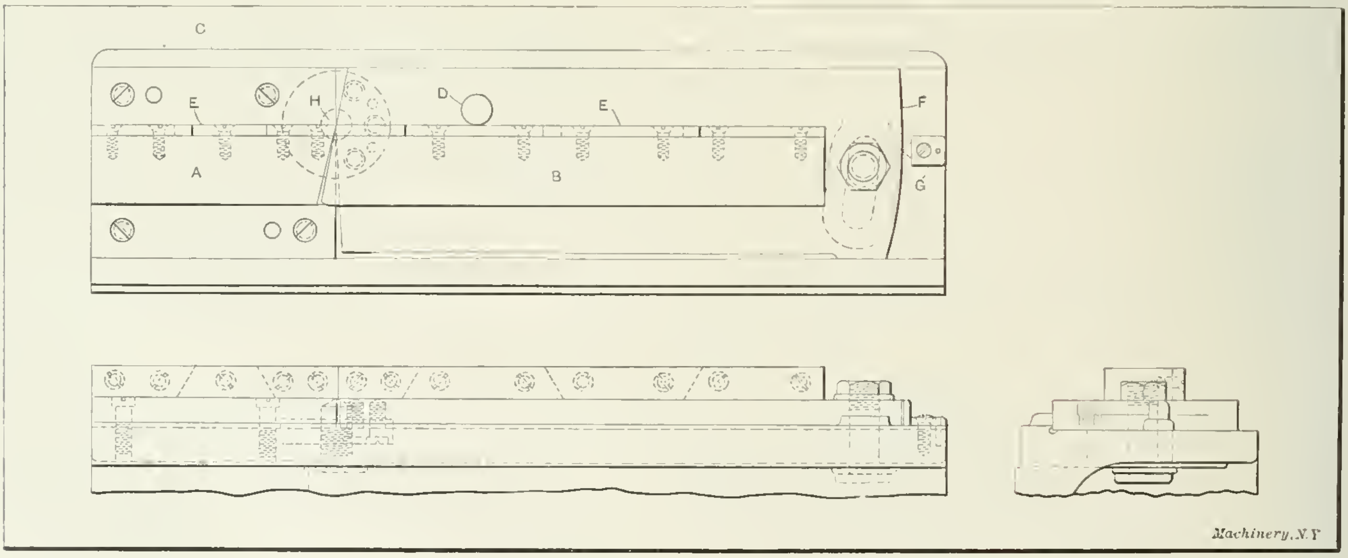

Fig. 7. Taper Attachment for Threading Taps of the Type shown in Fig. 4

error in the matching of the two threads. This error will always cause the taps to bind when reaching the point where the taper thread joins with the straight thread. The threads on the straight part of the tap will also cut on the sides, owing to this error, with the result of a very poor form of thread in the nut, it being generally cut away on one side. To avoid this difficulty, it is necessary to cut the straight and the tapered portion at one setting. When making only one or two taps, this can, of course, be easily accomplished in an ordinary lathe by connecting and disconnecting the taper bar for each tap, without, of course, disturbing the tool. When making taps in quantities, however, this method would not be permissible, owing to the length of time it would consume, and the consequent excessive cost of the taps.

In order to make these taps at a reasonable cost, however, both operations should be performed at one setting. This can easily be accomplished by means of a special taper bar similar to that shown in Fig. 7. This taper bar has a member *A* fixed to base *C* and parallel to the line of centers of the lathe; another member *B* may be set over to any desired taper. This movable member *B* is pivoted at *H*. The center of the stud *H* is located at the center of that edge of the bar against which the taper-bar block or roll *D* travels, and must of necessity be so located, in order that—no matter how much the movable bar is set over—no opening will be produced between the fixed and the movable members of the bar. It will also be noticed that the edge of the bar against which the block or roll travels has steel strips *E* fastened to it, hardened so as to take care of any wear. The outer end *F* of the adjustable member *B* is graduated, and has a pointer *G* to indicate the taper.

A taper bar made as shown should prove to be a valuable addition to any lathe, for, as may be more fully understood from the illustrations, it can do any taper work equally as well as the attachments furnished with regular commercial lathes, and it has the added feature of being able to turn or thread at one setting both straight and tapered parts. The construction might, of course, require some changes for different makes of lathes, but it is safe to say that the changes, additions and modifications made necessary by the adding of such a bar would be many times repaid, considering the extensive use to which a lathe so provided could be put.

* * *

ADVANTAGE OF ASSEMBLING STANDS

When machine tools and other machines are built according to the unit system of construction, that is, when the various mechanisms used in the complete machine are assembled as a whole by themselves, and then these various previously-assembled mechanisms are ultimately assembled to form the completed machine, it makes it very convenient for the assemblers and accelerates the work to a great extent, if assembling stands of an appropriate nature are provided. In several shops in the Middle West, convenient stands are provided for assembling gear boxes, lathe aprons, etc., the stands usually being of a very simple construction, consisting merely of a slight column on the top of which is mounted some kind of an angle plate, joined to the upright in such a way that it can swivel about it in a horizontal plane, and be raised to various positions in the vertical plane. By using such stands the assembler can quickly, and without undue exertion, place the parts in the most advantageous position for rapid and accurate work. He does not need to lift the heavy pieces, thus wasting time and strength. The stands should be placed in an open space, so that the assembler can walk around them and work in any position about the stand that is most convenient.

CONSTANTS TO BE DEDUCTED FROM THE STANDARD DIAMETER OF THE STRAIGHT PART OF THE TAP TO OBTAIN ANGLE AND ROOT DIAMETER AT STRAIGHT PART AND AT POINT OF TAP

Number of Threads per Inch	United States Standard Thread*			Theoretical V-thread*			Whitworth Thread*		
	For A. D., Straight Part	For R. D. Straight Part, and A. D. at Point	For R. D. at Point	For A. D., Straight Part	For R. D., Straight Part, and A. D. at Point	For R. D. at Point	For A. D., Straight Part	For R. D., Straight Part, and A. D. at Point	For R. D. at Point
64	0.0101	0.0203	0.0304	0.0135	0.0271	0.0406	......	......	......
62	0.0105	0.0210	0.0315	0.0140	0.0280	0.0420	......	......	......
60	0.0108	0.0216	0.0324	0.0144	0.0288	0.0432	0.0107	0.0213	0.0320
58	0.0112	0.0224	0.0336	0.0149	0.0298	0.0447	......	......	......
56	0.0116	0.0232	0.0348	0.0155	0.0309	0.0464	......	......	......
54	0.0120	0.0240	0.0360	0.0160	0.0320	0.0480	......	......	......
52	0.0125	0.0250	0.0375	0.0167	0.0334	0.0501	......	......	......
50	0.0130	0.0260	0.0390	0.0173	0.0346	0.0519	......	......	......
48	0.0135	0.0271	0.0406	0.0180	0.0360	0.0540	0.0133	0.0267	0.0400
46	0.0141	0.0282	0.0423	0.0188	0.0376	0.0564	......	......	......
44	0.0148	0.0295	0.0443	0.0197	0.0394	0.0591	......	......	......
42	0.0155	0.0310	0.0465	0.0206	0.0412	0.0618	......	......	......
40	0.0162	0.0325	0.0487	0.0217	0.0434	0.0651	0.0160	0.0320	0.0480
38	0.0171	0.0342	0.0513	0.0228	0.0456	0.0684	0.0169	0.0338	0.0507
36	0.0180	0.0361	0.0541	0.0241	0.0481	0.0722	0.0178	0.0356	0.0534
34	0.0191	0.0382	0.0573	0.0255	0.0510	0.0765	0.0188	0.0377	0.0565
32	0.0203	0.0406	0.0609	0.0271	0.0542	0.0813	0.0200	0.0400	0.0600
30	0.0216	0.0433	0.0649	0.0289	0.0578	0.0867	0.0213	0.0427	0.0640
28	0.0232	0.0464	0.0696	0.0309	0.0618	0.0927	0.0229	0.0458	0.0687
26	0.0250	0.0500	0.0750	0.0333	0.0666	0.0999	0.0246	0.0493	0.0739
24	0.0271	0.0541	0.0812	0.0361	0.0722	0.1083	0.0267	0.0534	0.0801
22	0.0295	0.0590	0.0885	0.0391	0.0788	0.1182	0.0291	0.0582	0.0873
20	0.0325	0.0650	0.0975	0.0433	0.0866	0.1299	0.0320	0.0640	0.0960
18	0.0361	0.0722	0.1083	0.0481	0.0962	0.1443	0.0356	0.0712	0.1068
16	0.0406	0.0812	0.1218	0.0541	0.1082	0.1623	0.0400	0.0800	0.1200
14	0.0464	0.0928	0.1392	0.0619	0.1238	0.1857	0.0457	0.0915	0.1372
13	0.0499	0.0999	0.1498	0.0666	0.1332	0.1998	0.0493	0.0985	0.1478
12	0.0541	0.1082	0.1623	0.0722	0.1444	0.2166	0.0531	0.1068	0.1602
11	0.0590	0.1181	0.1771	0.0787	0.1574	0.2361	0.0582	0.1164	0.1746
10	0.0649	0.1299	0.1948	0.0866	0.1732	0.2598	0.0640	0.1281	0.1921
9	0.0722	0.1443	0.2165	0.0962	0.1924	0.2886	0.0712	0.1424	0.2136
8	0.0812	0.1624	0.2436	0.1083	0.2166	0.3249	0.0800	0.1601	0.2401
7	0.0928	0.1856	0.2784	0.1237	0.2474	0.3711	0.0915	0.1830	0.2745
6	0.1082	0.2165	0.3247	0.1443	0.2887	0.4330	0.1067	0.2134	0.3201
5½	0.1181	0.2362	0.3543	0.1575	0.3150	0.4725	0.1164	0.2328	0.3422
5	0.1299	0.2598	0.3897	0.1732	0.3461	0.5196	0.1281	0.2562	0.3843
4½	0.1443	0.2886	0.4329	0.1925	0.3850	0.5775	0.1423	0.2846	0.4269
4	0.1624	0.3248	0.4872	0.2165	0.4330	0.6495	0.1601	0.3202	0.4803
3½	0.1856	0.3711	0.5567	0.2474	0.4948	0.7422	0.1830	0.3660	0.5490
3¼	0.1998	0.3996	0.5994	0.2665	0.5330	0.7995	0.1970	0.3940	0.5910
3	0.2165	0.4330	0.6495	0.2887	0.5774	0.8661	0.2134	0.4269	0.6403

* A. D. = angle diameter; R. D. = root diameter

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Fred. H. Moody,
Associate Editors

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

JUNE, 1911

PAID CIRCULATION FOR MAY, 1911, 26,205 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

WHEN BUSINESS IS QUIET, PUSH HARDER

It is surprising what a difference push will make in business results. In a comparison of two concerns of equal size and resources and with products of equal quality, let one concern lie on its oars and wait for business to revive before making any more than the usual effort, while the other concern just doubles its push for business. What will a comparison of the two businesses show at the end of a year, and is the one that has fallen behind likely to regain its loss?

In which class do you belong?

* * *

MANUFACTURERS' RIGHTS

The policy of some manufacturers in the machinery industry, as well as in others, who have endeavored to fix the price at which their product should be sold by dealers, was recently overturned by a decision of the Supreme Court in connection with the sales of patent medicines at cut rates, which allows the manufacturer to fix the price to the distributor, but denies him the right to regulate the price at which the distributor shall sell. The general tendency in all trades and industries is to widen rather than to restrict competition; and this decision will increase and confirm this tendency.

Generally speaking, a reduction in price, whether by cutting or otherwise, stimulates demand; but price cutting, especially when the sale of a product is comparatively limited, as is the case with machine tools and small tools, is more likely to demoralize business than to increase it. It means simply that one dealer is trying to get ahead of another, and the eventual result is that every dealer reduces his price until he reaches a point where he can no longer handle the product without loss. This is certainly not a desirable condition in any industry.

While the manufacturer no longer has a legal right to control distributors' prices, the heroic remedy which was applied by a well-known concern is always open to him. In the case in question the agency was discontinued, and orders amounting to some $300,000 were cancelled because of persistent price cutting on the part of the agent.

STANDARDIZATION OF AUTOMOBILE STOCK PARTS

If all the valuable papers read before the American Society of Mechanical Engineers were forgotten and all its work of standardizing engineering practice were lost except that of formulating and adopting the United States or Sellers standard screw threads—and thus bringing order out of the chaos of screw pitches—the mechanical world would still be in debt to the society. The annual saving in the cost of manufacturing machinery and appliances of all kinds due to the simplification of this detail alone can hardly be overestimated.

The standardizing of mechanical details has become a paramount issue in every field; and we note with great satisfaction that the Society of Automobile Engineers—one of the youngest of the engineering bodies—has undertaken the task of simplifying the mechanical details of automobiles. The need of this work is great, and few outside of the industry have a full knowledge of the immense number of sizes and varieties of common automobile parts. For instance, there are three or four hundred sizes of automobile lock washers between 3/16 and ½ inch, more than there should be; and manufacturers must make and carry a great variety of unnecessary stock sizes, thus considerably increasing the cost to the user. Clearly both makers and users will be benefited by cutting out useless sizes.

The great variety of details in automobile construction is the result of individual initiative without proper guidance. Designers and draftsmen lacked standards to guide them, and worked out the details to suit their own ideas. It is the aim of the society to compile a handbook of standard practice that will be a guide to automobile designers, and they should and doubtless will use it in the same way that engineers employ the handbooks compiled by the various steel companies. The steel handbooks list the sizes of I-beams, channels, and other structural shapes regularly carried in stock, and the engineer chooses the stock sizes whenever possible, avoiding the delay and extra expense incident to ordering special shapes. In the same way the automobile designer will consult the handbook of automobile standards and avoid choosing a special size of tubing, for instance, for which his concern will have to wait a long time and pay a higher price. Instead he will choose the tubing size nearest to his requirement that is carried in stock.

The aim of the society in the work of standardization is not to restrict original research or design which may result in real improvement, but to place in the hands of designers data that will enable them to avoid the selection of parts which must be made specially and which have no real advantage over the standard parts. The value of this work, we repeat, can hardly be overestimated; and every engineer connected in any way with the automobile trade should lend his influence to promote it.

* * *

COURTESY RETURNS DIVIDENDS

Our observation shows that machinery firms which are noted for their courtesy in receiving visitors, and which freely show their works and methods—within reasonable limits—are generally the most progressive and successful manufacturers in the industry; and the contrary is usually, but not always, the case.

The American method in this respect is quite rapidly extending to European works; and one of our editorial representatives who made a tour of Continental Europe several years ago found that most of the well-known firms did not object to showing their plants and explaining their shop methods. Some of our manufacturers say that their courtesy has been abused by foreign competitors who have visited the plants in this country for the purpose of obtaining ideas surreptitiously to use in turning out imitations of our machines; but we are satisfied that these cases are the exception. It is impossible to keep ordinary shop methods secret in a large plant where a skilled workman can readily obtain a job and in the course of a few months familiarize himself with most of the shop methods and devices in use there.

It is a valuable advertisement for any firm to be spoken of as one where the visitor is well received, and where he is welcome to increase his store of general mechanical knowledge by a circuit of the works. No matter how good the product of a manufacturer may be or how high his standing, an added advantage is gained by being well known for the courteous treatment of visitors.

* * *

NEED OF PRACTICAL APPRENTICESHIP INSTRUCTION

So much attention is being given to the technical instruction of apprentices that there is danger of neglecting the practical manual part of their training. The report of the apprenticeship committee of the National Metal Trades' Association, read by Mr. E. P. Bullard, Jr., chairman, at the recent convention in New York City, sounded a warning note, and the opinion was expressed that while many boys no doubt require school-room work, technical instruction should not be given at the cost of thorough manual training.

"The time has long passed when it is enough to sign a boy, and inform him, as a man in charge of a hardening room informed his successor some twenty-five or thirty years ago: 'Here is the coal; there is the leather; the furnace stands in the corner; the rest is in the air.' It is necessary that systematic work be done in the instruction of the apprentice; work should be carefully laid out in a manner to give him progressive training. His mental training should also be attended to. But it may be there are cases where it would be fully as profitable to the young man and the community if less educational work were tried and more attempted in the way of direct manual teaching.

"The purpose of training an apprentice is to make him a skilled workman, and according to the trend of the trades at the present time where specialization is becoming so pronounced, it is a case of training workmen to become so skilled in their work that they can readily take under their charge and impart to others that knowledge of their skill which makes these other men, men who are not able to become completely educated, best skilled in the class of work that they have to do. There are cases of men who have a varied technical education with but little manual training, who are making most successful leaders of men; but where one such man as this is required, hundreds are demanded who must give not only of their technical knowledge, but of their skill acquired by manual labor oft repeated."

The training that teaches a boy to think as he works, that enables him to use his hands skilfully, and through acquired skill to apply his powers intelligently, is the ideal. More is actually learned by performing a simple task than can be gained from any number of lectures on it. Learning that is of real value is acquired through the hands. But having acquired manual skill, personal efficiency is greatly increased by absorbing the theory of practice also. The teaching of theory and practice should go hand in hand; and for the mass, if not for all, the object should always be to promote manual skill in the practice of an art rather than mere knowledge of it.

* * *

DESIGN OF MULTI-TUBULAR BOILERS OF THE MARINE TYPE*

In the following are given a number of formulas for the design of multi-tubular boilers, the accompanying Data Sheet Supplement containing tables calculated from these formulas and other information useful in the design of this type of boiler.

Thickness of Boiler Shell Plates

The boiler shell should have its longitudinal seams double-riveted, and the rivet holes drilled. A formula commonly used for determining the minimum thickness of the boiler shell plates is as follows:

$$T = \frac{P \times D}{24{,}000}$$

in which

T = thickness of plate,

P = boiler pressure (gage) in pounds per square inch,

D = inside diameter of boiler in inches.

The thicknesses of plates for boilers from 2 to 16 feet in diameter, and for pressures from 80 to 250 pounds per square inch, calculated by this formula, are given in Table I of the accompanying Data Sheet Supplement. These plate thicknesses are the minimum thicknesses permissible.

* With Data Sheet Supplement.

Dimensions of Stay-bolts

Standard stay-bolts are provided with twelve V-threads per inch, the diameter of the stay-bolts ordinarily varying from ¾ to 1½ inch. In Table II of the accompanying Data Sheet Supplement, the effective diameter of stay-bolts, the corresponding area, and the permissible tensile stress, are given. The stress is based on a permissible load of 6000 pounds per square inch. The same table also gives the maximum area in square inches which can be supported by one stay-bolt at various pressures per square inch, when the stress in the stay-bolt does not exceed 6000 pounds per square inch.

Spacing of Stay-bolts on Flat Surfaces

The pitch or spacing of the stay-bolts may be determined by the formulas given in the following. For fireboxes, furnaces, and back-connections, the two formulas below are used:

$$p = \sqrt{\frac{T^2 \times 112}{P}} \text{ for } \tfrac{7}{16} \text{ inch plate and less,}$$

$$p = \sqrt{\frac{T^2 \times 120}{P}} \text{ for plate over } \tfrac{7}{16}\text{-inch thick}$$

in which

p = pitch or spacing of stay-bolts, in inches,

T = thickness of the boiler plate expressed in sixteenths of an inch; for example, if the thickness of the boiler plate is ¾ inch, then $T = 12$; if the thickness is ⅞ inch, then $T = 14$, etc.,

P = gage pressure in pounds per square inch.

For the boiler heads the formula is:

$$p = \sqrt{\frac{T^2 \times 140}{P}}$$

In this case there are nuts both inside and outside of the plate.

These formulas may be modified for special cases. When the stay-bolts in the boiler heads are provided with a washer riveted to the head, having a thickness of at least one-half of the thickness of the head plate, and a size equal to at least seven-eighths of the pitch of spacing of the stay-bolts, or when the heads have a reinforcing plate riveted either on the inside or on the outside, covering the area stayed, and equal in thickness to at least one-half of the head plate, then

$$p = \sqrt{\frac{(T + t \times 0.8)^2 \times 200}{P}}$$

in which

T = thickness of head plate in sixteenths of an inch, as before,

t = thickness of washer or reinforcing plate, in sixteenths of an inch.

The formula just given can also be used when the head is fitted with an angle iron riveted to the plate, the thickness of the angle iron being at least two-thirds of the thickness of the head plate, and the length of the legs of the angle being at least equal to one-quarter of the stay-bolt spacing. In this case, t in the formula just given, equals the thickness of the angle iron, in sixteenths of an inch.

In Table III of the accompanying Data Sheet Supplement, values of the pitch or spacing of stay-bolts calculated by the general formulas above, are given for plate thicknesses varying from 3/8 to 15/16 inch for the fireboxes, furnaces and back-connections, and from ⅜ inch to 1¼ inch for boiler heads, the working pressures varying from 80 to 250 pounds per square inch. In some cases the values are modified from those obtained from the formulas, for practical reasons. In the illustration in Table IV in the Supplement, the arrangements of standard boiler mountings are shown. The proportion of valves, etc., per square foot of grate area are also given for grate areas varying from 2¼ to 70 square feet.

THE DRAFTING-ROOM SYSTEM OF THE AMERICAN LOCOMOTIVE CO.*

By FRED. H. MOODY†

The American Locomotive Co., in its Schenectady plant, has what is probably one of the finest drafting room systems either in America or abroad. This system was originally based on the method employed by the Baltimore & Ohio R. R. for many years in the filing of drawings, correspondence, etc. Under the Baltimore & Ohio system everything in connection with the drafting-room was arranged in such a manner as to be filed along the lines of the alphabetical system to be explained in this article. The system in use by the American Locomotive Co., while originally based upon this, has changed so materially, due to the numerous improvements that have been instituted from time to time, that it is practically a new system with nothing but the basic principle of the old system left.

The first attempt at applying this system to the American Locomotive Co. was made in 1903, just after the locomotive merger; the individual plants at first retaining their identity and carrying on their engineering staffs as before, led to much confusion in the work. It was decided in 1907 to centralize as much of the engineering work as was possible. With that object in view the Schenectady plant was selected as being the one best suited for the purpose, for not only had it the largest individual plant, but it was the most centrally located and best adapted for the purpose.

The Drafting-room

When in 1907 it was decided to move the engineering departments of the various plants to Schenectady, it was found that the local drafting-room was much too small to accommodate the largely increased staff. It was, therefore, necessary to considerably modify and enlarge the drafting-room arrangement, enlarging it by increasing the length 110 feet, making it now 350 feet long by 56 feet wide. In addition, several other floors of the building have been brought into the service.

The general arrangement of the drafting-room is fairly well shown in the accompanying photograph Fig. 1, which shows the main body of the drafting-room. At the far end is the vault and beyond is the new addition previously mentioned, about one-half of which is devoted to drafting and the other half to clerical work. At the opposite end of the room to that shown are the offices of the chief engineer and his assistants and the superintendent of the general drafting-room; while on the further side of the aisle which divides the room is the library and the correspondence and scheduling department. Within the railing in the foreground the calculating department is arranged. The desks on the left of the aisle are occupied by elevation men, while on the other side all the detail drawings are made.

The type of desks used is clearly shown in the engraving. It will be noticed that they are of a very solid construction, built into position on the floor, thereby doing away with any unsteadiness which might occur, due to the latter being uneven. The tables are of three types: single, with drawers and a three-foot wide top; double, without drawers and a six-foot wide top; and combination, with drawers and a six-foot wide top. They are all 18 feet in length.

Fig. 1. General View of Main Part of Drafting-room

Indexing the Cards

The manner of classifying the drawings, or cards as they are called, the basis upon which this system was introduced, will first be explained. This is the principal feature of the system and is one which with slight modifications might be advantageously adopted for a wide range of work. In this scheme the parts of a locomotive are divided into 90 general groups, each group being given a number, the numbers ranging from 10 to 99; thus, group 10 is "ash-pans," 11, "axles," and so on up to 99; every part of the locomotive has a number.

As before mentioned the drawings were originally made in the works where the order was to be completed. As the system was to be uniform throughout the works, some distinguishing mark had to be given to the drawings from the different plants, so for that reason the initial letter was chosen Thus "S" stands for Schenectady, "B" for Brooks, etc.

Originally there were nine sizes of drawings, but as the work has increased in size, that is to say, locomotive sizes have developed more rapidly than was anticipated, the company has been forced to adopt two new sizes for the erecting cards. The following table gives the number of sheet, size and the details for which each sheet is to be used:

No.	Size	Use
1	12 x 9	Small details and brass work.
2	12 x 18	Small details and brass work.
3	24 x 18	Details.
4	24 x 30	Cylinders, boiler sections, grates, ash pans and tanks.
5	12 x 42	Engine frames, etc., and small designs.
6	12 x 60	Engine frames, etc.

*For additional information on drafting-room systems, see the following articles previously published in MACHINERY: "Drafting-Room of the Taft-Peirce Mfg. Co.," June, 1910; "Standard Drawing-Room Methods," February, 1908 (and the articles there referred to); and MACHINERY'S Reference Series, No. 2, "Drafting-Room Practice."
† Associate Editor of MACHINERY.

No.	Size	Use
7	24 x 42	Cylinders, tender frames and tanks.
8	24 x 60	Boiler elevations and small erecting cards.
9	25 x 66	Ordinary erecting cards.
10	25 x 84	Double-ender erecting cards.
11	25 x 102	Mallet erecting cards.

This covers sizes and shapes to meet all classes of work.

The previously mentioned general groups are further subdivided. For example, the "steam pipe, etc.," group 80 is sub-divided into steam pipe, tee-heads, joint rings, etc. The "tee-heads" subdivision is given a series of numbers ranging from 2000 to 3000; joint rings, 3000 to 4000, etc. Each drawing when completed is given one of these numbers, say 1000, and at the same time all the numbers from 1000 to 1009 are allotted to it, permitting nine further tabulations to be made. Another feature of interest is the manner in which certain sized sheets are allotted to certain work; for example, "steam pipe tee-heads" can be made on sheet size number 2 only; "steam pipe joint rings," on sizes 1 and 2, etc. Experience has shown that these sizes are the best for that particular line, thereby keeping the work uniform. This classification and numbering is looked after by a special drafting-office system index which tabulates all the groups, etc., giving all the details in connection with it. The majority of drawings, however, are made on size 3, which by reference to the above table, will be seen to be the best for general purposes.

It can be seen from the explanation given that the general group number, size drawing, works at which the drawing was made, and number of the drawing in that group, represent four different factors, seemingly with but little connection; it remained to combine these groupings in some simple, logical manner that they might be readily understood. An example will show what was done: Consider group 80, card size 3, Schenectady works, card number 71,660. In the system adopted this would be written as follows: 803 S 71,660. This is readily understood, the first two figures giving the general group number; the third, the size drawing; the letter, the works; and the final group of figures, the drawing number in that group. This arrangement is shown in Fig. 2 where the drawing number is placed in the upper right-hand corner. Below, as shown, are placed the ten tabulations allotted to the drawing as previously mentioned, and opposite to it, the

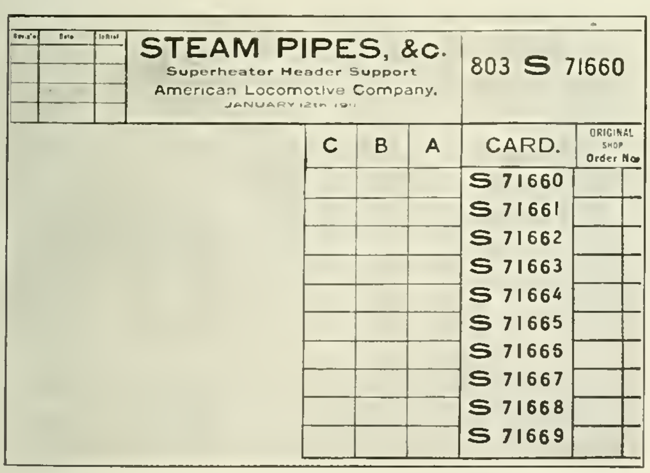


Fig. 2. Tracing Imprint, showing Method of Grouping into General- and Sub-divisions

original shop order number. Should any dimensions be lettered, the space to the left will be ruled to suit, as indicated; however, these tabulations are usually additions.

Immediately to the left of the drawing number is a space containing the name of the group and the sub-group, the company and the date. In the example, "steam pipes, etc.," corresponds to 80 and "superheater header support" corresponds to the sub-grouping 71,000 in general group 80. Further to the left in the small tabulations shown, is a space to be filled in case of any future revision of the drawing. All this corner piece of the drawing is printed in the local press room so that the work is absolutely uniform. Electrotypes of the different headings and sub-headings are kept in stock, so that no mistake in giving the titles can occur.

Record Prints and Blueprint Folios

As is customary in most drafting-rooms, the tracings were used for reference purposes until quite recently, when a new system of record prints was introduced. It was found that the constant handling of these tracings had a very bad effect, in many cases requiring their renewal long before it should have been necessary. Under this new scheme an extra blueprint is made from each tracing, on which, during the blueprinting process a large R, two inches high, is printed, with this legend directly below in good sized letters:

This is the Record Print
Must be treated as an Original
Return to vault promptly

In this way the tracings are saved; they cannot be taken from the vault except when absolutely necessary for changes, retabulating, etc. These record prints, being kept automatically

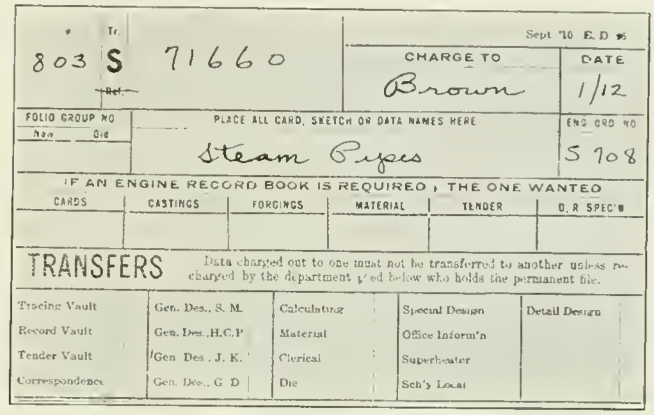


Fig. 3. Vault Slip, for use when taking Drawing from Vault

up-to-date by the blueprint department, are authoritative and serve their purpose equally as well as the tracings. While additional expense is incurred from having to make this extra print, it is more than compensated for by the diminished wear and tear on the tracing.

Further records are kept in the form of blueprint folios, which are loose-leaf books of the blueprints arranged according to their general groups and sizes. These are very convenient for the draftsmen in looking over previous records of what has been done in any particular line.

Vault

The vault for holding all permanent records is located at the end of the old portion of the building, as previously mentioned, and on account of the new addition is now about midway down the drafting-room. The majority of tracings are kept in the vault on the main floor, the only ones not kept there being those belonging to the tender department, which are kept in the vault adjoining that department on the floor above. The main vault has two floors containing tiers of shallow drawers in which the tracings are kept with respect to group, different sized drawers being used according to tracing sizes. These tiers of drawers are so arranged around the wall as to be conveniently gotten at by the clerks. In this vault are also kept any permanent records, such as specifications and the books for castings, patterns, cards and material. The reference prints previously mentioned are kept in tiers of drawers in a room adjoining the vault. Not being of a permanent nature, they do not require to be kept in the fireproof vault, from which they are excluded by reason of the lack of space. The card, pattern, casting and material books, are kept in the vault, arranged according to order number.

Anything in the vault or its adjoining room is let out on an order such as shown in Fig. 3; this card is self-explanatory. It will be noticed that everything kept in the vault is included on this one order card; for example, in the upper left-hand corner, either tracing or reference sheet may be called for by striking out the one not desired, or a folio may be taken out by marking its number; the "old" column has reference to prints made previous to the installation of this new system. Any of the record books may be taken out by checking the one desired. It will be noticed throughout, on

all forms, that whenever possible, checking is used instead of the usual method of writing a name; this proves to be more expeditious in nearly all cases, as well as obviating confusion from poor writing. At the bottom of the card are shown the transferring arrangements, whereby the charge may be removed from the party against whom it is posted, to any of the departments listed, by checking the proper department. As these orders come in they are filed vertically in boxes according to group and their order in the group, where the vault clerk has a record of the location of any particular tracing or reference sheet should it happen to be out of the vault. Upon the return of the tracing, the charge is removed and the slip destroyed.

Each of the principal draftsmen has a light wooden box 20 by 28 by 5 inches deep, in which all tracings are kept while being made, as well as drawings that are awaiting inspection. Each night these boxes around the drafting-room are collected and placed in the vault so that no records of a permanent nature are left around where they may be destroyed.

Personnel

The engineering department is directly in charge of a chief engineer and his assistant and the superintendent of the general drafting-room. Under these come the assistant engineers of whom there are over a dozen. Working in conjunction with all these engineers are three consulting engineers, who supervise the more important designs, or those involving new features; in all other cases, they act in an advisory capacity, assisting in the design when required. They are independent of the general drafting room, reporting directly to the head office in New York. The actual drawing is distributed among eight assistant engineers, four of them in charge of elevation design and four in charge of detail; the detail engineers look after groups of details, their department being divided into smaller sections under section leaders.

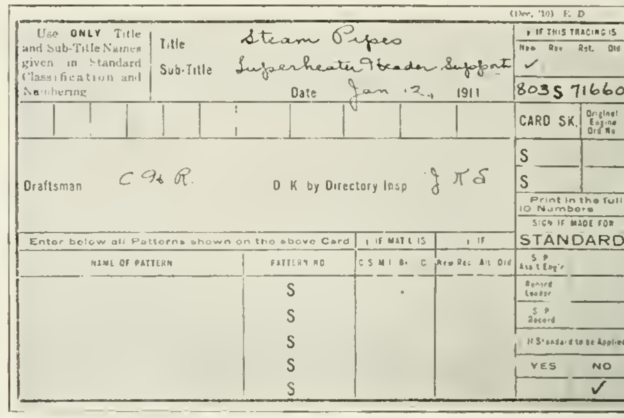
In addition to the assistant engineers who look after the actual drawings, there are assistant engineers in charge of each of the other departments, such as the material, forgings and dies, standard, office information and calculating departments. All these assistant engineers are on an equal footing, consulting each other when any question regarding a design arises. Matters that cannot be settled in this way are taken to the superintendent of the general drafting-room, the chief engineer or his assistant.

Specifications and Scheduling

The best way to obtain a clear understanding of the workings of the system is to follow an order through the engineering department. The engineering department in New York draws up a contract specification between the purchasing parties and the company; as a rule this is general in its nature and does not enter very deeply into detail. Each order is given a number; thus, "B 783" means Brooks, order number 783. A similar plan is adopted for the other works. A copy of the contract specification with an order to construct is forwarded to the chief engineer at Schenectady, who appoints one of his assistant engineers of elevation to look after the design. Just previous to this, however, the specification is given to an assistant engineer in charge of office specifications and scheduling. This engineer compiles more definite data from the contract specification, elaborating thereon in a special form supplied for that purpose; this form consists of a number of printed pages arranged in the same group order number as previously explained; complete data, as regards material, size of parts, etc., is given in this drafting-room specification. On its front page there is a table containing all of the vital data in connection with a locomotive, such as type, size and kind of cylinders, wheels, etc. As in general these specifications differ but slightly from those to be seen in any engineering office, no further explanation will be given.

While these specifications are being compiled, the process of scheduling the work is under way. The contract specification usually states a time delivery for the locomotives. The form for scheduling is shown in Fig. 4, which shows the schedule card for the locomotive on an 80-day basis; similar cards are made out for the tender. On this schedule form complete information is given, but the principal feature to be noted, however, is the scheduling. All the productive work is divided into three general groups: "A," material and specifications; "B," new and old patterns and flanging dies; and "C," cards and sketches.

A little consideration will make it clear that different lengths of time are required for making any particular part, depending upon such factors as the amount of machine work, whether it is purchased on the outside, and other equally important considerations. From long experience the company has been able to form a general schedule showing how long previous to the delivery date it is necessary to have the different details ready. This has been prepared in the department for various delivery periods, ranging from 105 down to 40 days, the former length of time being generally required


(Dec. '10) E. D

Use ONLY Title and Sub-Title Names given in Standard Classification and Numbering

Title: Steam Pipes

Sub-Title: Superheater Header Support

Date: Jan 2, 1911

If this tracing is: New | Rev | Rst. | Old — ✓ (New)

803S 71660

CARD SK. | Original Engine Ord No

Draftsman: C. H. R. — O K by Directory Insp: J. T. S.

S / S

Print in the full 10 Numbers

Sign if made for STANDARD

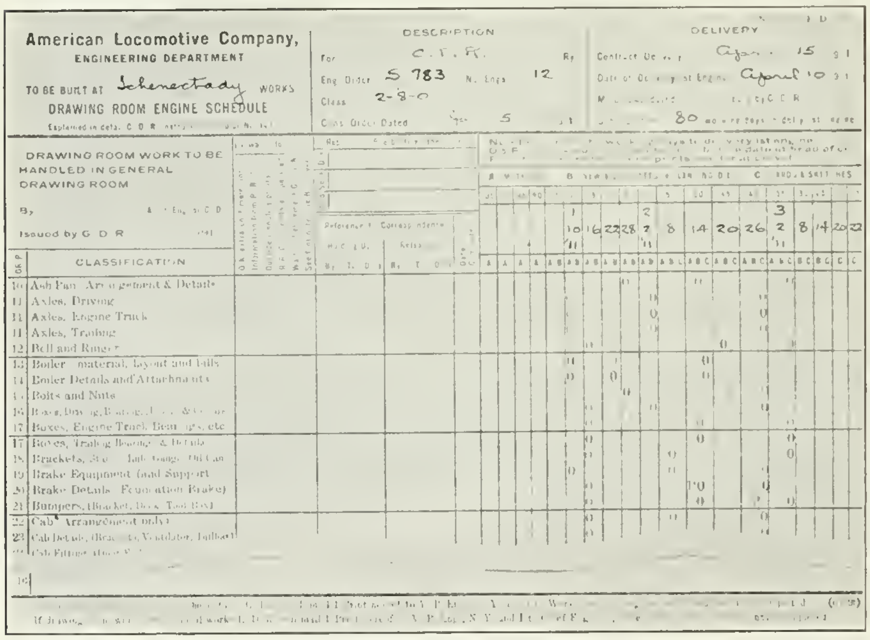
Enter below all Patterns shown on the above Card

NAME OF PATTERN	PATTERN NO	C S M I Br C	New Rec Alt Old
	S		
	S		
	S		
	S		
	S		

S P Ass't Eng'r; Record Leader; S P Record

If Standard to be Applied: YES | NO — ✓ (NO)

Fig. 6. Imprint Order Card to be sent to Press Department with Tracing


American Locomotive Company, ENGINEERING DEPARTMENT

TO BE BUILT AT Schenectady WORKS

DRAWING ROOM ENGINE SCHEDULE

DESCRIPTION — For: C. P. R.; Eng. Order: S 783; No. Engs: 12; Class: 2-8-0; Cons. Order Dated: 5

DELIVERY — Contract Del.: Apr. 15; Date of Delivery 1st Engine: April 10; 80

DRAWING ROOM WORK TO BE HANDLED IN GENERAL DRAWING ROOM

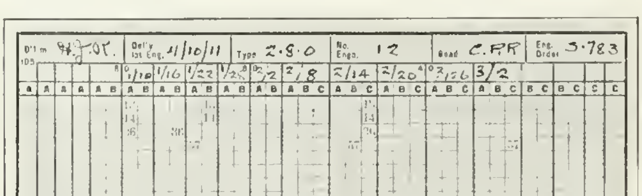
Issued by G. D. R.

Schedule heads: A, B, C; 10, 16, 22, 28, 2, 8, 14, 20, 26, 2, 8, 14, 20, 22

CLASSIFICATION

10 Ash Pan Arrangement & Details
11 Axles, Driving
11 Axles, Engine Truck
11 Axles, Trailing
12 Bell and Ringer
13 Boiler material, layout and tails
14 Boiler Details and Attachments
15 Bolts and Nuts
16 Boxes, Driving ...
17 Boxes, Engine Truck, Bearings, etc.
17 Boxes, Trailing Bearings & Details
18 Brackets ...
19 Brake Equipment (and Support
20 Brake Details (Foundation Brake)
21 Bumpers, (Bracket, Box, Tool Box)
22 Cab (Arrangement only)
23 Cab Details, (Brackets, Ventilator, ...)

Fig. 4. General Schedule of Engine for the Drafting-room


Drwn. H. J. W. | Del'y 1st Eng. 4/10/11 | Type 2-8-0 | No. Engs. 12 | Road C.P.R. | Eng. Order S-783

2/10, 1/16, 1/22, 1/28, 2/2, 2/8, 2/14, 2/20, 2/26, 3/2

A A A A B A B A B A B A B A B A B C A B C A B C A B C A B C B C B C C C

Fig. 5. Minor Schedule Card for Section Use

for new designs, while a repetition order may be completed within the latter time period, from the fact that in the latter case all drawings, patterns, etc., are ready. Consider an 80-day delivery: From this general schedule the engineer knows just how much time any part requires; from a computing calendar a date for any number of working days ahead can be readily determined. Take, for example, "axles" on an 80-day basis; the material for these must be ordered among the first things. This is shown by the cipher opposite "axles" under list "A" of the 80-day column. The date is placed in the vacant space just above, under the squares containing "75, 70, 65, 60," etc.; these dates are 5, 10, 15 and 20 working days ahead. It will be noticed that the dies for this order on the axles are required on the date set at 60. All cards and sketches must be gotten out on the date corresponding to 40 days. This schedule is kept by the scheduling department, which keeps in touch with all the other departments and sees that the schedule is lived up to. When the allotted time elapses, if the schedule is broken, inquiries are set on foot to ascertain the cause of the delay. When notification of the completion of each of the scheduled events occurs, the square is blocked out; the unblocked squares are the ones to be watched.

Minor cards, such as are shown in Fig. 5, are made up for distribution to the different drawing departments. For example, the one shown is given to the section getting out groups 13, 14, 36 and 57. It shows the day on which their work is expected, and that department is held responsible should the order fall behind on that date. These are usually dated a day or more ahead, in order to give that department time to transfer the drawings, etc., to the next.

Long cards, 22 inches in length, sections of which are shown in Fig. 7, are given to the material department—a separate strip for each order. When each part is completed, as with the other cards, the space is blocked out. The unblocked spaces on the date for which it is specified, are then followed up to ascertain the cause of the delay. The work in all departments is therefore automatically kept moving through at the proper rate.

Elevation and Detail Department

During the time that the work is being scheduled, the assistant engineer of elevation who has charge of the particular order, is making the elevation drawings of the locomotive, which usually include a side view, end view and several cross-sectional views, as well as a partial view from below. This design is purely tentative until passed upon by the calculating engineer, as will be explained later.

When well under way, the engineers in charge of detail are called in; they prepare detail drawings of the parts that come under their respective departments. Such details as the frames, grate arrangements and erecting cards are looked after by the elevation engineer, as the whole arrangement of the locomotive must be considered more particularly in the preparation of these parts.

In the detail department, when a drawing is completed, a slip such as is shown in Fig. 6, is attached to the card or tracing; on it are written the title, sub-title and date. It is then passed to a clerk whose duty it is to record the tracings, and give the drawing a number. It is then sent up to the printing department where a title as shown in Fig. 2 is printed on the drawing in the manner before explained. The drawing is returned to the detail department there checked, and if found correct from its standpoint, is passed to the elevation engineer. The elevation engineer, when it reaches that stage, re-checks the drawing as regards clearance with other parts, etc.; he is then through with it. This checking need not be further explained, being common to all drawing-rooms.

As the elevation engineer passes upon the drawings and finds them to be correct, before sending them on from his department, he enters the drawing numbers in what is called the "Card Book." This card book has the order number in large letters on the cover and is printed throughout with names of parts in the group order number just explained. All that is necessary then is to enter the drawing number opposite the name of the part.

Tender Department

The tender designs are handled in a similar manner except that in this case there is only one engineer in charge of both elevation and detail, who looks after the drawings as they come through in a similar manner to the one explained for the locomotive drawings. The tender department is independent of the rest of the drawing-room and has its own vault where its drawings are kept and from which they cannot be taken except by special order from the general drawing-room superintendent. A card book for tender parts is kept in a similar manner to that explained for the locomotive cards.

Calculating Department

All calculations come under a distinct department, so that the draftsmen have no computations to make. The work of this department commences immediately after the first lines of the locomotive are laid down. When the outlines of the locomotive have been drawn in by the elevation engineer, the calculating engineer goes over this outline and by comparison with drawings of locomotives of a somewhat similar build, is enabled to determine just how the weight of the locomotive is going to be distributed over the wheelbase, and whether this distribution will conform with that specified in the contract specification. The elevation engineer cannot proceed with the design until this information has been determined; so experienced have the engineers become through long practice that an arrangement seldom needs to be changed. If, for example, however, the boiler must be moved back, or other similar change made, the extent of this movement is determined by the calculating department so that the elevation engineer has no figuring to do in the matter, merely following what has been laid down by the calculating department.

While the principal work of this department is to regulate the distribution of weights, other work is also done such as determining the strength of different members—as for example axles, piston-rods and connecting-rods—and the determination of counterbalances, coal and water capacities, strength of springs and designs of brakes. This department must keep in touch with the work all the way through, from the time the order first comes into the drafting-room until the last drawing is completed. Special forms are supplied for all the calculations, so that they are retained in permanent form for future reference.

Inspection

The drawings, as they leave the elevation and tender departments, are inspected by shop men attached to each of the different departments, who examine the drawing in order to determine whether the part can be improved from a manufacturing standpoint, noting in the case of a casting, whether improvements might not be made to facilitate molding. This inspection is made with the sole purpose of facilitating manufacture and merely forms a re-checking of the drawing, for of necessity, the assistant engineers in charge are thoroughly practical men.

Die Department

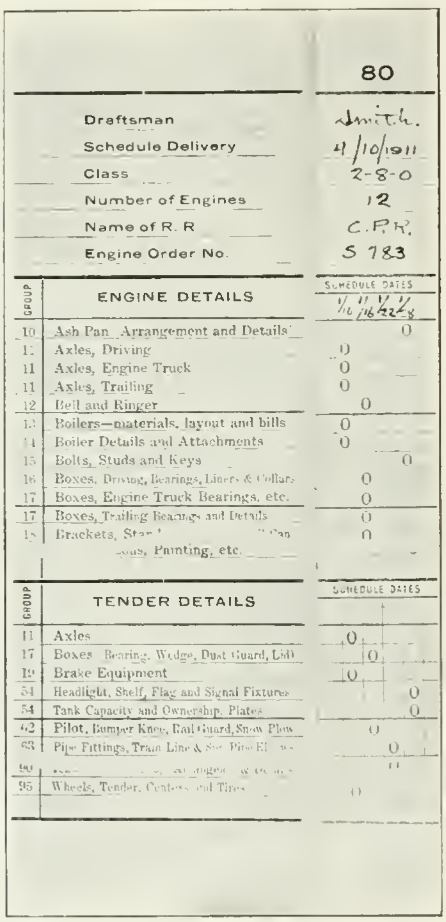
It might here be explained that in the detail department, in addition to the usual cards made of all parts, small cards called "sketches," which are not as complete in detail as the regular drawings, are made of all parts that must go through the smith shop. All sketches on being passed by the elevation men and inspectors, come to the die department where they are examined by the assistant engineer in charge of this department, who determines whether or not it would be possible to produce this part by some machine forging process, such as drop forging, bulldozing, etc. If practicable, drawings are made of the necessary dies, such as flanging dies, etc. This, of course, is not necessary in the case of drop forging work.

All plate work drawings also pass through this department to see if flanging dies cannot be preferably used to facilitate work. Just here it might be mentioned that a very complete

system of adjustable flanging dies is employed by the American Locomotive Co., which are very convenient in such places as the firebox shell, where on different locomotives, varying amounts of slope are given to the walls; having adjustable dies saves the making of many new dies for the purpose.

Most of the drawings that have to pass through the machine shop come under the inspection of the assistant engineer of the die-department, and he also determines the practicability of producing tools and jigs to increase machine shop production.

A special series of office information sheets is kept for the tools, dies and jigs. These are made out on standard M.C.B. letter-size tracing linen and are given a group number similar to the larger drawings. The principal difference is in the numbering; for example, with "tools," a "T" is added to the works signification; thus, 932 ST 510 means the tools on a Schenectady drawing. "D" and "J" are similarly added for dies and jigs. These office information sheets give the die or jig number and also the drawing number on which the die or jig has been designed. This gives a complete record in convenient form of all auxiliary appliances used in producing the work. These office information sheets are kept by this department and are filed away, a card index system, indexed according to order number and road, being used for this purpose.



80

Draftsman	Smith.
Schedule Delivery	4/10/1911
Class	2-8-0
Number of Engines	12
Name of R. R	C.P.R.
Engine Order No.	S 783

Group	Engine Details	Schedule Dates
10	Ash Pan Arrangement and Details	0
11	Axles, Driving	0
11	Axles, Engine Truck	0
11	Axles, Trailing	0
12	Bell and Ringer	0
13	Boilers—materials, layout and bills	0
14	Boiler Details and Attachments	0
15	Bolts, Studs and Keys	0
16	Boxes, Driving, Bearings, Liners & Collars	0
17	Boxes, Engine Truck Bearings, etc.	0
17	Boxes, Trailing Bearings and Details	0
18	Brackets, St[illegible] Painting, etc.	0

Group	Tender Details	Schedule Dates
11	Axles	0
17	Boxes Bearing, Wedge, Dust Guard, Lid	0
19	Brake Equipment	0
54	Headlight, Shelf, Flag and Signal Fixtures	0
54	Tank Capacity and Ownership Plates	0
62	Pilot, Bumper Knee, Rail Guard, Snow Plow	0
63	Pipe Fittings, Train Line & S[illegible]	0
90	[illegible]	
95	Wheels, Tender, Centers and Tires	0

Fig. 7. Schedule for Material Department

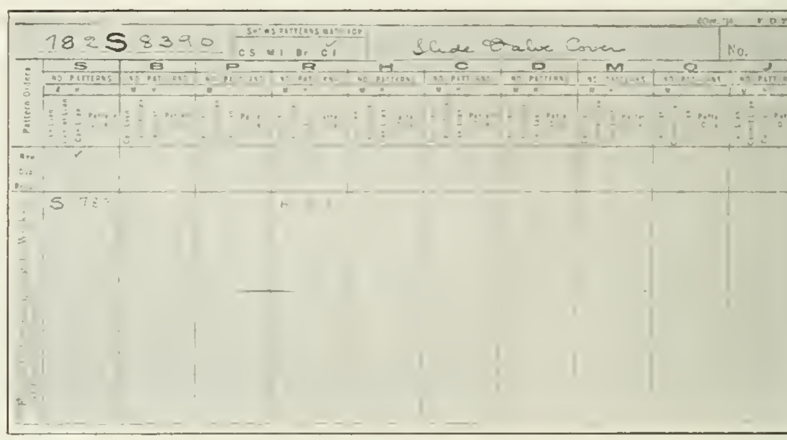


Fig. 8. Pattern Record Card

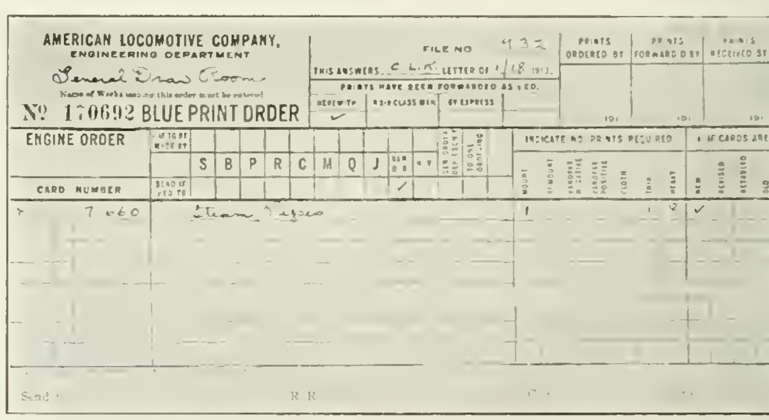


Fig. 9. Blueprint Order Slip for Ordering Blueprints

Material Department

The material department in charge of an assistant engineer makes a record of all the material required on any order; everything ordered on the outside must be recorded in a special material book. This material book is a specially printed book resembling the previously mentioned card book and is arranged in the group order number with all the principal names of parts printed therein. Complete information for the purchasing department is there given. This information is obtained from the designing draftsman in various ways. Some, depending on the nature of their work, compile bills of material which are handed over to this department to be entered in the material book, while a large part of the information is obtained directly from the cards. The results are carefully checked over by the department, so that no omissions or duplications can be possible. On account of the large amount of material obtained on the outside for the boilers and tanks, there are special material bills prepared for these, which obviate the necessity of drawings for all these parts, for the material book usually orders by drawing number.

The material book is posted with the new material requirements that come in day by day, until the time allotted on the schedule is fulfilled; at this point from 75 to 80 per cent of the material has been entered, as a rule, but as the book is called for by the schedule it must be sent forward. Just prior to the "call" day, therefore, the necessary copies are made. The original is retained in the drafting-room; one copy goes to the purchasing department; one to the stores to check the supplies as they come in; and a third to the scheduling department. To handle the balance of the material which has not been entered in the material book, there are special "Additional Material Sheet" forms which are made out in triplicate as the further material information comes in. These are made out daily and sent to the different departments to which the material book copies have been forwarded. A clerk in each of these departments then fills in the missing information and returns the sheet to the material department. In this way the books are finally completed, the material department keeping a check on this operation throughout.

Pattern Department

A very complete record of patterns is kept in the drafting-room, special forms such as are shown in Fig. 8 being used to file the records away. When a pattern has been made for any particular order such as S 783, referred to in the figure, the card shown is made out recording that fact. Patterns are numbered in a precisely similar manner to the drawings, the group, etc., being the same. When a pattern is made, a card similar to the one shown is filled out; this shows the material of which it is made and also in the three vertical and horizontal columns, whether it can be lent and whether it is new, duplicated or reconstructed. Now supposing an order went through the Richmond works, R 812, which used the same slide valve cover. A clerk at Schenec-

tady, looking up his records, would see that this pattern had been used last at Schenectady on order S 783. Notification would then be sent by the pattern clerk both to the Schenectady local works and to the Richmond works, notifying the former that the pattern was required, and the latter that the pattern they needed could be obtained from Schenectady. The charge is then removed from S 783 to R 812 as shown. The Richmond and Schenectady works then communicate with each other and have the pattern shipped from Schenectady to Richmond. Should it so happen that the pattern was in use at Schenectady, word to that effect would be sent to Richmond and the latter works would then be required to make a new pattern. When this is done notice to that effect is sent to the pattern clerk at the general drafting-room who records a new pattern under the same number, on the same sheet, by another check mark in one of the nine squares. The next order coming in, which requires the same part would then have two pattern selections from which to choose. While this feature appears to be rather complicated, a little examination will show that it is remarkably simple.

Blueprint Department

When the elevation draftsman has finished with the newly made tracing, before it passes on to the die department, etc., a blueprint order form such as shown in Fig. 9 is attached to the tracing. This gives the tracing number, name and number of blueprints required. If it is not a new tracing but is already in the vault, the order form goes directly to the vault and the tracing is charged against the blueprint room. The time the order was received, the time it leaves, and the clerk filling the order, are marked on the form, which then goes with the tracing to the blueprint room. Here it is again inspected for any clerical omission such as signatures, etc., when it is given to a clerk who schedules it.

The blueprinting is done by piece-work in large electric printing machines. The system is so arranged that blueprints pass in a direct line from the printing machine to the washing machines and on through the dryer over an endless chain, and are deposited at the far end where they are sorted. When the last blueprint has been printed, a boy takes the tracing and order from the printing machine to the sorting table where the order is checked with the number of blueprints made; the blueprints then pass out to the party ordering them. This order form is made out in quadruple: one copy is kept by the party ordering; one comes back with the prints; a third is held by the blueprint department until the fourth, which has been returned with the prints, has been signed by the party ordering them. The delivery and receipt are thus automatically checked. Something like 1200 prints a day go through the blueprint department with practically no confusion.

The blueprint department also makes vandykes, one of which is sent to each of the works for every drawing made, so that each drawing office has a complete record.

Standardizing

A special department is devoted exclusively to standardizing the details of the locomotive. Until recently there was a special series of drawings devoted to this line of work called the "A" drawings, this letter being used in place of the "S" or "B," etc., employed in ordinary drawings. This system was found to be faulty in that a drawing once made and lettered "A" must always be considered as standard. This led to a lot of idle drawings for, as progress was made, the standards frequently changed. For that reason it was decided to drop the "A" standards and use the same lettering as on the ordinary drawings. The distinction made is that the drawing is marked "standard" below the title. By this system this standard may at any time be rescinded and the standard drawing reduced to the status of the ordinary drawing by cancelling the "standard" mark. All drawings are thus kept operative.

This department, in its work, would take a series of drawings on any particular part, group them and, so to speak, make composites, forming a uniformly varying series of articles to replace more or less unsystematic designs of similar pieces. Necessarily this could not be done with all parts, but a great many improvements have been instituted in this department and considerable saving as well as improvement in work can be traced thereto.

An assistant engineer and staff devote their full time to this work, and are constantly on the lookout for new details to be standardized. When any part has been standardized to their satisfaction, before being accepted as such, it must be passed upon by the standardization board; this standardization board is composed of all the engineers whose business it is to decide upon such subjects. If it meets with their approval, the drawing passes out as standard and must in all cases be used as such except where it conflicts with the contract specification.

Office Information Department

This department, in charge of an assistant engineer, has to deal with a lot of general office information such as the tabulation of data for ready reference, and data of insufficient importance to bring before the standardization board. While in a sense the standard and office information departments cover much the same work, there is a distinct line of demarkation. The office information department merely works out ideas that are thought advisable to follow, whereas the standard department gets out ideas that must be followed.

The office information sheets are made on M.C.B. standard letter-size tracing linen. These sheets are formed off into oblongs, eight on a sheet, the information being printed concisely in each of these oblongs. Prints are made from these tracings and the individual parts sent to the particular department to which the information is of the most value. These little tickets are mounted in a large frame placed up on the wall so that each draftsman may consult them constantly.

Another of the duties of the office information department is to get out a different type of office information, such, for example, as standard bell drawings or standard Westinghouse pumps. These are made on tracings, vandyked and positives made, these positives being waxed and given around to the different elevation men, who can make use of them as templets, for the purpose of locating the bell or pump, as the case may be, in some convenient place on the locomotive. They are drawn to the same scale for that purpose, and being waxed, can be used for this purpose as they are as transparent as linen.

In general, the work of this department is to compile such existing locomotive data as can be obtained, and as the designing engineer has constant need of. The office information department takes this information and arranges it in the most convenient form so that no unnecessary time will be lost on this score; briefly, it looks after such information as is considered of insufficient importance to submit to the standardization committee.

* * *

STORING JIGS AND FIXTURES

The storing away of heavy jigs and fixtures presents some difficulties. Most frequently one sees them left in a corner of the shop where they get dirty and dusty, and do not add to the attractiveness or neatness of the general appearance of the shop. In other cases they are pushed underneath the shelving on which the smaller jigs and tools are kept. In this case they are equally exposed to dust and dirt, although there is a semblance of order in the manner in which they are kept. A very neat way of storing these tools is used in the Schumacher & Boye shops, in Cincinnati, Ohio. A large wooden cabinet with doors is used, and the jigs and fixtures are kept in this when not in use. As it is rather difficult to push in and pull out heavy fixtures when they are stored in a narrow space between the shelves, small rollers are provided underneath the heaviest tools, so that they can be pushed in or pulled out with very little effort. This method of storing the jigs involves very small expense, but is a great convenience, and it looks neat.

* * *

Accidents will occur in the best regulated institutions, but this is no excuse for tempting Providence by being reckless.

AIR COMPRESSOR DESIGN*

THE INTERCOOLER—ITS RELATION TO STAGE COMPRESSION

By J. WILLIAM JONES†

It is a well-known fact that in compressing air a great amount of heat is generated due to the friction of the molecules composing the air, which are being crowded into a smaller space. In compressing air to 100 pounds gage pressure, the final temperature, assuming the compression to be adiabatic, would be about 485 degrees F. The effect of this constant increase in temperature is to tend to expand the air under compression to a larger volume, thus necessitating a corresponding increase of work to compress this apparently increased volume. After the compressed air has been discharged into the receiver or pipe line the temperature rapidly falls to that of the surrounding atmosphere and the energy due to the heat generated during compression is lost. It therefore follows that in compressing air to any great extent, a large amount of work is expended due to temperature conditions and the only method of reducing to a minimum the amount of work lost is to cool the air during the period of compression. In theory, the air should be kept at a constant temperature during the period of compression; but the attainment of this is a practical impossibility in compressors of the present day.

In modern compressor engineering practice, the work is divided equally between two or more stages, the number of stages depending on the final air pressure required and the employment of an "intercooler" between the different stages to reduce the temperature of the compressed air to the normal between the stages. In effect, this arrangement is equivalent to doing all the work in a single cylinder if it were possible to stop the piston at a certain point of the stroke, reduce the temperature of the air already partially compressed to that of the surrounding atmosphere, at the same time moving the piston forward just fast enough to keep the pressure constant, and then start the piston again and continue the compression to the desired pressure.

A sectional view of an intercooler built in accordance with modern practice is shown in Fig. 1. This intercooler consists of a long shell of cylindrical shape containing a nest of tubes through which cold water is circulated. The air enters at one end of the shell from the low-pressure cylinder at a high temperature, passes around and between the nest of tubes and enters the high-pressure cylinder at the other end at a greatly reduced temperature. This cooler is placed immediately above or below the cylinders in order to secure the shortest connections possible, the air remaining in these connections being denied the cooling effect of either the cooler nest or the water jackets of the cylinders. The tubes constituting the nest are expanded at each end into steel or brass plates which are bolted directly to the water heads. Some advantages are claimed for brass tubes because of their higher conductivity; but these advantages are not of sufficient value to warrant their extra cost. Galvanized iron pipes have been found very efficient, attributable to the rough surface which these pipes possess.

As the intercooler is primarily the medium through which the saving in power is to be derived, it is obvious that unless proper attention is given to all its details the desired effect may not be realized. The essential points to be considered in the design of an intercooler are: Cooling surface, efficient water circulation, volume of cooler, proper deflection of the air around and between the tubes, convenient drains, and accessibility to the tubes.

The amount of cooling surface required is generally based on the quantity of "free air" compressed per minute. As the thermal condition of the air subject to compression is dependent on the final pressure, it is evident that the amount of cooling surface in relation to the free air capacity of the compressor varies with the discharge pressure. Theoretically, the cooler should have a sufficient amount of cooling surface to reduce the temperature of the air between the two stages to the same point at which it was first taken into the low-pressure air cylinder. In practical working conditions, however, it will be found that the majority of coolers fail to accomplish this result and a reduction to within 5 or 10 degrees of the original is usually conceded to be good practice.

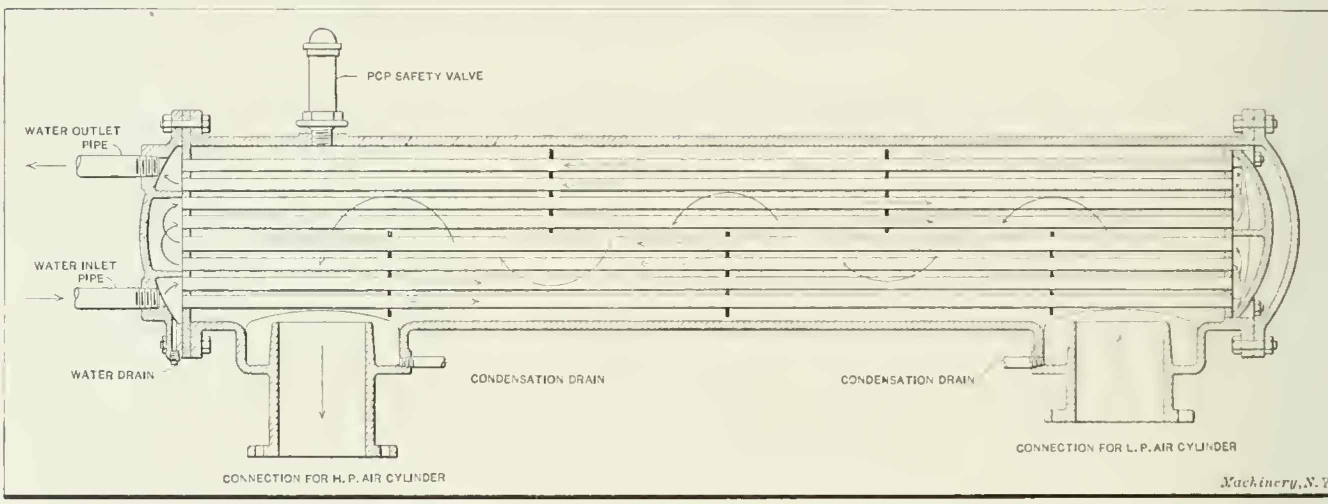


Fig. 1. Intercooler built in Accordance with Modern Practice

An efficient water circulation is a matter which requires some thought and consideration, as the water is the agent which absorbs the heat units. A cooler may be well designed in every other respect, yet if a proper circulation of the water is disregarded it may offset all the other efficiencies. The flow of the water should be through unrestricted pipes at such a velocity that the maximum number of thermal units is absorbed and carried away by the water; the flow of the water should also be directed properly in relation to the flow of the air. The best practice is to make the general flow of the water opposite to that of the air; the hottest air will then come in contact with that portion of the tubes containing the warmest water, and as the air is gradually cooled it comes in contact with the cooler portion of the cooling nest. In the intercooler shown in Fig. 1, the water circulates the entire length of the cooling nest four times. Entering through the lower pipe attached to the outside water head, the water being deflected by the partitions in the heads, circulates as indicated by the arrows shown on the small pipes. This circulation system is in accordance with the laws of thermodynamics; the hot water gradually finds its way to a higher level until it is finally discharged through the upper pipe leading from the outside water head.

*For additional information on this and kindred subjects previously published in MACHINERY, see "Horsepower Required to Compress Air," January, 1911, engineering edition; "Horsepower Required to Compress Air," December, 1910, engineering edition (and other articles there referred to). See also "Compressed Air, for Stiffening Beams, Struts and Flat Surfaces," October, 1910; "New Idea in Air Compression," September, 1908, engineering edition; "General Electric Co.'s Centrifugal Air Compressors," December, 1907; "Standards of Efficiency in Compressed Air Practice—The Air Compressor as an Air Meter," June, 1907, engineering edition; "Leakage in Compressed Air Plants," January, 1907, engineering edition; "Separator for Water in Compressed Air," January, 1907, engineering edition; "Air Compressor With Minimum Clearance Space," May, 1905, engineering edition; "Hydraulic Compression of Air," September, 1902; "A Novel Air Compressor," September, 1899.

†Address: Box 382, Painted Post, N. Y.

The cooler should have ample volume for the air, in its passage from the low- to the high-pressure cylinder, to obtain the best results. It is good practice to make the cooler of such cross-section as to readily admit a free passage of the air after the "baffle plates" have been placed; and then having determined this area, make the cooler of such length as is required to obtain the necessary amount of cooling surface. It is obvious that a cooler of large volume has advantages over one of smaller volume, even if the cooling surfaces be equal, because the air, in passing from the low to the high-pressure air cylinder, has a longer period of contact with the cooling tubes in the cooler which has the greater volume.

The compressed air should be well deflected in its course through the cooler. This result is obtained by placing several "baffle plates" in the cooler, as shown in the illustration, which deflect the air alternately towards each side, thus bringing the air into contact with all parts of the cooling nest.

There are several small details of intercooler construction which should not be neglected, such as proper drains for drawing off the condensation of the air. The moisture of the air is in the form of a vapor, which when rapidly cooled, is condensed, and should be drawn off at stated intervals. Convenient drain connections should also be provided for draining the cooling nest in case of a suspension of the operations of the compressor at any time when freezing is liable to occur. It will be noticed that the cooler shown in Fig. 1 is so constructed that the entire nest of tubes can be withdrawn at any time for examination or cleaning purposes. This is an important feature, as it enables a defective or leaky tube to be replaced with very little difficulty.

The Theory of Stage Compression with Intercooling

The theory of compound or stage compression is very readily understood. In the first paragraph of this article a statement was made relating to the heat produced in the compression of air. For all pressures above 70 pounds per square inch, it is generally conceded that compound or stage compression should be employed. The heat of compression increases with the pressure; therefore, the higher the pressure the more difficult it is to reduce the temperature to a point enabling efficient compression conditions and proper lubrication of the air cylinders. In compressing air to 100 pounds terminal gage pressure in a single stage compressor, the final temperature of the air would be about 485 degrees F., as before mentioned. Some of this heat would be absorbed by the cylinder walls; yet the final temperature would remain too high to insure efficient compression conditions or proper lubrication. The adoption of stage compression with intercooling between the stages, although introduced some thirty to forty years ago, has been neglected by compressor builders until within the last decade. At the present time stage compression is almost universally employed for all pressures above 70 pounds, unless the compressor is of such small size as to make compounding an uncommercial proposition.

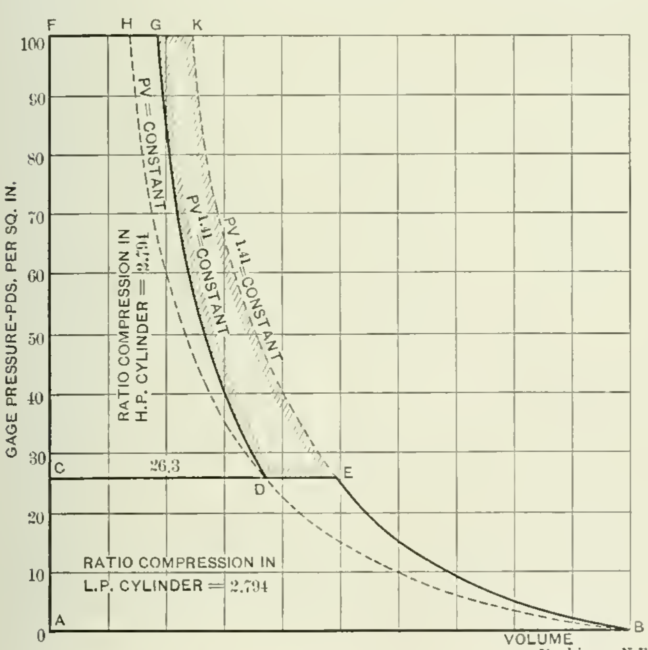


Fig. 2. Theoretical Combined Indicator Card from a Two-stage Compression

In Fig. 2 is shown a theoretical combined indicator diagram from a two-stage compressor. In this diagram it is assumed that the compression follows the adiabatic curve in both high- and low-pressure cylinders with perfect intercooling between the two stages. The horizontal lines A B and C D represent respectively the volumes of the low- and high-pressure air cylinders, drawn to the same scale. The

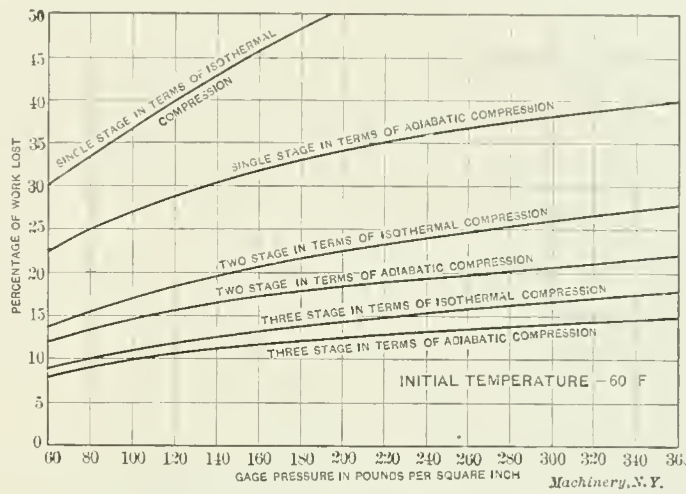


Fig. 3. Percentage of Work lost in compressing Air from Atmospheric Pressure to Various Gage Pressures, by Simple and Stage Compression

vertical line A C F on this diagram will represent pressures to some designated scale. The adiabatic curve B E K represents the relation between pressure and volume for any position of the piston, assuming that there is no intercooler employed and that no heat radiates through the cylinder walls. In other words, this curve is the one which compression would theoretically follow in a single cylinder with no intercooling. In this curve the product $P\,V^{1.41}$* is constant, P and V representing pressure and volume respectively. On the other hand the isothermal curve B D H shows the relation between pressure and volume providing the temperature of the air under compression could be kept constant so that the product $P\,V$ would also be constant.

Air taken into the low-pressure air cylinder at zero gage pressure, is compressed along the adiabatic curve B E until at the point E it attains a pressure of 26.3 pounds, equal to that of the intercooler, which allows the discharge valves to open and the air to pass into the cooler. In the intercooler the volume of a definite weight of the air is reduced from C E to C D so that the volume entering the high-pressure cylinder is less to the extent of D E which is to the same scale as C D and A B. This means that the given weight of air represented by the volume C E at a gage pressure of 26.3 pounds, when cooled to the same temperature at which it was originally taken into the low-pressure air cylinder will be reduced in volume to C D providing the pressure of 26.3 pounds remains constant. The air taken into the high-pressure air cylinder at 26.3 pounds is compressed along the adiabatic curve D G. At the point G the high-pressure discharge valves open, and the air is discharged into the receiver at the desired gage pressure of 100 pounds. The shaded portion represents the saving effected by the intercooler.

Assuming that a volume of 1000 cubic feet of free air per minute is to be compressed to a gage pressure of 100 pounds with perfect intercooling between the stages, 153 horsepower is required. Compressing this same amount of air in the same time in a single stage requires an expenditure of 180 horsepower, or an excess of 27 horsepower over the amount required in two stage compression. This excess is equivalent to a saving of about 15 per cent in two stage compression, which can be attributed directly to the intercooler. The actual saving, however, would fall somewhat below the above percentage due to the fact that there are necessarily more frictional losses in the two stage machine than in one having a single cylinder; also the intercooler cannot be relied upon

* The exponent 1.41 is the ratio between the specific heat of air at constant pressure and at constant volume.

to reduce the temperature of the air between the stages to the normal in all cases. It is safe to state, however, that the saving in compressing to 100 pounds gage pressure would equal or exceed 10 per cent in a well-designed compressor. At higher pressures, the saving in power is much more marked.

In Fig. 3, curves have been plotted which show the loss of work due to heat in compressing air to various pressures in one, two, and three stages, assuming an initial temperature of 60 degrees F. in all cylinders, which is equivalent to perfect intercooling in the curves for stage compression. These curves show very readily the advantages of two stage compression over single stage.

As previously stated, the intercooler is primarily the medium on which the principle of compound compression is based, yet the saving due to the reduction in temperature between the stages does not constitute all the advantages of stage compression. The maximum temperature in each cylinder is reduced to a point where the heat can be more thoroughly drawn off by the water jackets surrounding the cylinder walls; also, the lower temperature in the cylinders is less liable to affect a good oil, thus insuring good lubrication of the pistons, valves, etc., with easier running conditions, less wear and longer life.

Increased Volumetric Efficiency

The volumetric efficiency of a compound compressor is obviously greater than that of one having a single cylinder. The compressed air remaining in the clearance space of the low-pressure cylinder being at a much lower pressure, requires less movement of the piston on the return stroke before the air in the clearance space is expanded to a pressure equal to that of the surrounding atmosphere, which permits an opening of the air inlet valve. As free air is taken into the low pressure cylinder only, the high-pressure cylinder bears no relation to volumetric efficiency, for it follows that all air taken into the low-pressure cylinder must necessarily pass through the high-pressure cylinder unless there is some leakage present. The reduced temperature conditions in the low-pressure cylinder also causes less heating of the intake air when it comes in contact with the cylinder heads and walls, which results in obtaining a denser volume of air at each stroke of the piston, with a corresponding increase of volumetric capacity.

In addition to the advantages already mentioned, the maximum stresses in a compound compressor are reduced to about 55 per cent of what they would be in a single stage machine compressing to the same pressure. In a single stage compressor having a cylinder of 20 inches diameter compressing to 100 pounds terminal gage pressure, the piston starts against no load at the beginning of the stroke and at the end of the stroke meets a maximum resistance of 31,416 pounds. Assuming the compressor to be running at a speed of 150 revolutions per minute, the piston meets this resistance and its release 300 times every minute. On the other hand, a two stage machine compressing to this same pressure with the intake or low-pressure cylinder of the same size as the above-mentioned single stage cylinder, would encounter a maximum pressure of only 9424 pounds when working against a cooler pressure of approximately 30 pounds. In order to divide the load equally, the high-pressure piston area would be proportioned to the low-pressure piston area in the same ratio as the square roots of their absolute pressures. That is

High-pressure area : $314.16 : : \sqrt{14.7} : \sqrt{114.7}$.

Or high-pressure area = 112.5 square inches.

The area 112.5 square inches is equivalent to a high-pressure cylinder diameter of about 12 inches. Compressing from 30 to 100 pounds in the high-pressure cylinder gives a maximum unbalanced pressure of 70 pounds, which is equal to a maximum load of 7917 pounds to be met in this cylinder. The total maximum resistance in both high- and low-pressure cylinders, is therefore, 9424 pounds plus 7917 pounds, or 17,341 pounds, which is only about 55 per cent of that in the single stage compressor.

* * *

MUELLER TESTING STAND

The accompanying half-tone Fig. 1 shows an interesting testing stand used by the Mueller Machine Tool Co., Cincinnati, Ohio, for varying the speed while testing the radial drills built by the company, when completely assembled and ready for shipment. As will be seen from the illustration, the apparatus is portable and can be easily moved to any machine on the assembling floor. The power for driving the radial drill while testing is derived from a motor placed on the base, and transmitted from the motor to a gear-box at the top of the testing stand, by means of a belt as shown.

With the gear-box at the top of the testing stand it is possible to obtain six different speeds, thus making it convenient to test the machine at any required number of revolutions of the spindle. The gear-box is of the same type as that used on the regular gear-driven radial drill presses built by the company, the construction of which is shown in the halftone illustration Fig. 2, and also indicated in the line engraving Fig. 3. In this latter engraving A is the driving shaft, B is the intermediate shaft, and C the shaft from which, by intermediate gearing, the spindle of the machine is driven. On shaft A is placed a clutch which can engage either the gear to the right or that to the left, thus giving two speeds to shaft B. The gears on shaft C are sliding gears and can be brought in mesh, respectively, with either one of the three gears D, E and F on the intermediate shaft B, thus giving six changes of speed to the spindle. The most interesting part of the construction of the gear-box is the clutch on shaft A, which is of an exceedingly simple construction. The general principle upon which it operates is shown in Fig. 4. It will be seen that it consists of a sliding collar operated by a forked lever from the outside of the gear-box. On each side of the collar is a taper projec-

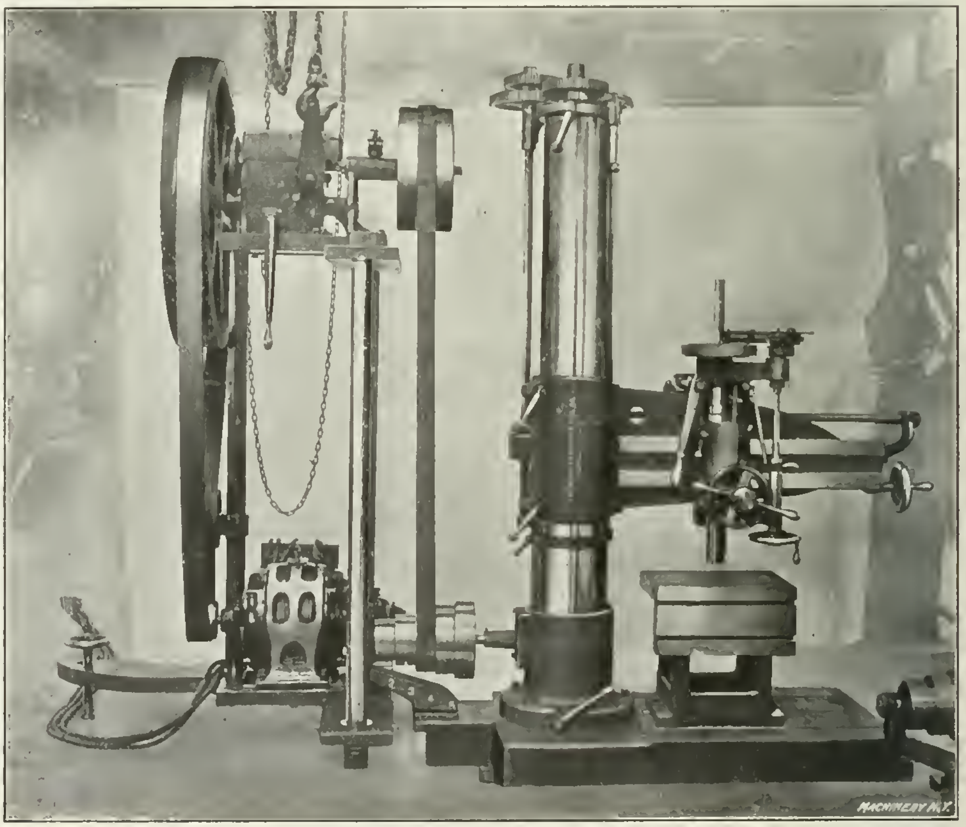


Fig. 1. Testing Stand used for Driving a Radial Drill while Testing on the Assembling Floor

tion which, when the collar slides either to the right or left, enters into a correspondingly tapered slot in the friction ring, thus expanding the latter and forcing it to grip on

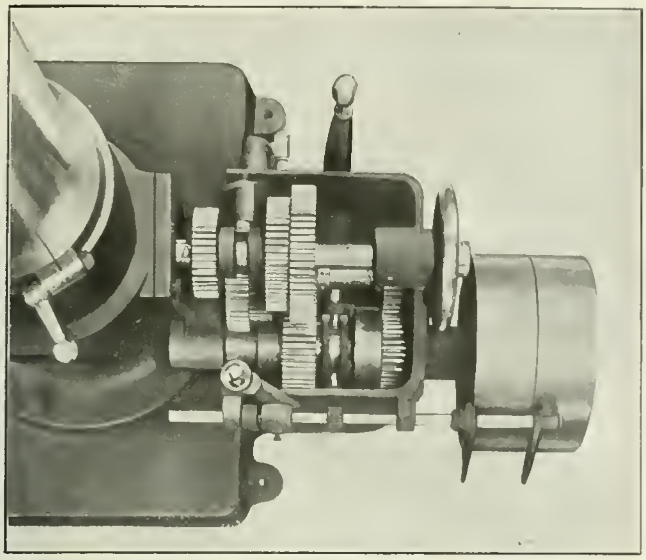


Fig. 2. View of the Gear-box used on Testing Stand

the inside of the gear to be driven. When compared with a great many other constructions of similar kinds, it will be seen that this clutch is unique in its simplicity, and it will, therefore, undoubtedly be of interest to mechanics who are not familiar with this type of clutch.

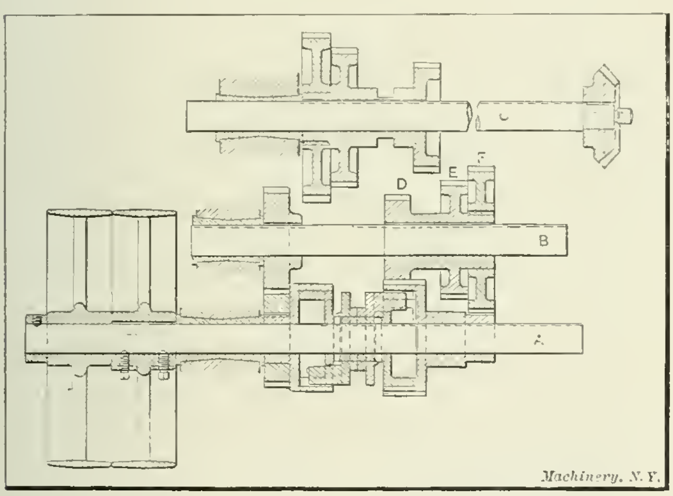


Fig. 3. Arrangement of Gears in Gear-box shown in Fig. 2

Referring again to the testing stand, it will be noticed that it is provided with leveling adjustment; so that it can always be placed in proper position relative to the machine in connection with which it is to be used. It is supported at three points, and the supporting point to the left consists of a

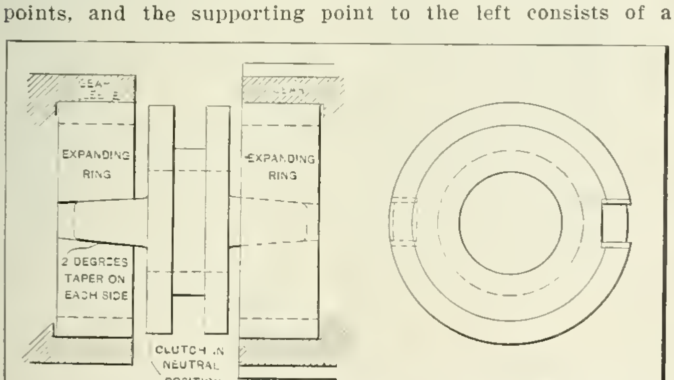


Fig. 4. Principle of Action of Clutch used in Mueller Gear-box

screw provided with a handwheel so as to make this support adjustable. The convenience with which this testing stand can be moved from machine to machine makes it a very economical and useful device, and makes it possible to test the assembled machines in any location that they may occupy on the assembling floor.

GENERAL APPLICATION OF SPRING CHUCKS TO LATHES

The oldest and most indispensable machine tool—the lathe—has, within recent years, received much attention at the hands of the mechanical engineer, until to-day the number of different designs probably exceeds that of all other machine tools combined; but notwithstanding this fact the designer of modern lathes seems to have given little attention to the means for holding the work in a standard engine lathe. Lathes designed to handle bar work exclusively, are, as a rule, provided with efficient chucking facilities, but on the other hand, standard engine lathes and even so-called "chucking" lathes are rarely provided with better means for holding work than two-, three- or jonr-jawed chucks. These are, of course, indispensable for holding some classes of work, such as pieces of irregular shape, and in many cases for first operations. For practically all second operations, regardless of the shape of the piece, and frequently all operations when the shape of the piece permits, split chucks could be used at a great saving of time, if the lathes were suitably designed for the use of

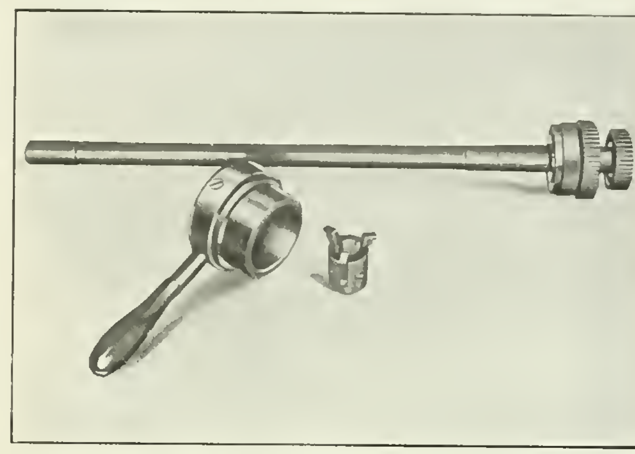


Fig. 1. Muehlmatt Mechanical Opening and Closing Spring Chuck Operator

these chucks and if proper means were provided for operating the chucks.

By "split chucks," the ordinary steel split collet sometimes found in the tool-room is not alone referred to, but chucks of any size, either expanding or contracting, made of steel, cast iron or bronze, as the nature of the work demands, and suitable for holding work up to the full capacity of the ma-

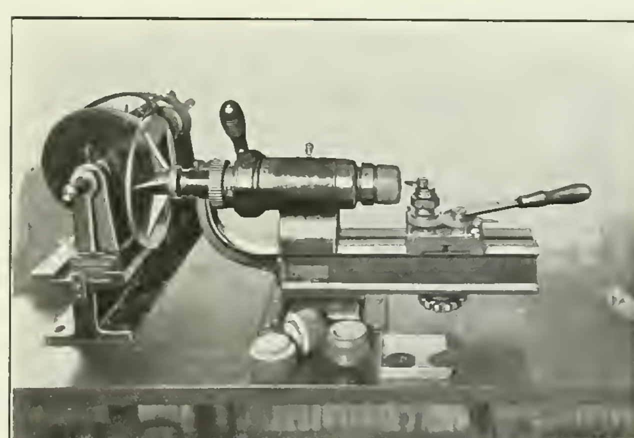


Fig. 2. Special Wood-turning Lathe with Spring Chuck and Operator

chine. Split chucks have been in universal use in the watchmaking industry for over a quarter of a century. Small precision lathes have been equipped with split chucks for many years, and more recently a few of the leading lathe builders have placed what are known as "tool-room lathes" on the market, equipped with chucks of this type. While the application of split chucks to the engine lathe is doing much toward educating the machinist to their use, the average mechanic still considers such chucks as belonging to precision work.

For the past eighteen years Adolph Muehlmatt, Cincinnati, Ohio, has been engaged in the manufacture of a class of tools

and devices demanding rapid chucking facilities as essential to profitable production, so that considerable time and attention has been given to the problem of chucking work, and experience has demonstrated that in many instances cast-iron split chucks answer every purpose as well as the tool-steel or casehardened chuck. These cast-iron chucks are produced at a low cost, and when used on second-operation work their life is indefinite. In the Muehlmatt shops, a number of such chucks have been used on from 5000 to 10,000 operations without showing signs of wear. On a Jones & Lamson flat turret lathe, used as a chucking machine exclusively, all contracting chucks above 1-inch bore are made of cast iron, while the expanding chucks for the same machine are generally made of tool steel and hardened, if under 2 inches in diameter. Cast iron is used for sizes above 2 inches. Probably because of the lack of experience and investigation, few mechanics are ready to grant that cast-iron split chucks will hold the work securely under all conditions and that the life of such chucks can be anything but short. A little research, however, will show this principle in use in an endless number of mechanical devices, working satisfactorily under conditions not nearly so favorable as in the case under consideration. Countershafts where the power consumed by a machine is transmitted through cast-iron friction clutches, offer a good example.

After the superiority of the split chuck for holding many classes of work in connection with machining operations had been proved, the problem of devising mechanical means for operating this type of chuck had to be solved. At first the chucks were operated and closed in the ordinary way, that is,

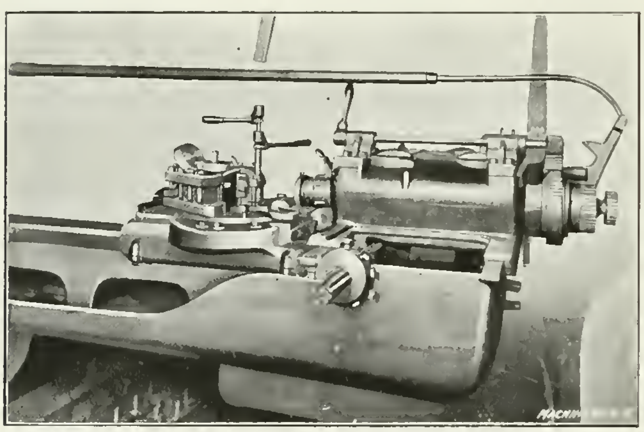


Fig. 3. Jones & Lamson Turret Lathe equipped with Muehlmatt Chuck Operator

by stopping the lathe and throwing in the back-gear to lock the spindle; the quill was then unscrewed, thus opening the chuck, when the work would be removed, another piece put into the chuck, and the operations referred to repeated inversely. Under these conditions the time consumed in chucking would frequently exceed the time required for tooling, though, at that, it was an improvement over the use of the ordinary machine chuck.

In order to handle work with greater facility, a device was needed that would deliver the maximum of power required with little effort on the part of the operator; it had also to be applicable to lathes of various classes with the least possible disturbance to the design, and to be so simple in construction that it could be built at a comparatively low cost. Devices already in use for automatically operating chucks on screw machines or turret lathes, though answering very well their specific purposes, were rejected, due to limitations that would not permit their universal use on the standard engine lathe for chucking purposes.

The requirements referred to in the foregoing have been met by the mechanical opening and closing chuck illustrated in Fig. 1, which in its application to such machines as are suited to the use of spring chucks, has proved so satisfactory that spring chucks are now used in the Muehlmatt shops for all lathe operations, except the first, and in many instances for all operations including the first. While some bronze castings, brass tubing and rod stock is machined, the greater part of the work consists of iron castings that are finished all over. All work is of the interchangeable type, jigs and special fixtures being used throughout; hence the lathe work has to be accurate, and this accuracy has been easily maintained. Since the time required for chucking is a negligible factor, in not a few instances, where but two operations are required, a saving of time is effected by chucking the piece twice, rather than revolving the turret for each operation. Engine lathes equipped with spring chucks and a chuck operator could, of course, be used to advantage in such cases instead of the chucking lathe.

The time consumed in chucking work varies from 5 to 20 seconds, depending upon the size and form of the work. On

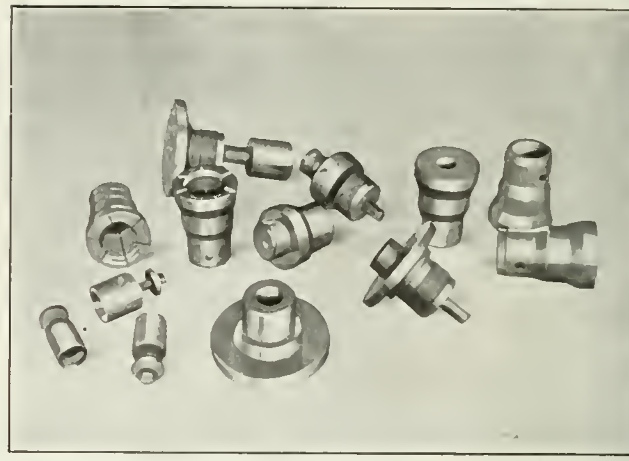


Fig. 4. Group of Chucks, Chuck Blanks and Work Ejectors

the Jones & Lamson flat turret lathe, as many as 1000 pieces are chucked in a ten-hour working day. On a 14-inch Hendey-Norton lathe, the number of pieces chucked quite frequently exceeds 1500 per day, while on the friction-driven bench lathe, illustrated in Fig. 2, from 3000 to 4000 pieces are handled daily. This lathe was built in the Muehlmatt shops for a special class of wood turning. It is, of course, understood that these figures apply to rapid tooling operations, and the point we wish to emphasize is that little time is wasted in chucking the work; this applies to all classes of work whether large or small. It is rarely necessary to stop the spindle of the machine during a chucking operation, the operator wearing gloves to protect his hands from burns and cuts while chucking.

For some classes of work, ejectors are placed within the chuck to discharge the work when the chuck is opened. These ejectors also keep the chuck slots and the work seats free

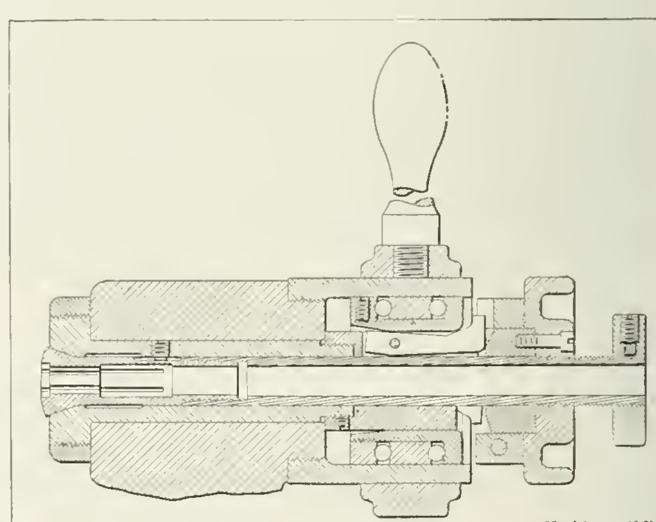


Fig. 5. Sectional View of Chuck and Operator

from chips when boring open holes. When ejectors cannot be used to advantage, a knock-out rod is substituted for discharging work that cannot be grasped by the hand.

Lest this system be confounded with that in vogue in tool-room practice, where split chucks are used to some extent and where quite often—for good reasons or otherwise—a

mincing cut at the slowest speed and finest feed is run on a piece of drill rod held in a split chuck, let us emphasize the fact that the heaviest cut that the tool can take care of or that the case justifies is practicable with a properly-designed spring chuck. This system was developed as a manufacturing proposition for the rapid and accurate production of duplicate parts with the smallest expenditure of effort on the part of the operator.

The standard type of cast-iron contracting chuck used on the Jones & Lamson flat turret lathe, measures 2¾ inches in

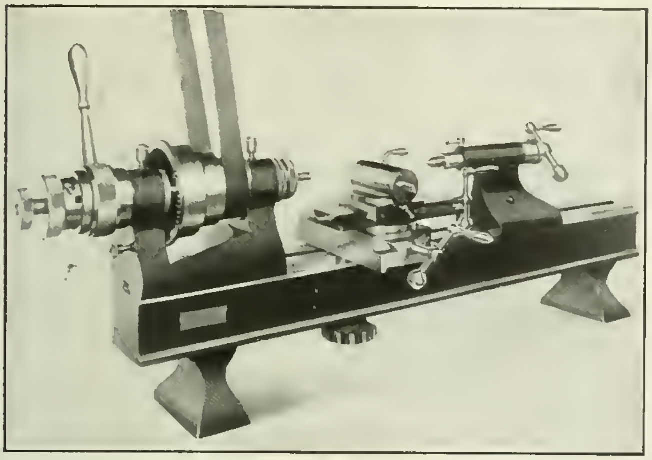


Fig. 6. Chuck Operator applied to a Bench Lathe

diameter through the section back of the closing angle, and the thickness of the wall through the split section measures ½ inch. The chuck protrudes from the end of the spindle but 11/16 inch. A chuck of these dimensions is sufficiently resilient for all purposes, yet under these conditions the chuck and the work held by it practically becomes a component part of the machine spindle. Chattering is eliminated, and a cutting tool working under such favorable conditions does not become dull so quickly. A Jones & Lamson machine equipped with one of these chucks is shown in Fig. 3. In this particular case, the lever for the chuck-operating mechanism is located just above the chuck, connection being made by a shaft and sector gears as shown. In Fig. 4, a group of chucks, chuck blanks, and work ejectors used on this machine are shown.

With the spring chuck system, the part of the work gripped by the chuck is generally well within the spindle of the ma-

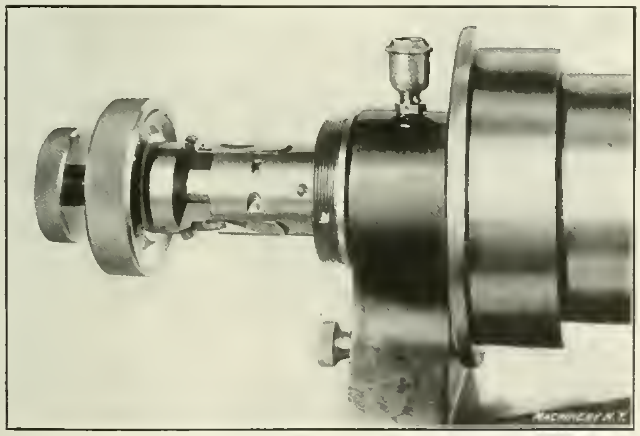


Fig. 7. Operator Housing Removed to show Position of Fingers when Chuck is Closed

chine, which is much better than the common practice of holding the work in a three- or four-jawed chuck, where the distance from the end of the lathe spindle to the work-holding jaws measures anywhere from 4 inches to 10 inches. The jaws, as a rule, are also more or less strained and frequently do not have a square contact with the work.

Few favorable conditions exist for the general adoption of spring chucks, as the machine tool designers have been so deeply absorbed in all-geared heads, quick-change feed boxes, etc., that the problem of holding the work has, to a great extent, been left to the purchaser to solve. Few of the older types of lathes are suitably designed to receive spring chucks and their adjunct—the chuck operator; at least, not so that the fullest benefit may be derived from their use. Two different types of machines were found suited to the equipment illustrated herewith, with practically no alterations to their original design. Briefly the component parts of the Muehlmatt mechanical opening and closing chuck, which is shown in section in Fig. 5, are simply a plurality of cylinders working within each other, whose cooperative members are coupled together in a simple yet positive manner. The chuck operator forms a self-contained, independent unit, that, on suitably-designed machines, can be applied or removed as easily and as quickly as a machine chuck and should be interchangeable with any number of lathes of the same type. One of these operators is shown applied to a bench lathe in Fig. 6, and Figs. 7 and 8 are detailed views of the lathe headstock with

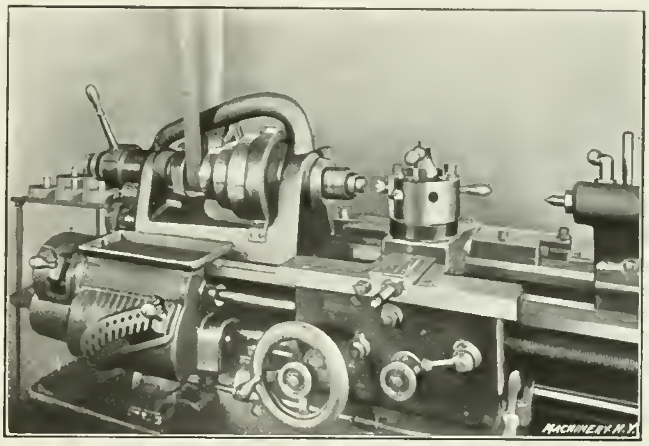


Fig. 9. Spring Chuck and Operator applied to Hendey-Norton Lathe

the operating lever and housing removed. Fig. 7 illustrates the position of the operating fingers when the chuck is closed, and Fig. 8 their position when the chuck is open.

In the matter of drives and feeds, the lathe has been developed to a high degree, and now the efforts of the designer should be centered on the features that, from a logical point of view, should be the most important in a metal-turning machine, namely, the spindle and its accessories for holding the work.

The work-holding capacity of a lathe instead of being described as, for instance, a 16-inch by 6-foot size, will doubtless at some future time be referred to as a 2-inch by 16-inch by

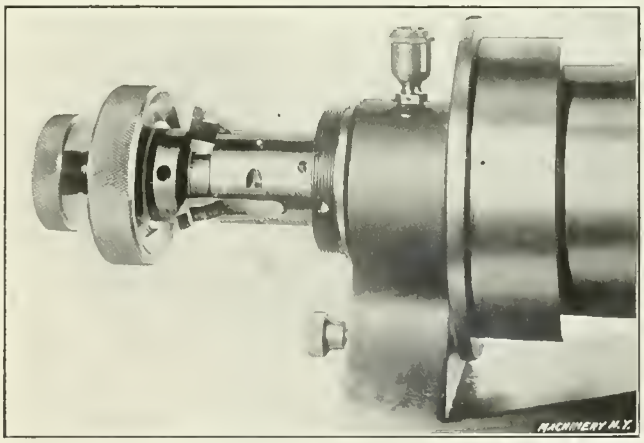


Fig. 8. Position of Fingers when Chuck is Open

6-foot machine, the first figure standing for the spindle capacity of the lathe. We see no reason why a machine, of say, 16-inch swing, should not be equipped with chucking facilities that would enable it to handle certain classes of work up to that diameter through the spindle. For faceplate work, work that has to be turned between centers, and frequently first operations and pieces of unsuitable shape for the split chuck, the lathe as at present developed leaves little to be desired. This, however, represents but one division and probably the minor one of the work that a modern lathe should be capable of handling.

The means for holding a large part of the work that should

come within the scope of the engine lathe has so far remained largely undeveloped. This division embraces, besides an endless variety of castings and forgings, all tube and rod work up to the capacity of the spindle of the machine. Practically all of this work is handled now in a crude, awkward and time-wasting manner on the engine lathe. This, in many cases, leads to the installation of special or single-purpose machines, which is a justifiable course when sufficient work is at hand to run such machines to their capacity—idle machines do not produce dividends.

* * *

HOLLOW-HANDLE CUTLERY

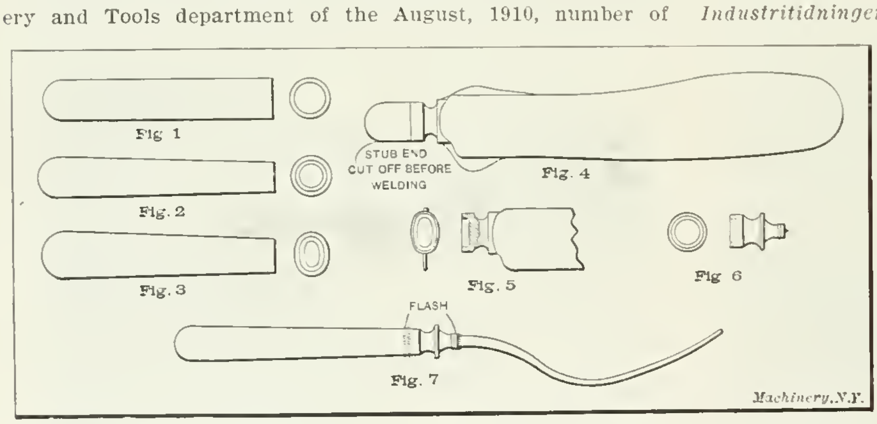
By ROBERT S BROWN*

The mechanic with his instinctive realization of the due relation between weight and size, is immediately struck with the lightness of the all-metal knives and forks with large, comfortable-feeling handles. A simple test for center of gravity, balancing one knife over the edge of another will show by the location of this balancing point that the handle must be hollow, although there is nothing in the outward appearance to prove this or indicate how the job is done. A solid-handle knife will perhaps balance an inch back on the handle from the bolster while the hollow-handle center of gravity moves forward out on the blade.

These light hollow handles which save stock and yet fill the hand, were formerly made in the same manner as the silver ones are still, with a seam all around, joining two shells like the halves of a pea pod, and also welded to the stub tang. This involves joints approximately 8½ inches long, which must be perfectly welded or there follows a leakage of dish water into the interior of the handle which will condemn it.

A later method of making these steel handles gives a welding surface less than 1½ inch long. This consists in drawing up a steel shell, Fig. 1, from a flat circular blank, and is done in several operations with inter-annealing in the well-known manner. The rough end of the handle is then trimmed with a wheel cutter. Following is the tapering of the shell in a Goodyear swaging machine to the shape shown in Fig. 2, then ovalling it into the exact contour of the finished handle, Fig. 3; this last is done in a press. The finished handle is also shown at *A*, in the halftone Fig. 8. This method is employed by the American Cutlery Co., of Chicago.

The blade shown in Fig. 4, has in the meantime been rolled in the automatic rolling mill illustrated in the New Machinery and Tools department of the August, 1910, number of MACHINERY, after having first been drop-forged from the solid round stock as shown at *B*, Fig. 8. *C* in this same figure shows the blade at the completion of the rolling operation. After trimming the blade and flashing, the tang beyond the bolster is chambered out in an upsetting machine, to the shape indicated in Fig. 5. The object of this is to provide a welding surface of the same sectional area as the handle, so that both will come to a sticking heat at the same instant and neither will be overheated.



Figs. 1 to 3. Hollow Handle in Successive Stages of Production. Fig. 4. Knife Blank after the Drop-forging and Rolling Operations. Fig. 5. End of Knife Blank after Stub is cut off and End upset. Fig. 6. Bolster for Fork as it comes from Screw Machine before Ovaling. Fig. 7. Welded Fork, showing Flash at the Two Joints

On forks, the same result is arrived at in a little different manner; the portion with the tines may be rolled as the knife blades are. The handle is the same as the knife handle, but the bolster is a separate piece. This is a simple screw machine job turned with the chamber above mentioned in one end, as shown in Fig. 6, and at *D*, Fig. 8, and then ovaled by pressure. It is welded first to the tine portion as at *E*, Fig. 8, and then to the handle. As electric welding unites dissimilar metals, it is practical to use the non-ferrous metal alloys joined to the steel, and a choice of steel handles say, with German silver blades or tines is feasible.

Differentiating between the rolling and the hammering of the blades, the former is now generally preferred. Small pieces of coal from the fire which may adhere to the heated blade are more or less imbedded in the steel by the hammering process of drawing out or plating. These become an aggravation later showing as spots or pits in the blade when ground; the blades so spotted must be re-ground to take out the defects. In rolling with water running over the dies this spotting trouble does not appear and the thickness of the blades is constant. These features conduce to uniformity in the mechanical grinding now generally practiced.

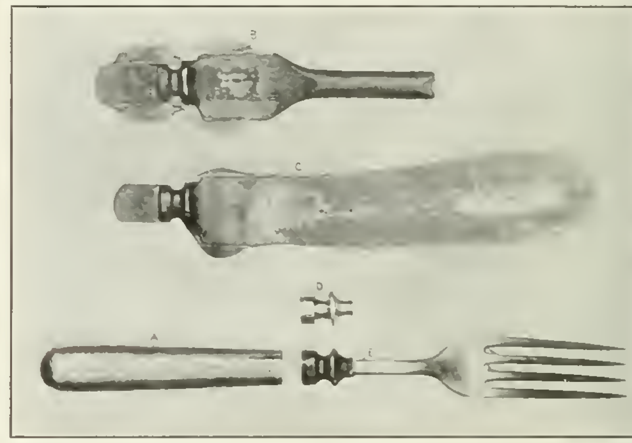


Fig. 8. Details of Knife and Fork in Different Stages of Manufacture

There is but a slight flash ringing the welded joints indicated in Fig. 7 between blade and handle and handle and tines, and this, with the seamless process of smooth handle construction, makes polishing an easy matter there.

*Secretary, New Britain Machine Co., New Britain, Conn.

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An interesting method for measuring the area of diagrams, or of sections of a map, is referred to in a recent issue of *Industritidningen Norden*. The diagram or map is drawn carefully to scale on a piece of plain drawing paper, preferably of high quality and of hard surface so as to be of uniform texture throughout. Then a unit area is drawn to scale on the same paper, this area corresponding to one square inch, one square foot, one acre, one square mile, or whatever the unit area of the diagram or scale of the map may be. This unit area is then carefully cut out and the piece of paper representing it weighed on a sensitive laboratory scale. The diagram to be measured is also cut out and weighed. In this manner a fairly accurate expression of the area can be obtained by dividing the weight of the total diagram or area to be measured by the weight of the unit area. A still higher degree of accuracy can be obtained by drawing to scale an area representing, say, ten times the unit area, and weighing a piece of paper corresponding to this larger area. The weight of this, divided by ten, is then the unit measure. It is stated that considerable accuracy has been obtained by employing this method.

* * *

Radioro is the name of a new alloy which is claimed to have the unfading yellow of gold, the hardness of hardened steel and to be unaffected by the atmosphere or ordinary acids. It is predicted that it will be used for household utensils, heavy machinery, armor, jewelry, and many other purposes.

DATA FOR FLUTING AND RELIEVING TWIST DRILLS

When making twist drills in the tool-room of the ordinary shop, one of the questions which the toolmaker must settle is that of the thickness of the point or web of the drill. He must also settle upon the width of the land back of the cutting edge on the cylindrical part that is left when relieving the drill. The latter question may not be of such great importance, but the former constitutes one of the vital points in twist drill making. The form of the flute or groove is, of course, also of the greatest importance, as it is required that the cutting edge of the drill should be practically a straight line; that is, the form of the flute should be such that the intersection between it and a plane making a 59-degree angle with the axis of the drill—the angle to which the drill is ground—will be a straight line. Cutters which will mill a flute having the required form are available in the market; but the toolmaker or tool designer may be called upon to produce cutters for this purpose occasionally in large plants making, in the shop tool-room, a considerable number of the tools required. In the accompanying table, therefore, are given dimensions for a satisfactory line of drill grooving cutters. The dimensions are calculated according to the following formulas:

$$W = 0.8\,D$$
$$A = 0.475\,D$$
$$R = 0.675\,D$$
$$r = 0.525\,D$$

In which W = width of cutter,

D = diameter of drill to be fluted,

r = small radius of cutter form (see illustration),

R = large radius of cutter form (part of cutter forming the cutting edge of the drill, see illustration),

A = distance from side of cutter to point where radii meet (see illustration).

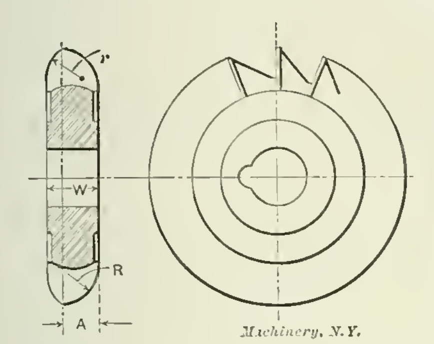
Drill fluting cutters are usually made with eccentric relief, but they also may be provided with ordinary milling cutter teeth, as shown in the accompanying illustration, in which case they must be ground by the aid of standard forms in special fixtures of the type described in the October, 1908, issue of MACHINERY.

The circular arcs drawn with radii R and r should each be tangent to their respective sides of the cutter itself. At the point where they meet, the sharp edge which would result from having the two arcs intersect is slightly rounded off. The radius for this rounded portion is of no particular importance, its object being merely to remove the sharp corner which would otherwise result. When a cutter of this type is used for fluting drills, the curve formed by radius R cuts that part of the groove which represents the cutting edge, while that part of the curve formed by radius r cuts that part of the groove which forms the heel or the back of the drill spiral.

Dimensions are given for the form of grooving cutters for drills from the smallest drill gage size up to 3 inches diameter. It is evident that it is not necessary to have an especially formed fluting cutter for all the sizes specified in the table. As a rule the same cutter can be used for a group of drills, these groups including several sizes below and above the diameter for which the form is specifically calculated. In the case of the "number sizes" of drills, the dimensions of the cutter specified for No. 64, for example, are intended for sizes Nos. 61 to 64, inclusive; those for No. 36, for sizes Nos. 33 to 36, etc.

The table also gives dimensions for the thickness of the web, and the width of the land of twist drills. When speaking of the width of the land, that part immediately behind the cutting edge on the cylindrical portion which is left the full diameter—that is, not relieved—is meant. While the table does not give all the fractional sizes to which twist drills are commonly made, the dimensions for the sizes not given may be easily interpolated.

TABLE OF DRILL GROOVING CUTTERS, THICKNESS OF WEB AND WIDTH OF LAND (PORTION NOT RELIEVED) OF TWIST DRILLS



Diam. of Drill (Drill Gage No.)	W	r	R	A	Thickness of Web of Drill	Width of Land
80	0.013	0.008	0.011	0.007	0.003	No clearance
76	0.018	0.011	0.014	0.010	0.004	
72	0.022	0.015	0.017	0.012	0.005	
68	0.027	0.017	0.021	0.015	0.006	0.010
64	0.030	0.019	0.025	0.018	0.007	0.015
60	0.033	0.022	0.028	0.020	0.008	0.015
56	0.043	0.027	0.035	0.025	0.009	0.015
52	0.055	0.035	0.046	0.032	0.010	0.015
48	0.064	0.041	0.053	0.037	0.012	0.020
44	0.073	0.047	0.061	0.042	0.014	0.020
40	0.081	0.052	0.068	0.047	0.016	0.020
36	0.088	0.055	0.073	0.051	0.017	0.025
32	0.101	0.065	0.085	0.059	0.019	0.025
28	0.116	0.075	0.097	0.068	0.021	0.025
24	0.124	0.081	0.104	0.073	0.023	0.030
20	0.133	0.087	0.112	0.079	0.025	0.030
16	0.143	0.094	0.119	0.085	0.027	0.030
12	0.152	0.100	0.128	0.090	0.029	0.030
8	0.160	0.105	0.135	0.096	0.031	0.035
4	0.173	0.114	0.146	0.103	0.033	0.035
Inches						
1/4	0.200	0.131	0.168	0.119	0.038	0.040
9/32	0.225	0.147	0.189	0.133	0.042	0.045
5/16	0.250	0.164	0.211	0.148	0.045	0.050
11/32	0.275	0.180	0.232	0.163	0.048	0.050
3/8	0.300	0.197	0.253	0.178	0.051	0.055
13/32	0.325	0.213	0.274	0.193	0.054	0.055
7/16	0.350	0.230	0.295	0.208	0.058	0.060
1/2	0.400	0.262	0.337	0.238	0.066	0.060
9/16	0.450	0.295	0.379	0.267	0.074	0.065
5/8	0.500	0.328	0.422	0.297	0.082	0.065
11/16	0.550	0.361	0.464	0.327	0.090	0.070
3/4	0.600	0.394	0.506	0.356	0.098	0.075
13/16	0.650	0.426	0.548	0.386	0.106	0.080
7/8	0.700	0.459	0.590	0.416	0.114	0.085
15/16	0.750	0.492	0.632	0.445	0.122	0.090
1	0.800	0.525	0.675	0.475	0.128	0.090
1 1/16	0.850	0.558	0.717	0.504	0.134	0.095
1 1/8	0.900	0.591	0.759	0.534	0.140	0.095
1 3/16	0.950	0.623	0.801	0.564	0.146	0.100
1 1/4	1.000	0.656	0.844	0.594	0.152	0.100
1 5/16	1.050	0.689	0.886	0.623	0.158	0.105
1 3/8	1.100	0.722	0.928	0.655	0.164	0.105
1 7/16	1.150	0.754	0.970	0.683	0.170	0.110
1 1/2	1.200	0.788	1.012	0.713	0.176	0.110
1 9/16	1.250	0.820	1.054	0.742	0.182	0.115
1 5/8	1.300	0.853	1.097	0.772	0.188	0.115
1 11/16	1.350	0.886	1.139	0.801	0.194	0.120
1 3/4	1.400	0.919	1.181	0.831	0.200	0.120
1 13/16	1.450	0.951	1.223	0.861	0.206	0.125
1 7/8	1.500	0.984	1.265	0.891	0.212	0.125
1 15/16	1.550	1.017	1.307	0.920	0.218	0.125
2	1.600	1.050	1.350	0.950	0.224	0.130
2 1/8	1.700	1.115	1.434	1.009	0.236	0.130
2 1/4	1.800	1.181	1.518	1.069	0.244	0.135
2 3/8	1.900	1.247	1.603	1.128	0.252	0.135
2 1/2	2.000	1.313	1.687	1.187	0.260	0.140
2 5/8	2.100	1.378	1.772	1.247	0.268	0.145
2 3/4	2.200	1.444	1.856	1.306	0.276	0.150
2 7/8	2.300	1.509	1.940	1.365	0.284	0.155
3	2.400	1.575	2.025	1.425	0.292	0.160

* * *

Thomas P. Brooke of Chicago, has developed a twin revolving cylinder gasoline engine for automobiles and airships in which the gyroscopic action of the engine is dangerous. The principle of the Brooke engine—named the "Non-gyro" motor—that eliminates gyroscopic action is simply the use of two flywheels, or their equivalent, revolving in opposite directions. The helical or corkscrew action of a skidding automobile that overturns when rounding a curve at high speed is largely influenced by the gyroscopic action of the flywheel. If another flywheel of the same weight were running close to it in a parallel plane and at the same speed in the opposite direction, the gyroscopic action would be practically neutralized. Two sets of cylinders in the Brooke engine revolve around the same axis but oppositely. It is claimed that the fatal aeroplane accidents following a glide or dip were due to the twisting of the machine because of the gyroscopic force of the propeller and engine.

"INS AND OUTS OF GEAR HOBBING"—THE FELLOWS CUTTER

By RALPH E. FLANDERS*

This reply to Mr. Lees' letter in the April number of MACHINERY naturally divides itself into two parts. To begin with, the writer will answer in the first person the criticism of his original article in the January number of MACHINERY. The second part of the reply will explain (on behalf of the Fellows Gear Shaper Co., with which the writer is connected) the alarming puzzle propounded by Mr. Lees in relation to the circular pitch of ground-down cutters when used in gear shapers. It should be noted, in passing, that this second question is entirely foreign to the original subject of discussion.

Reply to Criticism of Original Article

I find myself in agreement with Mr. Lees in the main, particularly as to the cause of flats on generated gears. He evidently understands the nature of these flats, which is not the case with some of the other bright men who have written on the subject lately. As he realizes, any flats large enough to be troublesome are not due to theoretical causes, but to practical defects in the generating. If he will but add two more causes to his list—imperfect generating action due to torsional deflection and back-lash in the drive, and inaccuracies due to wear of index-wheels rotated at high speed and pressure—we will be in full agreement.

As to the centering of the hob tooth, we both agree that the distortion of the ordinary hob, as a result of hardening, is so great that it would be hard to find any slight improvement that might be produced by shifting the tooth toward or away from the center line. That conclusion is not disputed by my experiments.

Mr. Lees' scheme of having a straight flute at an angle is interesting. This is theoretically about as good as the helical flute, if allowance is made for its peculiar shape in grinding the teeth and in the form of the relief. Without definite information as to the design and making of the hob, it would not be safe for me to offer criticisms.

Circular Pitch of Gear Shaper Cutters

The other question, relating to the gear shaper cutter, involves an understanding of the nature of the relief of the cutter; and this is a subject, as every student of gearing knows, on which the Fellows Gear Shaper Co. has talked, written and explained continuously for the last dozen years. Will the editor permit valuable space to be taken up by another discussion of so threadbare a subject? Inasmuch as there appears to remain at least one mechanic who has not gotten to the bottom of this elementary matter, and inasmuch as we propose to discuss it in a new and simpler way, it may be that the editor will indulge us while we go over the subject once more. Here is the "direct answer" to the question asked: The sharpening of the gear shaper cutter certainly does reduce its diameter, but the reduction of the circular pitch which thus results does not reduce to the slightest degree the circular pitch of the work, nor does it change the acting tooth surfaces in any way.

To understand this, let us first study Figs. 1, 2 and 3. Here we have the same 10-pitch cutter C, which has 30 teeth, generating 30 teeth in each of the three blanks N, L and S. Blank N is of the normal size for a standard gear of 30 teeth. Blank L is larger than standard, being right for 31 teeth. Blank S is smaller than standard, being right for 29 teeth. Gear N and cutter C both being normal and of the same number of teeth, have of course the same outline on the acting surfaces, the only difference being that the point of the cutter tooth is extended beyond that of the gear so as to cut out the clearance at the bottom of the tooth space.

Gears L and S were generated by cutter C, so it must be that they would mesh with cutter C, considering the latter as a gear; and since cutter C has exactly the same outline as gear N, it is evident that L and S will both mesh properly with N, as shown in Figs. 4 and 5. Furthermore, they will mesh with any standard 10-pitch gear of the same system as that to which N belongs. They are both shown meshing with a standard 76-tooth 10-pitch gear in Fig. 6.

Suppose that in Fig. 4, L, instead of being an enlarged gear, is an enlarged cutter of the same outline. Since L as a gear meshes properly with a normal gear, it is evident that as a cutter it will properly generate a normal gear. In the same way, the abnormally small gear S of Fig. 5 could be replaced by a cutter of decreased diameter and of the same outline, and this cutter would generate a normal gear properly. In short, since abnormally large and small gears run correctly with normal gears, the corresponding enlarged or decreased cutters will generate normal gears correctly. This holds good whether a 30-tooth or a 76-tooth gear is being generated, or a gear of any number of teeth from 12 up. So much for the matter of generating the same true involute with cutters of enlarged, normal or decreased diameter.

Now we are ready for this troublesome question of decreased circular pitch. It is a well-known elementary characteristic of the involute gear that the actual or working pitch diameter is a flexible dimension, not a fixed one. This is due to the fact that involute gears run correctly at varying center distances. In Fig. 7, for instance, the nominal pitch line (located 0.100 inch from the tops of the teeth in all these 10-pitch gears) is shown by dotted lines. The actual or working pitch circles are in different positions, as shown by the full lines. Since here we have a small gear running with a normal gear, the center distance is less than normal, and so the two pitch circles (which must touch each other and be equal to each other in diameter, since each gear has the same number of teeth) are smaller than standard. The actual pitch line thus falls outside the nominal pitch line on the small, and inside the nominal pitch line on the normal gear. In Fig. 8, where the center distance is increased by running a large gear with the normal gear, the conditions are reversed.

The student must get a firm grasp on this fact that the pitch diameter of the involute gear is a flexible dimension. This condition applies to the involute form of tooth alone, and not to the cycloidal or to any other system. As a further illustration, see Fig. 9, where the normal gear N of Fig. 8 is shown running with another normal gear N_1 of identical dimensions. The same gear N which is here running on standard pitch line No. 1, used pitch line No. 2 in Fig. 7. In both Figs. 7 and 9 the action is theoretically as well as practically accurate.

It is this shift in the actual or working pitch line which enables a cutter of decreased diameter to cut a normal gear of standard circular pitch. In Fig. 7, for instance, suppose that S, instead of being a small gear, is a cutter reduced by grinding. As measured on the nominal or dotted pitch line, it has a smaller circular pitch than standard, but it is not rolling on that nominal pitch line at all. It is rolling with the mating gear on the actual pitch line, shown by the full line. On this actual pitch line, the cutter, of course, transfers the exact thickness of its tooth to the width of the tooth space *at that point*. At the nominal or standard pitch diameter of the gear, however, shown by the dotted lines, the cutter tooth rocks somewhat as it goes in to and out of action, thus cutting a tooth space wider than itself—just wide enough, in fact, to give the standard width of space at the pitch line for the standard circular pitch. By reversing this train of reasoning, it can be shown that an enlarged cutter having the outline of gear L in Fig. 8 will also cut a tooth space of normal thickness at the standard pitch diameter in the standard gear.

Thus we see that we can cut gears of standard dimensions with a cutter so made that it will have the dimensions of gear L when new and of gear S when ground down, as illustrated in Figs. 1 to 8. Gears S and L, however, show extreme variations in diameter and circular pitch, the case being exaggerated to show the principle. The real difference in the diameter of the cutter is scarcely one-eighth of that here illustrated, but the principle remains the same. All that has been

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said relating to gears S and L applies to the cutter as well. Fig. 10 shows a new and Fig. 11 a ground-down 10-pitch cutter. The general resemblance of the change of shape to that of gears L and S can be traced. For instance (as is shown more plainly in the edge view, Fig. 12) as the diameter decreases, the width of the top of the tooth increases slightly. This agrees with the tooth point of gear S, which is slightly thicker than that of gear L.

How shall we make a cutter so that it will resemble gear L when new and gear S when ground down? To answer this,

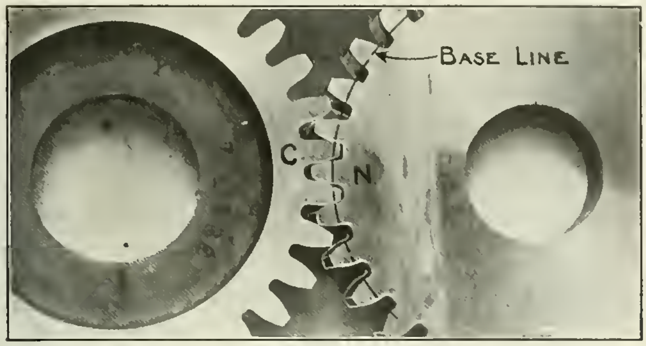


Fig. 1. A 30-tooth 10-pitch Cutter of Normal Diameter generating a Normal 30-tooth Gear

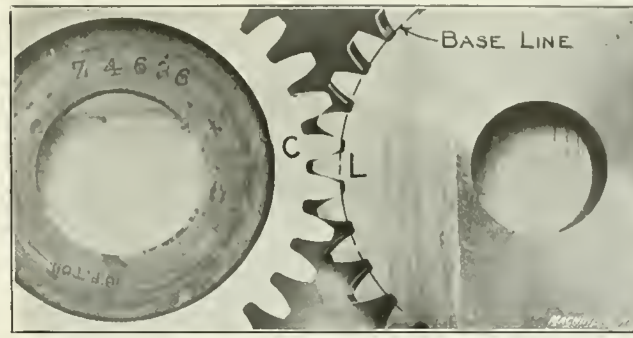


Fig. 2. Normal 10-pitch Cutter generating Thirty Teeth in a Blank of Proper Size for Thirty-one Teeth

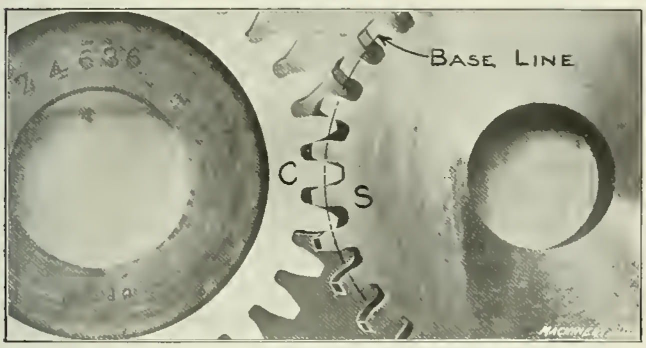


Fig. 3. Normal 10-pitch Cutter generating Thirty Teeth in a Blank of Proper Size for Twenty-nine Teeth

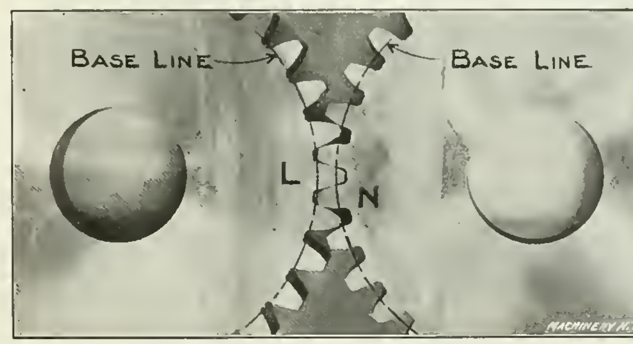


Fig. 4. The Large Gear Fig. 2 and the Normal Gear of Fig. 1 in Accurate Theoretical Mesh with each other

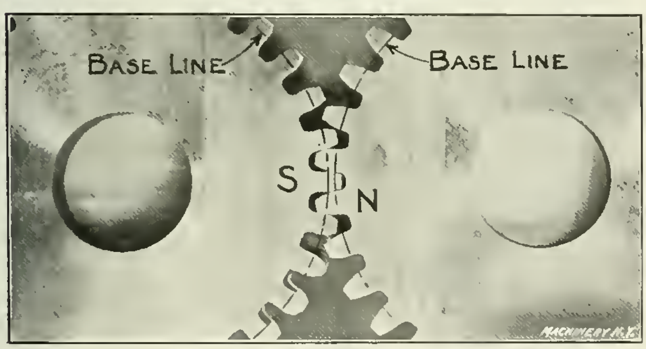


Fig. 5. The Small Gear of Fig. 3 and the Normal Gear of Fig. 1 in Accurate Theoretical Mesh with each other

Fig. 6. The Small Gear of Fig. 3 and the Large Gear of Fig. 2 in Accurate Theoretical Mesh with a 76-tooth Gear

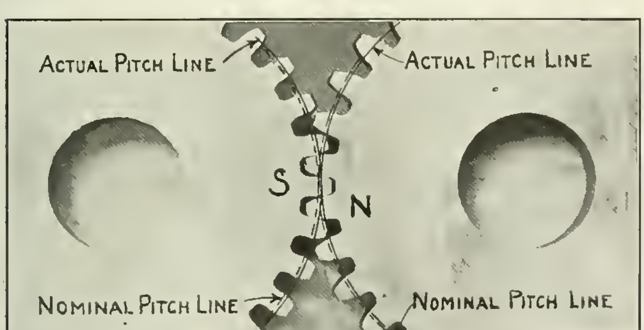


Fig. 7. The Small Gear and the Normal Gear in Mesh, showing the Difference between the Actual and the Nominal Pitch Lines

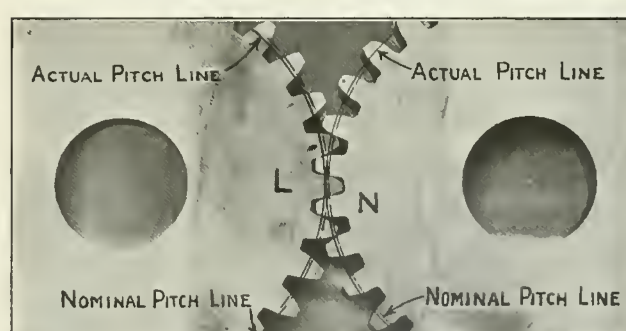


Fig. 8. The Large Gear and the Normal Gear in Mesh, showing the Difference between the Actual and Nominal Pitch Lines

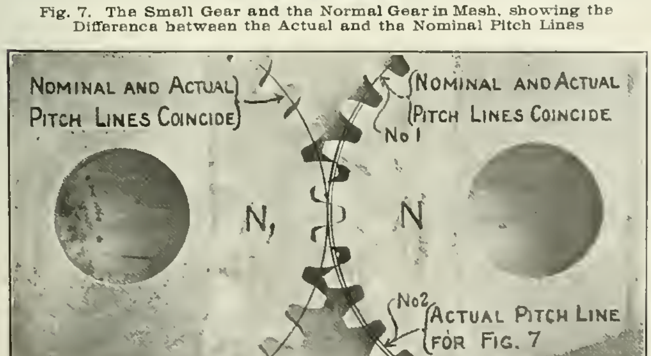


Fig. 9. The Normal Gear of Fig. 7 in Mesh with another Normal Gear, showing the Change in Pitch Line from Fig. 7


Fig. 10. A New Cutter having an Outline corresponding to the Normal Gear of Fig. 1, or even slightly enlarged, like the Gear in Fig. 2

we must first examine the nature of the tooth curves in L and in S. The three gears L, N and S are shown superimposed in Fig. 13, with one edge of a tooth of each matched up. Ocular evidence is thus given of the fact that the same involute is used for the teeth of all three gears, *i. e.*, the involute acting surface of each tooth of the three gears L, N and S is developed from the same diameter of base circle. The same identical curve is carried to successively larger diameters on the three gears. (The reader understands, of course, that the points of the teeth will show correction, as with all 14½-degree gears.)

To make a cutter, therefore, whose top, central and lower

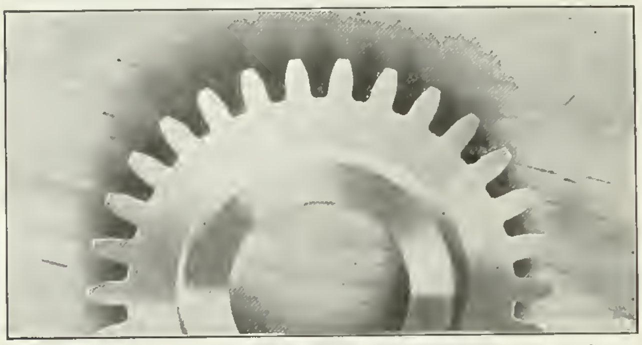


Fig. 11. A Ground-down Cutter having an Outline approaching the Abnormally Small Gear of Fig. 3

sections shall conform to the outlines of L, N and S, we have only to make its teeth all the way from front to back on the same involute curve, generated from the same base circle, but thinner at the back than at the front, in just the same proportion that the tooth of S is thinner than the tooth of L. The method of grinding this involute shape was described in our advertisement in MACHINERY in January, 1911, page 48, to which reference should be made. We will here simply call attention to the fact that the setting of the spindle of the

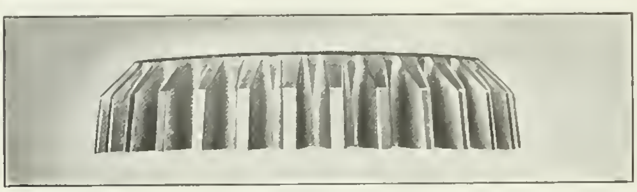


Fig. 12. Edge View of a Cutter, showing the Widening of the Tooth Point as the Diameter decreases

emery wheel to the "clearance" angle thins the tooth of the gear at the back by the required amount, but it does not change the shape of the involute, which is generated from the same base circle throughout the whole length of the tooth.

There is another important practical consideration which should be mentioned in connection with Fig. 6. An abnormally small gear or an abnormally large gear generated on the gear shaper will run correctly with standard gears or with each other. This is exceedingly important, as it makes it

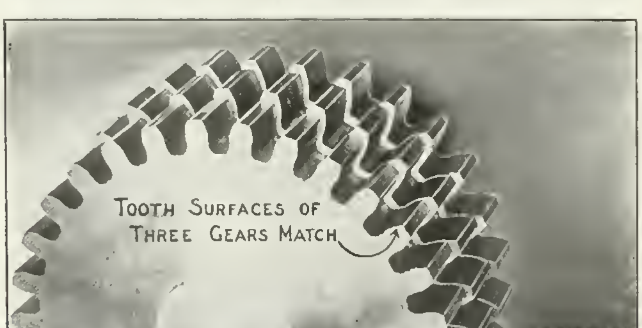


Fig. 13. Tooth Surfaces of the Small, Normal and Large Gears Matched, to show that they are all made from the same Involute

possible to cut theoretically correct running gears for center distances somewhat greater than normal or somewhat less than normal. It also permits cutting gears deeper than standard so as to have a certain amount of back-lash and still have them run correctly. Where considerable back-lash is desired, a ground-down cutter has to be set a few thousandths deeper than a new one, but there is absolutely no change in the acting outline of the tooth, and no change in the tooth action. None of these things can be done with the standard formed and relieved cutter, which must be set at exactly the right pitch diameter to get correctly running gears; there is no flexibility possible. Flexibility of this kind is confined to generated gears only.

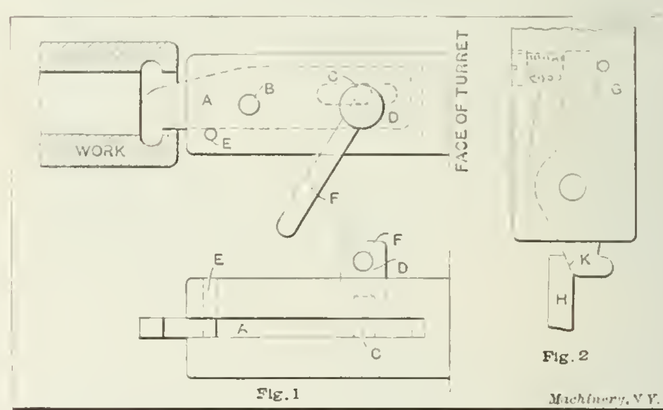
We have chosen to illustrate these elementary principles by simple elementary experiments rather than diagrams, because we wish to make the matter as clear as possible. Anyone with a gear shaper at his disposal can repeat these experiments. Anyone who does this will learn more about the relief of the gear shaper cutter, and about the action of involute gearing in general, than he could learn from whole volumes of reading matter and whole acres of diagrams.

* * *

RECESSING TOOL

On a recent visit to the Robbins & Myers Co., of Springfield, Ohio, manufacturers of electric fans, the writer saw a simple and quickly-operated recessing tool, the principle of which is indicated in the accompanying illustration Fig. 1. The recessing tool A is pivoted at B and actuated by a pin C fitting an oblong slot in the tool. The pin C is inserted eccentrically in stud D, which is provided, at its outer end, with a handle. It is evident that when the handle is turned it will move the cutting point of the tool out or in, as the case may be. The tool is used in a turret lathe, and the operator, after having finished the other operations necessary, and having brought the turret into position for the recessing operation, simply turns the handle F until it assumes the position shown in the engraving. A stop may be provided at E, as shown, if the depth of the recess is of importance.

A similar device for recessing in the drill press, the recessing tool being automatically fed into the work, was also seen at the works of the company mentioned. The tool-holder in this case, of course, is held in the drill spindle in a vertical position. The construction of the tool is identical with the



Figs. 1 and 2. Recessing Tools for Turret Lathe and Drill Press

one shown, except that the eccentric pin C, stud D and handle F are not used. Instead a spring holds the tool, when not in action, against a positive stop G, as shown in Fig. 2, and a pin H inserted in the drill jig operates against the back of the tool at K, thus feeding it automatically into the work. As the tool is sketched from memory, the actual construction may have been slightly different, but the principle involved is clearly indicated. E. O.

* * *

An interesting device for pulling shaper rams when scraping is used in the Walcott & Wood Machine Tool Co.'s shops at Jackson, Mich. When scraping in a shaper ram, the machine to be scraped is placed in front of another shaper, and the ram of the shaper to be scraped in is attached by a link to the ram of the other shaper, and is pulled to and fro by the motion of this shaper. This is a simple and convenient arrangement and has proved very satisfactory.

* * *

A writer on machine photography states that the "pose" of machinery is a matter of much importance if the best effect is desired. "Reciprocating parts should not be shown at the end of their travel; their functions and form are much easier seen, as a rule, if they are at some intermediate, but not exactly mid-position."

DEVELOPMENT IN LODGE & SHIPLEY LATHE PRACTICE

In the June, 1909, number of MACHINERY, in the department of New Machinery and Tools, a crankshaft lathe built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, was illustrated and described. One of the novel features of this machine was the provision made for positive stops for both longitudinal and cross movements. These stop arrangements are now provided on other types of Lodge & Shipley lathes as well, and the application of the longitudinal stops to manufacturing work is of especial interest.

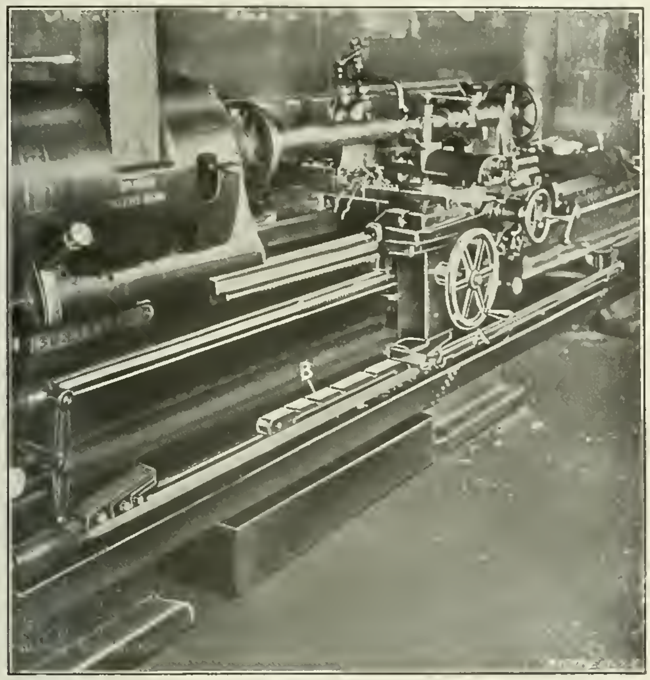


Fig. 1. Turning Spindles by the Aid of a Spacing Bar on a Lodge & Shipley 22-inch Lathe

The essential features of the longitudinal stops are, briefly, as follows: A rectangular bar *A*, Fig. 1, is placed in the front of the bed, just below the apron. This bar slides in brackets bolted to the bed. To this bar are clamped stops adjustable the entire length of the bar. At the bottom of the apron is bolted a bracket with a pivoted arm which engages with the stops on the sliding bar. When engagement takes place, the bar slides with the carriage, and by means of the mechanism at the headstock end, a clutch on the lead-screw is drawn out of mesh and the feed stopped.

It is evident that while the stops can be set to take care of any manufacturing work, insuring that all the parts are turned alike, it is necessary to set them for each lot, if the machine has been used, in the meantime, for other work. This setting, of course, requires time, and unless carefully done, slight inaccuracies may creep in, making the work not strictly interchangeable. For this reason the Lodge & Shipley Machine Tool Co. has adopted a system of standard spacing bars for work that is put through the shop in lots from time to time. A collection of these spacing bars is shown in Fig. 2, which illustration also indicates the method by which they are kept when not in use on the lathe. These spacing bars, when used, are placed on the sliding bar previously referred to, and act as a substitute for the adjustable stops. In these bars each notch acts as a stop for a shoulder on the work turned, and as in this case one bar is used for each piece of work, there is no need of setting the adjustable stops for standard work. All that is required, after a spacing bar has once been provided, is to place it in position on the sliding bar, and the workman can proceed with his work. The spacing bar acts as a jig, insuring that every time the same bar is used, interchangeable work will be produced. It will be understood that the pivoted arm on the apron bracket drops into each of the slots in the spacing bar successively, instead of engaging the individual adjustable stops, and that thus a permanent relation is established as regards the distance between the shoulders on the work.

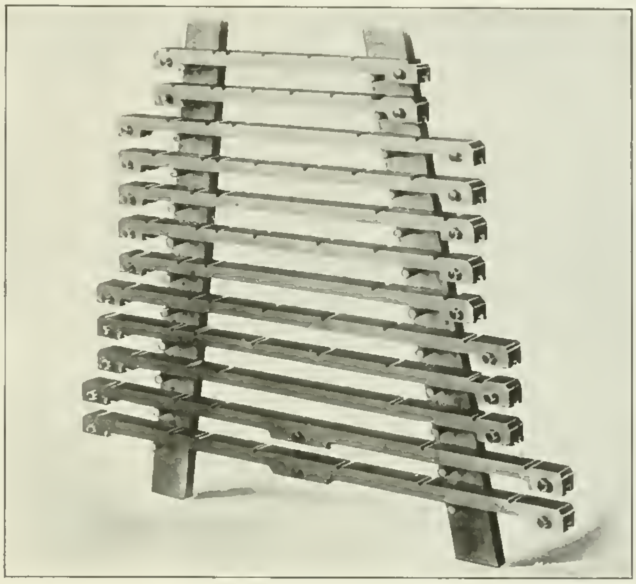


Fig. 2. Rack for Spacing Bars used on a 22-inch Lodge & Shipley Lathe for Spindle Turning

An important feature is that these spacing bars can be kept in the tool-room, and that the workman calls only for the one required for the work in hand. The bars are all stamped for ready identification, and mistakes are thus guarded against.

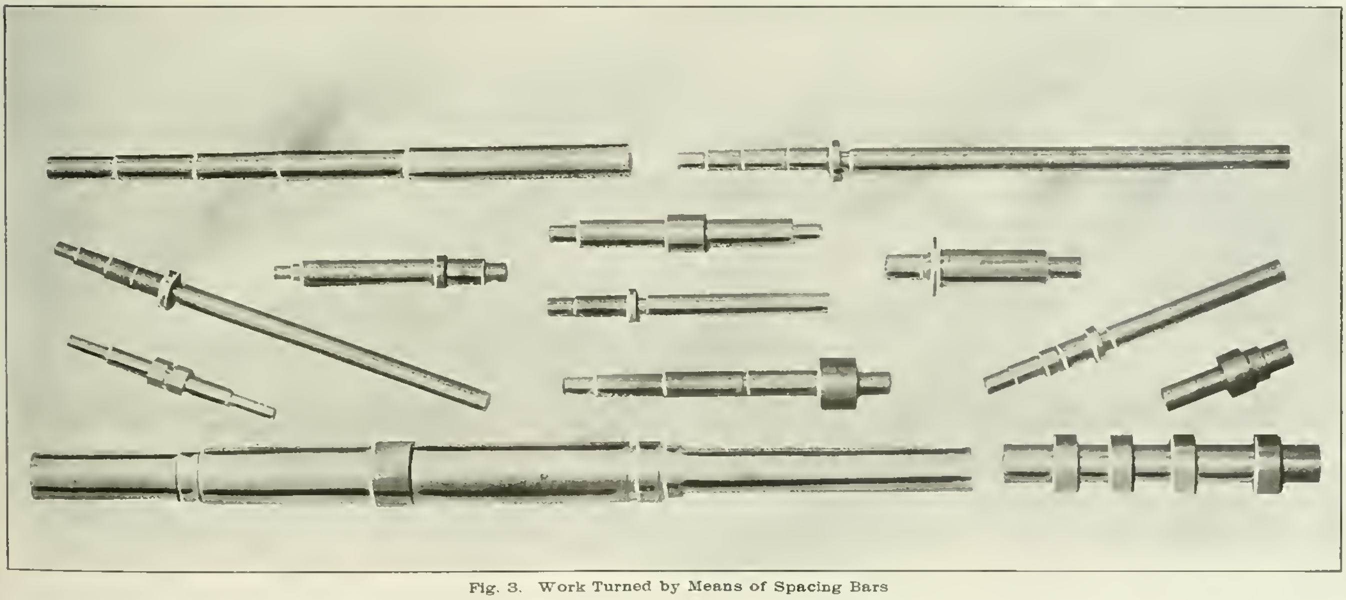


Fig. 3. Work Turned by Means of Spacing Bars

In the accompanying illustrations, Fig. 1 shows the finish turning of spindles by the aid of a spacing bar *B*. Fig. 2, as mentioned, shows the spacing bars, while Fig. 3 shows shafts and spindles turned by the aid of spacing bars.

COMMUTATOR MAKING

By ALTER EGO

As electrically-driven machinery becomes more generally used, many shops will have more or less to do with the making and repairing of generators and motors, and so for that reason, an article dealing with the manufacture, should prove acceptable. The writer, after going through the many stages of experimental construction and having to devise ways and means for the practical production of several sizes of small motor commutators has worked out a system of tools and operations that has proved very satisfactory. In a general way, what is true in the making of one commutator is also true in the making of a greater number; this has been borne in mind throughout.

In an electrical sense at least, the word "armature" implies commutation, and commutation means a change in current direction, which change is brought about through the medium of a very pretty mechanical contrivance technically

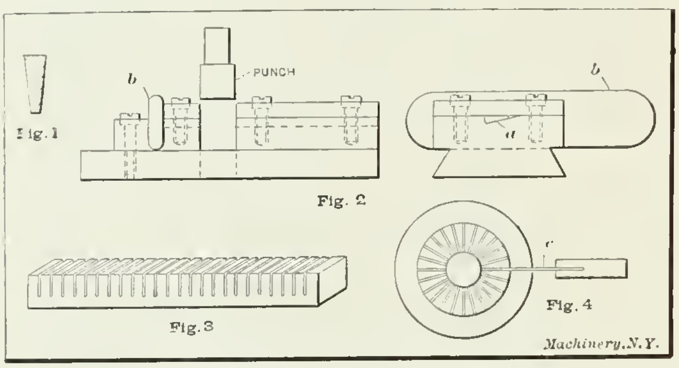


Fig. 1. Section of Copper Rod Stock. Fig. 2. Shearing Die. Fig. 3. Stock Rack for Copper and Mica Pieces. Fig. 4. Assembling Ring

called a "commutator." Briefly stated, a commutator is made up of a number of wedge-shaped copper segments separated or insulated one from another by carefully measured and selected pieces of sheet mica. The copper is first accurately rolled into rods of any convenient length, these rods having a cross-section more or less wedge-shaped—more accurately sectors of a circle—the angle changing as the number of sections in the commutator increases or decreases. Such a section is shown in Fig. 1.

The first machine operation after rolling the stock is that of cutting the segments to length. Sawing off was tried and found too slow and wasteful of stock, so shearing-off has been tried and proved successful. The die used, shown in Fig. 2, is a very simple one and, being made in sections, can be repaired at little expense. In operation, the stock is introduced into an opening in the end of the die, this opening being slightly larger than the stock, and so constructed that the upper side is in a flat or horizontal position as at *a*,

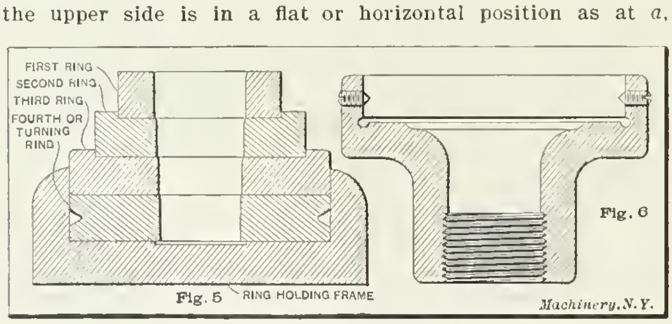


Fig. 5. Compression Rings and Holder. Fig. 6. Chuck for Holding Rings in Turret

Fig. 2; the stock is pushed ahead until it comes against the stop *b*. With the descent of the punch, two pieces are cut off, one dropping through an opening in the die and the other remaining until the stop *b* is withdrawn, the stock on being forced ahead knocking this piece out. The stop is then replaced and the operation repeated. The die is made in three sections, namely, the left, center, and right. The left and center sections are of the same width and determine the length of segment; the sections left and right are covered, the purpose being to support the stock on all sides, by which means the copper segments are delivered from the dies with practically no rounding off or breaking down of the edges.

Consider an order for a lot of commutators of, say, 24 sections each. The copper segments and mica insulations, having been inspected, are placed in racks such as shown in Fig. 3, each holding just 24 pieces; without these racks trouble might be experienced from introducing one too many or too few pieces into the commutator which might not be discovered until too late to be corrected. The counting of these pieces after they are assembled would be rather a tedious and difficult job. In assembling, use is made of a ring having a

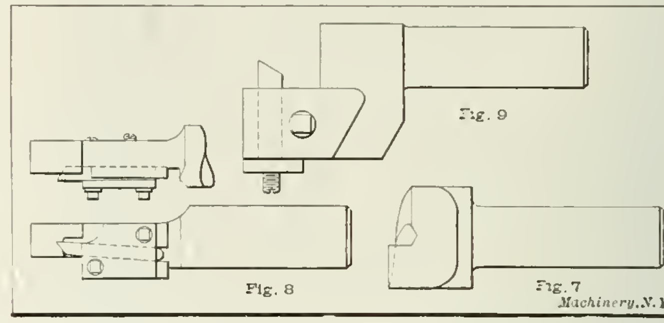


Fig. 7. Formed Facing Tool for Roughing the Sides. Fig. 8. Single-point Tool for Angular Recesses. Fig. 9. Outside Roughing Tool using Cutters Interchangeable with those in Fig. 8

hole large enough to easily take in all these pieces; such a ring is shown in Fig. 4. This ring has a slot cut in it to receive a removable blade *c*. Around the inside of the ring and resting against the blade are placed on end pieces of copper and mica alternately, until 24 pieces of each have been assembled; when the ring is filled, the blade is pulled out and the pieces are bound together with a wire to form a blank.

The next operation is that of compressing the blanks, and consists of forcing them through a number of cast-iron rings, which have slightly tapered holes, a set of which is shown in Fig. 5. The first ring is of such a size that it permits of the blank being pressed in by hand, this operation straightening up the copper and mica if at all twisted. The second ring is made somewhat smaller, and a pressure of about two tons is used to force the blank in. A third ring is still smaller and a pressure of about five tons is used this time,

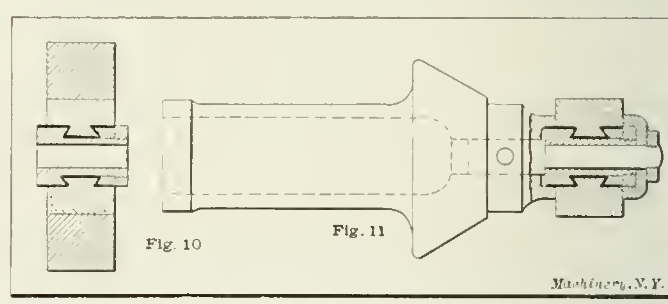


Fig. 10. Section through Turning Ring and Blank showing Sleeve and Insulations assembled ready to be faced from Ring. Fig. 11. Turret Lathe Arbor indicating method of Clamping the Copper by the Sides

while the fourth ring, which will be called the "turning" ring, because the turning is done in it, is so constructed that a final pressure of about seven tons gives all the needed compression. It is obviously impractical to have only one ring in which to turn the blanks, and it would be equally impractical to have one for each commutator when making them in large lots. However, as these rings may be made at small cost, a stock of from five to ten per cent of the number of commutators to be made, will be sufficient. The large side of the hole in the turning rings is well rounded to allow the blanks to enter without shaving the sides, hydraulic presses being used for this purpose. The slow, steady action of these presses is very desirable, giving ample time for the parts to adjust themselves.

The rings are now put into a special turret lathe chuck, Fig. 6, and finished completely inside and roughed on the outside faces, allowance being made for final finishing; Figs. 7, 8, and 9 show the tools employed for the purpose. Copper is not a good material to work in a screw machine, and when there is an additional five to ten per cent of mica, trouble

arises that calls for much care and patience on the part of the operator. The use of oil, soapy water or kerosene emulsions in the machining of commutators, is for chemical and electrical reasons, prohibited. Good turpentine is perhaps the best tool lubricant that may be used, for in drying out it leaves a thin coating of resin that in itself is a good insulator and is not likely in its chemical change to attack the copper, setting up an electrolytic action which may eventually cause a breakdown of insulation. All tools other than the drill and reamer for the sleeve hole are of the single cutting point style and so made that they may be ground without changing their shape. All are made from some of the various high-speed steels and are left as hard as they can be used; and yet they require constant attention to keep them in such a condition that they will not drag the copper across the mica insulations.

In view of the difficulties encountered in machining, controlling sizes, etc., and the non-essential features involved in this piece, very liberal limits are allowed up to the point of assembling the sleeve and insulation. Limits of from 0.001 to 0.003 inch for all inside diameters and 0.002 to 0.005 inch for thickness are not excessive and may be maintained without much trouble to the operator.

Small commutators such as those under consideration, are seldom repaired; by this is meant that they are not taken apart in order to replace pieces. The smallness of the parts, trouble of refitting insulation, and the general design, make this impractical; therefore absolute interchangeability of parts is in no way essential to the making of good commutators. After the first side of the blank has been machined, the ring is reversed in the chuck and the other side machined. When taken from the chuck, the piece looks bright and clean, but upon examination under a glass, little chips and threads of copper crossing over the mica from section to section may be found; these must all be very carefully removed or trouble is sure to follow. Time spent on this operation will more than pay for itself later on. After cutting and scraping away these small short-circuits, the sleeve, clamp-nuts and the various insulations are ready for assembling to the copper blank. Assuming that the insulations have been made up ready for use, the amount of trouble likely to be experienced in this operation depends largely on the nature of the material from which these insulations have been made. Consider briefly the three kinds of material most generally used for this class of work:

Mica—a mineral—owing to its peculiar structure, does not lend itself readily to any sort of shaping; therefore, for use it must be cut as nearly as possible to the form needed, building up thin pieces until the form and thickness have been made, binding the whole together with thin shellac, and finally putting it into place while wet.

Micanite—a commercial article—is made up of thin sheets of mica pasted together with shellac, copal, sandarac or other heavy gum varnishes; it is then placed between hot plates, the excess of binder squeezed out, and after cooling, it is ground to the desired thickness. From these sheets many forms may be cut and molded by heating in suitable forms, thus making less work in assembling.

Vulcanized fiber—a vegetable fiber chemically treated—may be purchased commercially in many sizes, in the form of sheets, rods, tubes and special forms, and with little machining makes a most desirable insulation, its one drawback being its liability to swell and shrink under varying atmospheric conditions. Experience has shown that if this material be well dried before machining and afterward coated with some good moisture-resisting varnish and then well baked, it will be found to have lost its hygroscopic properties to a marked degree.

Much has been done to prove the values of different kinds of insulating materials, and from these records it has been found that the values of the insulations are rated in the following order: Mica, micanite, and fiber. The fact that it is third in the scale, does not condemn the fiber, as these scales of values have been calculated for cases involving great power and high voltages, and in no way apply to small motors that seldom operate on more than a 220-volt circuit. This fiber insulation, 0.032 to 0.062 inch thick, will safely stand five to six times this voltage without breakdown or other signs of distress.

Having assembled the parts and tightened up the nut as much as possible, as in Fig. 10, the copper blanks are forced from the turning ring. These rings may now be re-filled and the foregoing operations repeated.

The outside turning is now in order and is to be done in the turret lathe, the commutator being held by a clamp arbor, Fig. 11, so made that the piece is clamped on the copper sides; if held in any other way, there is danger of the sections turning and pulling out of the sleeve, completely destroying the commutator. In the machining, front and back roughing tools are used for the flange diameter, and first and second roughing box-tools for the body diameter; these with the necessary gages complete the outfit for this operation, 0.008 to 0.010 inch being allowed for a finish turning. After the roughing operation is completed, the sides, flange and body of the commutators are skimmed or finish turned with a fine-pointed tool in a bench lathe. If provision is made to face the copper, working from the sleeve ends, it is possible with very little care to get these pieces into an interchangeable condition as regards outside dimensions.

After skimming, the slots for the armature wires are milled, one for each section in the commutator; two cutters may be used to good advantage in this operation. The milling of the wire slots marks the ending of the machine operations on these commutators and they are ready for a very careful inspection with an ohmmeter, galvanometer or simple "trouble-finder" that may be attached to any electric-light wire, indicating at once if there is a short circuit or a "bug"—as it is called in shop parlance—in the commutator. This so-called "bug," is usually a small chip—a sort of connecting link—between two or more segments or between any segment and the sleeve; this must be found and removed. Many expedients are resorted to in doing this, and these will suggest themselves to the workman, but the most successful and the cheapest one in the end, when the fault is known to be on the inside, is to throw the commutator away, for by so doing, the company will be saved money and the mechanic a good deal of trouble.

On the other hand, should the inspection show a perfectly insulated commutator, a slow baking for a day or two at a low temperature of, say 120 degrees F. will complete the job. If, now, out of the total number of commutators made, the loss is not greater than five per cent, the workman is to be congratulated.

* * *

In the shops of the Bradford Machine Tool Co., Cincinnati, Ohio, special tools and gages are provided for every operation, and if in the same piece there are, for example, several holes to be reamed, one reamer is provided for each hole even if the holes should be of the same size. Each hole is tried with a standard plug used for that hole exclusively, and when the reamer is found to be under size it is immediately sent to the tool-room for re-adjustment and grinding. Gages are used for setting the taper attachment on the lathes when turning standard tapers. The gages used are not short gages of the regular length that would be required for the standard taper, but are made from three to four times longer than the length of the standard taper shank, so that in setting the taper attachment, greater accuracy is possible on account of the length in which the taper is measured.

* * *

An Irishman recently over from the "ould sod" took a job in a machine shop as a handy man, and, being naturally smart, soon advanced. One day he was set to work on a shaper and everything seemed to be progressing favorably except from Mike's viewpoint, for he called the boss over and remarked: "Oi don't loike the way this machine runs. When she digs in when going ahead and working hard, why doesn't she take her toime when she's coming back?" You see he was comparing a shaper to a wheel-barrow. V. J. M.

THE PROBLEM OF CONE FRICTION CLUTCH DESIGN

By A. C.

The article entitled, "The Problem of Cone Friction Clutch Design," from the pen of Mr. Oskar Kylin, which appeared in the February number of MACHINERY, engineering edition, is a very useful one, and while the writer does not entirely agree with all the conclusions there drawn, he thinks that Mr. Kylin is to be commended for his able treatment of a subject concerning which there is but little reliable information.

The importance of this type of friction clutch as a detail of modern machine construction will probably increase in the future as quick-acting machinery becomes still further developed for (in the opinion of the writer at least) the speed limit for the expanding clutch is now approaching. As an instance of this, there is at the present time a machine being built with a more or less complicated combination of cone friction and positive reversing clutches, the designer claiming that expanding clutches would not be suitable, for the high speed develops a sufficiently great centrifugal force to

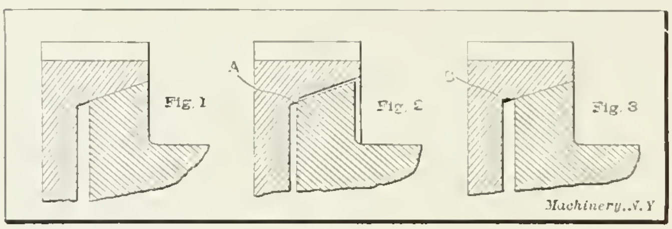


Fig. 1. Clutch as shown by Mr. Kylin's Drawings Fig. 2. Result of Wear on the Clutch shown in Fig. 1. Fig. 3. Clutch designed to compensate for Wear, by removing Triangular Ring B

expand the clutch ring (the idle one), materially affecting the efficiency of the machine. Whether this is actually true or merely a talking point for the combination, the writer does not profess to know, but it would seem reasonable to assume that such a condition is well within the realm of possibility, particularly when it is remembered that centrifugal force increases directly as the square of the velocity. It is evident in this respect that the cone clutch has the advantage, because it is obviously impossible for it to expand, no matter how high the speed may be within practical limits.

Another point wherein the cone clutch is superior, lies in the better distribution of the pressure. The writer has seen several expanding ring clutches in which the wear (and therefore the pressure) was confined to two comparatively small portions of the rings immediately opposite the expanding mechanism. In the case of the cone clutch this would be impossible if ordinary care were taken in the design and construction, for the pressure would be equally distributed over the whole of the friction surfaces, making possible a greater unit pressure.

In addition to the two advantages just named, it is probable that, from the standpoint of simplicity and ease of adjustment, the expanding clutch is outdistanced. This statement is rather general and perhaps should be qualified slightly, for some expanding clutches are quite simple; but speaking generally the cone clutch is much better where simplicity is concerned.

The first and most important item to be considered among the details of design is the unit pressure allowable on the friction surfaces. What is the maximum pressure under varying conditions of speed, different operators, etc., that can be maintained day after day without undue wear? Referring to standard engineering text- and hand-books, it will be found that the majority devote more or less space to the design of ordinary journal and other types of bearings, and it will also be found that the allowable pressure per square inch of projected area varies between remarkably wide limits; thus for slow-moving shafts, a safe limit of 3000 pounds per square inch is given, while for propeller thrust bearings, from 50 to 70 pounds per square inch is about the average—other classes of bearings come somewhere between these two.

It must be remembered, however, that these figures are for bearings in which the rubbing action or operation is constant, and it will be found that for a bearing in which the pressure alternates diametrally from side to side, as, for instance, in a crank-pin a considerably higher unit pressure is allowable. The reason advanced for this is that the bearing, when relieved of pressure on one side, lets oil into that side from external sources, and to some extent from the pressure side as well; also when the pressure does come on the bearing the period during which it acts is so short that the oil cannot be altogether squeezed out.

While in some instances friction clutches are operated quite frequently, there are certainly no cases where the operation is as frequent as the revolutions in the slowest of steam engines, and while in the latter the crank-pin bearing rubs or slips on one side or the other constantly, the bearing surfaces of a friction clutch slip very little. The slip that does occur is confined to a very short period at the moment of engagement, and it is quite probable that slipping has ceased before the oil with which the friction surfaces cannot fail to be covered, has had an opportunity to be squeezed out.

If then, the conditions under which the crank-pin and friction clutch operate are similar, it would appear that Mr. Kylin very clearly underestimates the unit bearing pressure allowable when he advises a pressure of only 60 pounds per square inch for the reversing clutch which he cites. Even on high-speed engines the unit bearing pressure for the crank-pin is as high as 600 pounds per square inch, while at low speeds it may reach as much as 800 pounds per square inch.

As an example of what has been done at higher pressures the writer will mention a clutch which he has designed: Mean diameter, 4¼ inches; width, 1 inch; maximum speed, 600 revolutions per minute; unit working pressure, 260 pounds per square inch; both members of the clutch made of cast iron. In service, the clutch is engaged about 100 times a day, and though rarely engaged or reversed while under load, the fact that there were four shafts and three pairs of

TABLE OF FRICTION CLUTCH DATA

Case	Horsepower Transmitted	Revolutions per Minute	Diameter, Inches	Width, Inches	Surface, Square Inches	Surface Speed, Feet per Min.	Tangential Force or Resistance R	Pressure between Surfaces to produce R $\mu = 0.1$	Unit Pressure, Pounds per Square Inch
								Pounds	
1	4	600	3	1	9.5	430	310	3100	325
2	4	300	5	1	16	390	335	3350	210
3	8	400	6	1¼	24	630	420	4200	180
4	12	400	7	1¼	28	730	540	5400	200
5	4	30	8½	1½	40	67	1970	19700	495
6	4	30	9	1¼	35	71	1860	18600	525
7	8	25	10	1½	47	65	4000	40000	850
8	12	20	12	1½	57	63	6300	63000	1115
9	7½	6	16	1¼	63	25	9900	99000	1570

gears to be accelerated to a speed of 600 revolutions per minute, gives some idea of the work it performed. The bearing surfaces of the clutch were turned out with a fine feed of about 1/60 inch per revolution, but after running about six months, it was found that very close examination was required to discover any wear at all, as the feed marks were but slightly worn; in this case the only oil on the friction surfaces found its way there from the bearings as there were no special facilities for oiling the frictions. Of course, it will be readily understood that all oil working out from the inner end of the gear bearing on the shaft must be drawn onto the friction surfaces, and this applies in a varying degree to friction clutches of all designs.

The accompanying table was published in the *American Machinist* some years ago in an article on the theory and design of friction clutches, and while it has special reference to expanding clutches, it seems a safe premise to use the same figures for cone clutches. The writer of the article mentioned, asserted that some of the clutches tabulated were in actual use, and had given every satisfaction for years. Both parts of these clutches were of cast iron. He also pointed out that the driving power of a friction clutch was

increased about 20 per cent if a number of transverse grooves were cut across the face of the inner clutch. The reason assigned for this was that the oil was thereby allowed to escape more quickly. In the clutch designed by the writer (previously referred to) there were twelve of these grooves equi-distantly spaced around the circumference, cut about 1/16 inch deep with a 12 to 13 tooth, 7 pitch gear cutter.

In conclusion the writer would like to point out another little detail of construction which though insignificant in itself is of sufficient importance in its results to merit consideration. The length of the bearing surfaces should be exactly equal in both parts of the clutch. Fig. 1 shows the condition as existing in Mr. Kylin's drawings; when any wear takes place the clutch will be in the condition as shown exaggerated in Fig. 2, all the pressure being taken by a narrow strip of metal at *A*. If all the metal represented by the triangle *B* in Fig. 3 were removed, no matter how much wear took place there would always be a full bearing between the two parts of the clutch.

* * *

SPLICES FOR ANGLES

I note in the April number of MACHINERY, engineering edition, an article entitled "Splices for Angles," with accompanying Data Sheet Supplement. It is unfortunate that this Data Sheet was not revised by some one familiar with good practice in such details. I call your attention to this because your Data Sheets are often used with the utmost confidence by those who are unable to detect errors for themselves. Many who are not well acquainted with good shop practice are permitted to detail important structural work, and those of us who are in this business know that they often insist on designs being followed that are little short of criminal. The writer has not gone through the details with reference to number of rivets, etc., but would call your attention to the following violations of accepted practice:

The splices detailed may be used for compression, but the spacing of 4 inches is longer than needed in angles with a single line of rivets. The larger sizes of angles could be better spliced by using an inside angle in addition to the outside bars. When the splices are used in tension members, a more serious fault is to be found, because the net section of the angle is unnecessarily reduced by cutting one rivet from each leg at the same point, and by spacing the rivets next to the ends of the splice-bars so close that more than one rivet should be deducted from each leg having two lines of rivets. This also applies to rivets near the center of the splice-bars.

It is possible to detail these splices so that one rivet hole only need be deducted from the entire angle, and a standard splice should be so arranged. It should also be noted that the use of end distances of 1 and 1⅛ inch is bad practice from every point of view. One-inch rivets should seldom, if ever, be used for splicing 8 by 8-inch angles, and certainly not in ¾-inch metal.

Everett, Mass. E. N. PIKE
Chief Engineer New England Structural Co.

Mr. Pike deplores the fact that the Data Sheet "Splices for Angles" was not revised before publication by someone familiar with good practice in structural work. I would say that I am not exactly a novice in such matters; neither, I believe, is the editorial staff of MACHINERY. Now let us analyze the points which Mr. Pike intimates are but little short of criminal. The rivet spacing of 4 inches objected to occurs in the 4- and 3½-inch angle splices, with minimum thickness of metal ⅜ inch, or one-eleventh of the rivet pitch. A standard structural steel specification contains this clause: "The pitch of rivets in the direction of the stress shall not exceed 6 inches or sixteen times the thickness of the thinnest plate connected."

As regards the supplying of an inside angle in addition to the splice-plates shown, a careful scrutiny of these splices will reveal the fact that their lowest tension efficiencies are for the net section of the angles. Any further addition of splice-plates to those detailed will not increase this efficiency; besides the bending efficiencies of the splice-plates shown are in every case more than 100 per cent. Therefore, adding to the splice-plates would appear to be needless and of little value.

These splices are not so much at fault when in tension as Mr. Pike would have us believe. The rivets are staggered in the splices which have a single row of rivets in each leg, while in those splices having two rows of rivets in either or both legs the rivet arrangement is such that the loss from rivet holes is a minimum. It is true that in splices having three or four rows of rivets, the rivets come opposite each other, and this is necessary if a symmetrical design is to be obtained. The carrying out of the suggestion that the rivet spacing should be such that the net section of the angle would be only one rivet hole less than the gross section, would result in much longer splice-plates, and therefore heavier and more costly splices. For example, in the splice for the 4 by 4 by ½-inch angle, the net section of the angle when in tension is $\frac{1}{2}\left(1\frac{7}{8} + 1\frac{7}{8} + \sqrt{[2(2\frac{1}{8} - \frac{1}{4})]^2 + 2^2} - 2 \times 13/16\right)$, or 3.2 square inches. Since the gross area is 3.75 square inches, the area lost is 0.55 square inch or equal to 1 1/3 rivet hole. To reduce this loss to one rivet hole the rivet spacing must be 5⅛ inches. But it has already been objected to that the rivets are as far apart as 4 inches! Placing the rivets in this splice 5⅛ inches apart will not allow the splice-plates to be made much thinner, so their weight will be increased 25 per cent, while the increase in the tension efficiency of the splice is only 3 per cent. The 4-inch spacing was chosen in this case as a compromise between high efficiency and an unwieldy splice.

The spacing of the rivets from the ends of the angles and splice-plates is in no case less than one and one-half times the diameter of the rivets used. This is good practice, and a clause referring to it is found in dozens of first-class specifications for the fabrication of structural steel. If a rivet is placed 1½ diameter from the edge of the plate, the metal in front of the rivet will never shear out. The joint will fail either by shearing off the rivet or crushing the plate at the rivet, due to excessive bearing. I have at hand a set of standard splices used by the Baldwin Locomotive Works in their locomotive boilers. In every case, from a double riveted lap joint to a triple riveted butt joint, the outer rows of rivets are located 1½ rivet diameter from the edges of the plates.

In the general run of structural work, rivets larger than 1 inch are seldom used, except in special cases. A pneumatic riveting hammer cannot successfully drive larger rivets, and therefore field connections are usually made with 1 inch rivets or smaller. Then, to avoid having more than one size of holes the shop rivets are detailed the same size as the field rivets. The American Bridge Co. built in 1908 for the LaSalle Hotel in Chicago a girder truss 74 feet long, 26 feet deep, and weighing 110 tons. The gusset plates are 1 inch thick, while the built-up members are made of plates and angles from ¾ inch to 1 inch thick. All the rivets in this truss with one or two exceptions are ⅞ inch in 15/16 inch holes. No less a structure than the lamented Quebec bridge, which failed in 1907 during erection, was largely built with ⅞ inch and 1 inch rivets.

In conclusion, the writer wishes to state that the major purpose of the article in question was to show how a set of angle splices of high efficiency could be designed, thus giving each one the means of designing them to suit his own standards. However, a careful examination of the designs submitted will prove them to be an excellent compromise of the conditions involved, and safe to use if the efficiencies given are considered when introducing any of these angle splices in a design. A. L. CAMPBELL

Detroit, Mich.

* * *

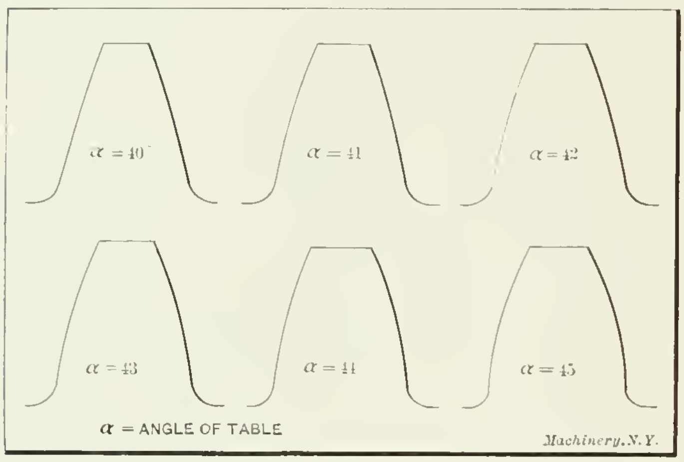
The National Tool Co., Cleveland, Ohio, employs a simple and effective method of marking its milling cutters and other tools manufactured. The name of the company and the size of the tool are engraved with an electric pencil. The apparatus consists merely of a primary battery generating a current of from twelve to fourteen volts and a tool consisting of an insulated pointed copper rod connected by flexible cord to one pole of the battery, the other pole of the battery being connected to a plate on which the cutter to be marked rests. The operator uses the tool the same as an ordinary pencil. The metal of the cutter is fused as the pencil traverses the surface, the lines of the writing showing as shallow grooves in the face of the hardened metal.

THE SETTING OF THE TABLE WHEN MILLING SPIRAL GEARS*

By GEORGE W. BURLEY†

It has been recently and severally stated that the most suitable angle (and the one most likely to produce the best results) at which to set the table of the milling machine when milling spiral gears, is that corresponding either to the diameter of the gear measured at the bottom of the space, or to the diameter measured at the working depth. The reason invariably adduced for this is that, if the angle chosen is the angle of the spiral measured on the pitch cylinder of the gear, an undue amount of undercutting, and therefore weakening, of the teeth will occur, owing to an excessive amount of interference with the sides of the teeth on the part of the cutter; and that, therefore, a somewhat smaller angle should be selected to reduce these effects.

To determine whether there was, practically, anything in this idea or not, the writer recently made some experiments on a spiral gear, the immediate object of the experiments being to find out what the effect of altering the angle of setting of the milling machine table was upon the shape of the tooth cut.



Shapes of Teeth obtained by Setting the Table at Different Angles, Cutter and Lead remaining the same

The experiments were made upon a cast-iron gear, with a pitch diameter of 4.242 inches, and designed for 24 teeth, the diametral pitch (corresponding to the normal circular pitch) being 8. The correct cutter to use was determined by the formula $N_e = \frac{N}{\cos^3 a}$, this cutter being No. 3 in each of the cases dealt with. The experiments consisted of cutting six teeth in the gear blank, all being of the same depth, the angle of setting of the table of the milling machine being different in each of the six cases. The spiral angle measured on the pitch cylinder was 45 degrees, the lead of the spiral being 13.32 inches, for which the gears of the spiral dividing-head were arranged. The six spirals chosen were at angles of 45, 44, 43, 42, 41, and 40 degrees, each tooth being formed by two cuts at one angle, the lead of the spiral remaining the same throughout the series of tests. It should be here noted that 43 degrees is the angle which corresponds to the diameter measured at the bottom of the space, and is the one which, in accordance with the reason referred to above, would be recommended as the angle of setting of the table.

TABLE OF OBSERVED TOOTH DIMENSIONS

Angle of Table Setting, Degrees	Width of Tooth at a Depth of Inches						
	0	0.050	0.100	0.125	0.150	0.200	0.250
45	0.104	0.145	0.185	0.200	0.203	0.221	0.239
44	0.102	0.144	0.181	0.195	0.202	0.220	0.238
43	0.099	0.142	0.176	0.188	0.200	0.218	0.236
42	0.094	0.135	0.168	0.180	0.196	0.215	0.234
41	0.087	0.128	0.158	0.171	0.185	0.211	0.232
40	0.078	0.115	0.146	0.158	0.171	0.205	0.230

The profiles of the teeth taken as sections normal to the spiral on the pitch surface are indicated in the accompanying engravings, these being drawn to scale accurately, the scale adopted being three times full size. The various widths of the teeth at different depths were obtained as accurately as possible by means of a Brown & Sharpe gear-tooth vernier caliper. These widths are given in the accompanying table.

Of course, it will be readily seen that although great care was exercised in securing measurements that would be as accurate as possible, the dimensions given above may be incorrect to the extent of one or two thousandths inch, though not more.

In regard to the shapes of the teeth, it will be noticed that the 40-degree tooth is slightly undercut at the root, while the other teeth do not show any undercutting whatever. The undercutting referred to in the 40-degree tooth, amounts to a reduction in width below the widest part of the tooth of about 0.010 inch.

The deductions drawn from the results of these tests are:

1. That the practice of setting the table at an angle less than the spiral or helix angle measured on the pitch surface is justified; though this angle should not be less than the spiral or helix angle measured at the bottom of the tooth.
2. That a cutter for a larger number of teeth than that given by the formula $N_e = \frac{N}{\cos^3 a}$, should be employed, in order to counteract the flattening and widening effect of the cutter with an angle as indicated above.

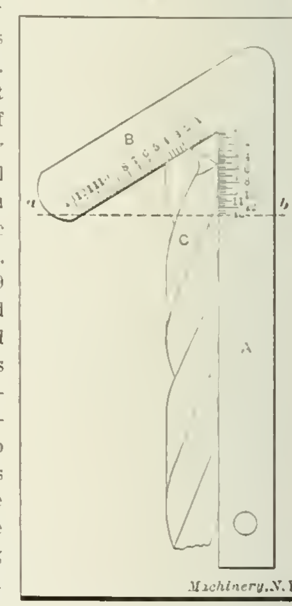
* For further information on the subject, see "A Study in Spirals," April, 1908.

† Address: University of Sheffield, Sheffield, England.

* * *

TWIST-DRILL GAGE

A convenient twist-drill gage is the subject of U. S. patent No. 989,857 (April 18, 1911), issued to George Mack, Elliston, Mont. This invention has in view the supplying of a cheaper and more reliable and quickly available gage for twist drills than those now in common use, which are usually inconvenient through having a complexity of parts. The gage is preferably made of a flat piece of sheet metal having a main arm A and an oblique arm B, the included angle being made as required, which, for twist drills, is preferably 59 degrees. Both arms are graduated arbitrarily or in the standard units, as desired, the graduations on the two arms being so arranged as to project across as indicated by the dotted line ab, so that when a twist drill such as that shown at C is placed in the gage, it can be seen at a glance whether each side of the cutting face of the drill has been ground down the same distance or not. Also by the oblique scale, it can be determined whether or not the drill has been ground concentric. By this means, the two requisites for a twist drill are easily obtained.



Patented Twist Drill Gage of Simple Construction

* * *

An interesting innovation has been introduced by the Swedish Engineers' Society of Chicago, Ill., in printing its list of members. Opposite the name of each member is printed a small portrait, ⅞ inch high and ⅝ inch wide. This practice may not be suitable for a large society with a membership scattered over a whole continent, but a local society, where personal acquaintance among the members is highly desirable, and the membership comparatively small, would probably profit considerably by such an arrangement of its membership list.

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—2

By S. N. BACON

An assembling operation which is a little more difficult than that described in the previous article is shown at *A*, Fig. 4. This operation was accomplished in a No. 2 Brown & Sharpe automatic screw machine and consists in making and assembling the socket joint *a* and grooved roller *b*. When in use this grooved roller rides between two tracks as shown at *A*, and the ball part rotates freely in the socket joint *a*. The work was not required to be held to very close limits, and

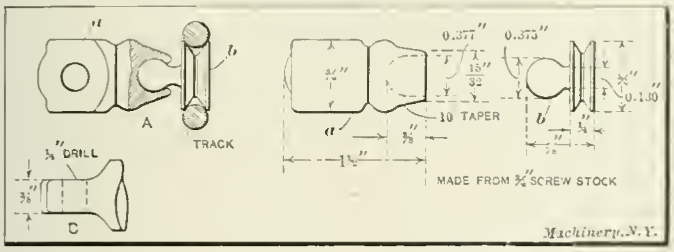


Fig. 4. Pieces to be made and assembled

the milling and drilling, as shown at *B*, were done in separate operations.

In setting up the machine for making the pieces *a* and *b*, the stock is first fed out by hand to the length shown at *A* Fig. 5, where the bar is faced off, and the grooved roller formed; the stock is then fed out to the length shown at *B*

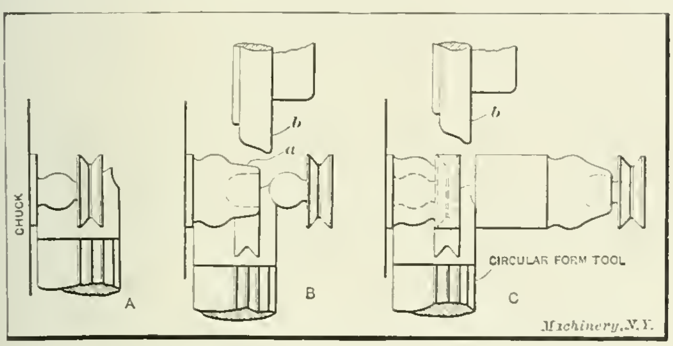


Fig. 5. Positions of the Stock for the Various Operations

where the grooved roller is cut off. When in this position the slotting arm descends, carrying the pick-up shown at *C* in Fig. 6, which grips the grooved pulley, and after it is cut off lifts it out of the way ready to be brought back, when it is to be assembled in the socket joint. While the stock is in the position shown at *B* the hole is drilled and reamed. The reamer, shown at *A* in Fig. 6, is so shaped that it makes a correct seat for the ball on the grooved roller.

The tapered part *a* of the socket joint is formed with a box-tool after the hole has been drilled and reamed. When this

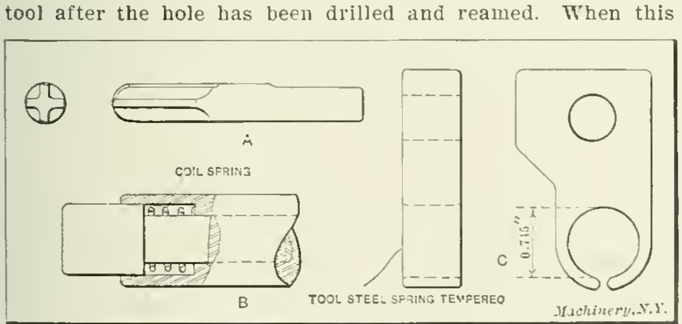


Fig. 6. Reamer, Assembling Tool, and Pick-up

operation is finished, the slotting arm is brought down, carrying the grooved roller, and the spring stop *B*, Fig. 6, which is held in the turret, forces the roller into the socket joint. The spring stop remains stationary in this position, as does the pick-up, while the spinning tool *b*, shown in Fig. 5, which is held rigidly to the rear cross-slide is advanced and turns the nose of the joint over the ball, thus assembling the two parts. When this is accomplished the spring stop is dropped back and the stock fed out against it. The stock is now in the position as shown at *C* Fig. 5, where the completed joint is cut off and the next roller formed to shape, as shown by the dotted outline, which would leave the stock in the same position as at *A*. The operations for making and assembling these two pieces are as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	23	3
Cut off 0.375 inch rise at 0.0021 inch feed	177	23
Cut off and form 0.040 inch rise at 0.0012 inch feed	32	4
Clearance to bring down slotting arm while cutting off piece, take hold of piece and return slotting arm	7	1
Center 0.200 inch rise at 0.0051 inch feed	39	5
Revolve turret	23	3
Turn with box-tool 0.375 inch rise at 0.006 inch feed	62	8
Revolve turret	23	3
Drill 0.387 inch rise at 0.0046 inch feed	85	11
Revolve turret	23	3
Ream 0.387 inch rise at 0.0082 inch feed	47	6
Revolve turret and bring down slotting arm with piece	23	3
Push in piece with holder *B*, held in slotting arm, Fig. 6	(23)	(3)
Spin over end with spinning tool held on rear slide 0.125 inch rise at 0.0054 inch feed	23	3
Withdraw holder and feed stock to stop	31	4
Cut off and form 0.270 inch rise at 0.002 inch feed	131	17
Revolve turret	23	3
	772	100

With a spindle speed of 421 revolutions per minute, it requires 110 seconds to make one piece, which gives a gross production of 327 pieces in 10 hours. The cams for making and assembling the pieces *a* and *b*, Fig. 4, are shown in Fig. 7, where the lobes for performing the various operations are clearly outlined. This was a very interesting job to see

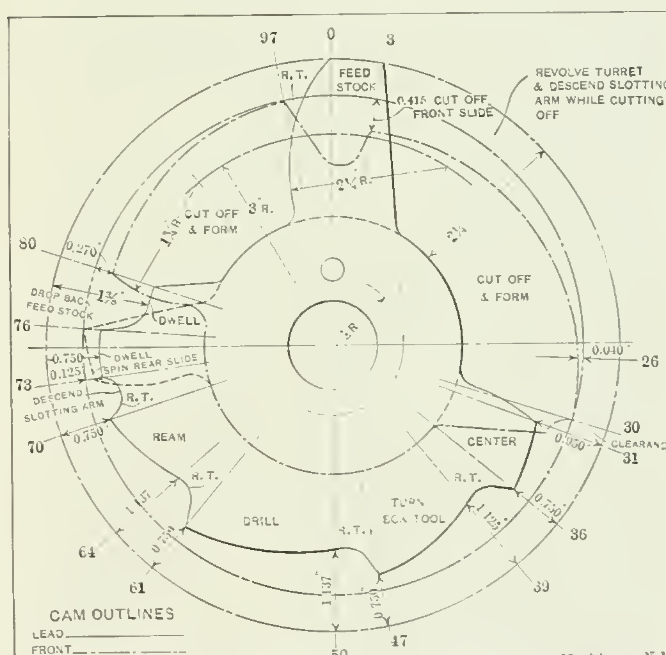


Fig. 7. Cams used for Making and Assembling the Grooved Roller and Socket Joint

running and the saving was much more than would be supposed, because if the parts were assembled as a separate operation it would require a fixture which would be, in reality, a special machine. The advantage of completing the work in the automatic screw machine is, therefore, obvious.

* * *

The steam turbine has caused a complete revolution in German ship-building, according to *Page's Weekly*. It has proved so satisfactory, both in the merchant marine and in the navy, that there are at the present time not less than 42 turbine warships built or under construction. The great efficiency of the turbine engines was shown in the trial of the cruiser *Mainz*, which developed a speed of 28 knots, or approximately 33 statute miles, per hour

FIXTURE FOR MACHINING STEERING-SPINDLE BALLS

By J. F. BRIGHAM*

The tools shown in the accompanying illustrations, for turning balls, will probably not meet with the approval of any one desiring an extremely accurate ball, *i. e.*, one within a limit of 0.0005 inch; but they were designed for one such as goes on steering spindles of automobiles, where extreme accuracy is not required, a limit of 0.003 inch being considered sufficiently accurate by most designers.

There are a number of ways in which balls of this kind may be made. The most common method is to turn them on a lathe, and while this is good, it requires the use of a 24-inch lathe with a large faceplate and fixture, which, when running at the high rate of speed required, if not properly guarded, is very dangerous to the operator; also, if not very rigid, it is quite likely to chatter. In one shop that the writer had the pleasure of visiting, they were turning, or rather milling, a ball of this kind on a gear-hobbing machine. The results were fair as far as finish is concerned, but the output was small, and it tied up an expensive machine. In the case of either a lathe or a gear hobber a much more experienced and expensive operator is required than is necessary on a drill press. The writer believes in placing work of this kind where it can be done most cheaply, and to the best advantage. There is always enough work to be done on a lathe, that cannot be handled to good advantage on any other kind of a machine, and therefore he believes that a drill press, provided with tools such as here described, is best suited to the purpose.

It will be noted in Fig. 1 that a ball is being turned on an ordinary 24-inch Cincinnati drill press. Steering spindle *A* is held in place in an ordinary vise provided with machine-steel casehardened jaws *B*, machined to fit the ball-arm.

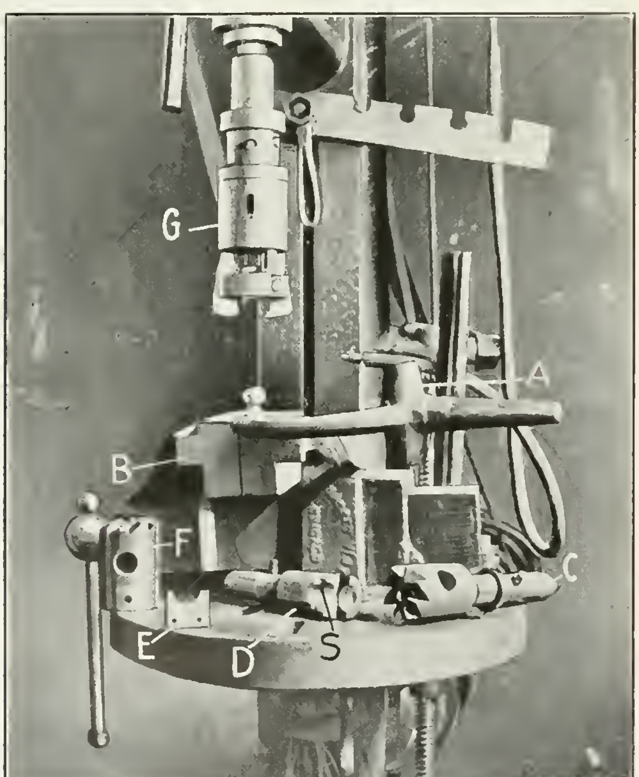


Fig. 1. Fixture used on the Drill Press for Turning Tops of Steering-spindle Balls

Tool *C* forms the first operation, milling to size and forming the top of the ball. This tool consists of three parts, *D*, *E* and *F*. *D* is a machine-steel body with a shank turned to fit a Wizard quick-change chuck, and milled out on the center line at its opposite end, to take cutter *E*. Cutter *E* is held by two straight pins and two 3/8-inch headless set-screws, to take up the variation in width which is caused by sharpening on the face. *F* is a hollow mill which fits over body *D* and is used to mill the diameter of the ball, being held in place by a No. 6 taper pin. The large hole inside of the cutter is for the cutting compound and for cleaning out the chips. *G* is a tool for forming the lower half of the ball; this can be seen to better advantage in the detail drawing, Fig. 2.

This tool, although simple in construction, does remarkably good work. The shank or body *A* is made of machine steel, turned at one end to fit the Wizard quick-change chuck. Two 1/4-inch slots are milled along the center line on opposite sides, at a 30-degree angle, to fit cutters *B*, so that by pressing down on the hand lever the cutters close around the ball, thus completing the operation. There are two small set-screws provided with lock-nuts that act as stops and set the cutters to the proper size. The cutter shank *C* is turned to 3/4 inch, and is a close slip-fit in *A*. It is bored out on the opposite end to fit over the ball, and also acts as a steady-rest for the cutters. It will be noted that there are two plugs with springs back of them to force the cutter shank down. The least upward movement of the hand lever will force the cutters away from the work. *C* is held in place by a 3/8-inch pin pressed into the shank and fits in an elongated slot in *A*. The cutters *B* are made of high-speed steel and are held in place by 3/8-inch hardened pins. These tools have worked out very satisfactorily, and by using a little judgment a man is capable of turning out 150 steering-spindle balls in one day.

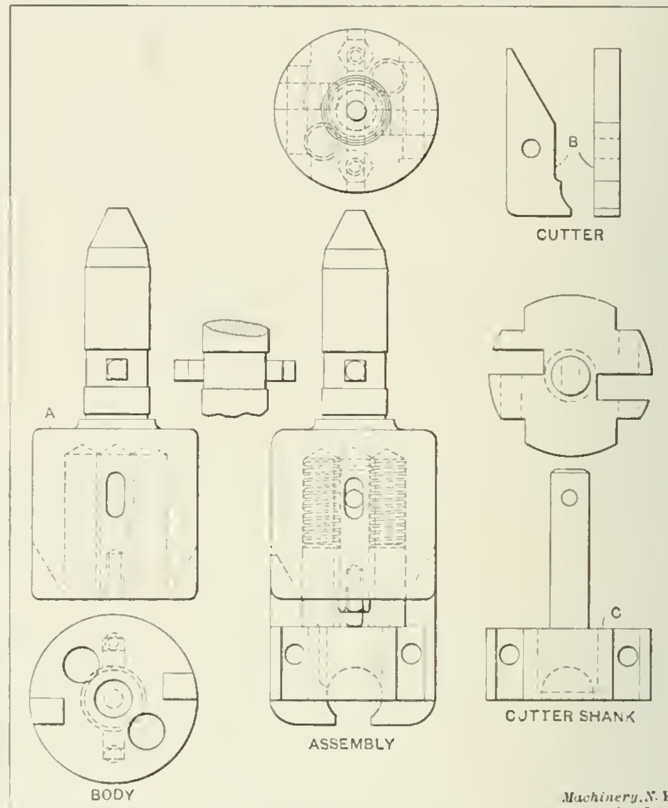


Fig. 2. Details of Fixture used on the Drill Press for Turning the Lower Part of Steering-spindle Balls

* * *

The British Board of Trade has recently issued some interesting statistics relating to the leading industrial countries in the world, giving, in percentages of the total working population, the number employed in eight of the principal occupations or industries. From these statistics it appears that the metal-working industries employ a greater percentage of all workers in the United Kingdom than in any other country. Next in the list comes Germany, then Belgium, then France, and in the fifth place, the United States. The percentage of men employed in the transportation and postal service is greater in the United Kingdom than in any other country, the United States occupying the second place. Thirty-five per cent of all workers of the United States and Germany are engaged in agricultural pursuits, and in all the other leading countries, with the exception of the United Kingdom and Belgium, the percentage is even higher. Of all industries, therefore, farming is, and will undoubtedly always remain, the most important.

* Jig and Tool Designer, Reo Motor Car Co., Lansing, Mich.

TOOLS AND METHODS USED BY THE SPRINGFIELD MACHINE TOOL CO.

A number of interesting tools and methods used in the shops of the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, are illustrated and described in the following article. Some of these methods are unique, and all of them are an indication of the attention and care that are given to the accuracy of the resulting product, as well as to the rapid and convenient handling of the work while passing through the various shop operations.

Method for Milling T-slot in Shaper Ram

An unusual method is employed in this shop for producing the circular T-slot in the face of the shaper ram of the shapers

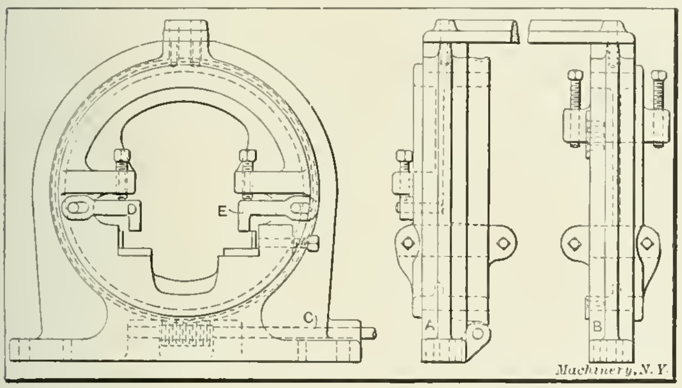


Fig. 1. Device for Milling T-slot in Face of Shaper Ram

built by the company. Ordinarily, this T-slot is turned in the lathe, the ram being supported by a steady rest at the end where the cut is to be taken. This is a slow method, and unless very carefully carried out, is not always conducive to the highest accuracy; nor does the twisting strain set up in the shaper ram have a very beneficial effect on it, as cases are known where the turning operation has produced a permanent set in the ram.

For these reasons a method of milling the T-slot in the face of the shaper ram has been adopted, the device used for this operation being shown in the line engraving Fig. 1. The face of the ram is cast solid, without coring a groove as is usually done. The T-slot cutter by which the slot is cut is sunk into the metal to the required depth, after which the ram is rotated

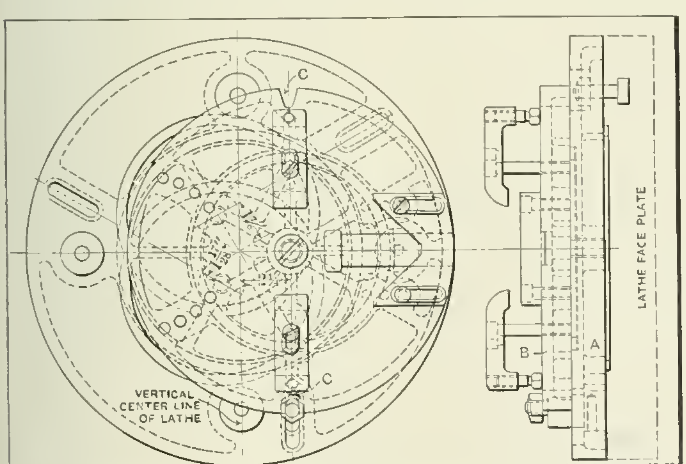


Fig. 2. Device for Hollow-milling Gear Cases shown in Fig. 4

in the fixture in which it is held. As will be seen from Fig. 1, the device consists of two frame castings *A* and *B*, each containing a ring which is free to revolve in the casting. The ring in casting *A* is provided with a worm-wheel, and is given a circular motion by operating the worm-shaft *C* by means of a crank, not shown. Clamps *D* and *E* are provided for holding the ram securely, these clamps binding upon the ways. A strap is used to hold the two frame castings together at the top, and at the bottom they are bolted to the milling machine table. The method has proved rapid and accurate, and presents none of the difficulties met with when these T-slots are turned in the lathe.

Universal Jig for Drilling Gear Cases

In Fig. 2 is shown a jig for drilling gear cases in the lathe. The gear cases to be drilled are of the type shown in Fig. 4, and three sets, each having a different center distance, can be drilled in this jig. As each set consists of three covers for three different gear ratios, as shown, nine covers in all are drilled in the jig. The design of the jig, to accomplish this result, is rather ingenious. It consists of a faceplate *A*, Fig. 2, held on the regular lathe faceplate by means of a circular tongue and groove and four bolts. This secondary faceplate, which is shown in detail in Fig. 3, has mounted upon its face a third plate *B*, which, in turn, holds the work to be drilled. Plate *B* has a circular tongue on its inner face, and plate *A* is provided with three sets of circular grooves as shown in Fig. 3, so that *B* can be placed upon it in any of three positions, each position corresponding to one set of center distances between the holes to be drilled in the gear cases. Plate *B* is held to plate *A* by a screw at its center, three holes, one for each of the three positions, being therefore provided in plate *A*. Two notches *C*, 180 degrees apart, are cut in plate *B*, so that when one of the two holes in a gear case has been drilled, the plate can be indexed around 180 degrees and the other hole drilled.

From this description of the construction of the device, its action and operation will be easily understood. Assume that gear cases with a center distance of 4½ inches, as shown in

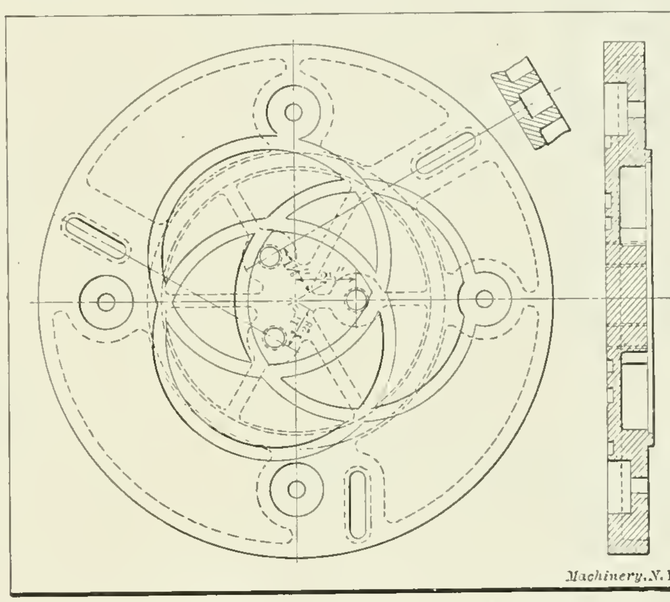


Fig. 3. Secondary Faceplate of Device shown in Fig. 2

Fig. 4, are to be drilled. Half of this center distance is 2¼ inches, and the plate *B* is, therefore, attached to plate *A* by means of the hole which is located at a distance of 2¼ inches from the center of plate *A*, which latter center coincides with the line of centers of the lathe. The index pawl is placed in one of the notches *C*, and tightened, and the gear case clamped to plate *B* by the clamps provided. It will be seen in Fig. 2 that these binding and locating clamps are so made that they will locate the gear case in the correct position to be drilled, and also that means are provided for adjusting the locating points and the clamps for the three types of gear cases shown in Fig. 4. When the gear case is clamped as described, one of its holes will be exactly in the line of centers of the lathes, and this hole is then hollow-milled and the boss faced. The plate holding the work is then indexed 180 degrees, and the other hole is hollow-milled and this boss faced. The bosses on the inside are also faced. As the distance between the center of revolution of plate *B* and the lathe center is 2¼ inches, it is evident that the distance between the two holes drilled will be twice this, or 4½ inches, as required. If the gear case having a center distance of 3¾ inches were to be drilled, the plate *B* would be attached to plate *A* by the hole located 1⅞ inch from the center of *A*. The procedure would otherwise be the same.

Jigs for Holes in Lower Part of Steady-rest

In Fig. 5 is shown the lower part of the steady rest used on the company's 18-inch Ideal lathe and 18-inch standard

engine lathe. In Fig. 6 is shown a drill jig used for drilling the holes in this part. It will be seen that there are holes to be drilled in both directions for the two jaws and their adjusting screws, one hole for the clamp screw at the bottom,

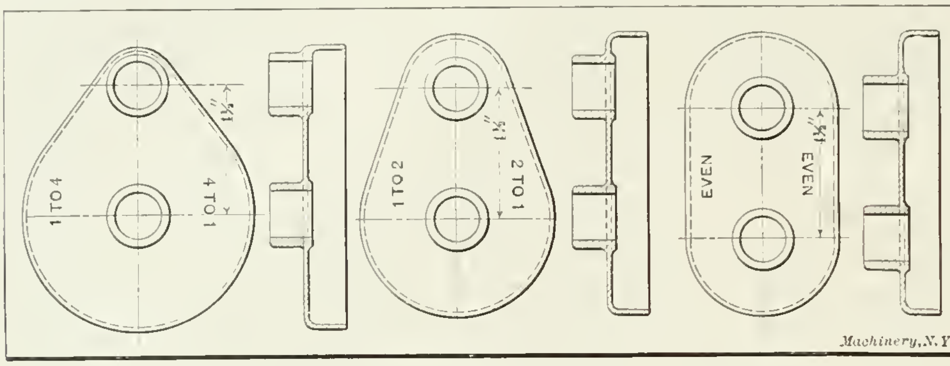


Fig. 4. Gear Cases Hollow-milled in Device shown in Fig. 2

and four holes, in total, from the sides. As the center lines of the holes for the jaws and adjusting screws and for the clamp screw form angles of 60 degrees with one another, the jig was made of a hexagon shape, holes being drilled from five of the six sides. This facilitates the handling of the jig, as it is not necessary to lift it when moving from hole to hole, but merely to roll it on the drill press table, drilling the holes in the most convenient order. The jig is first laid on its side, and the horizontal holes are drilled. Then it is raised up onto one of its hexagon sides, and the holes of the same size

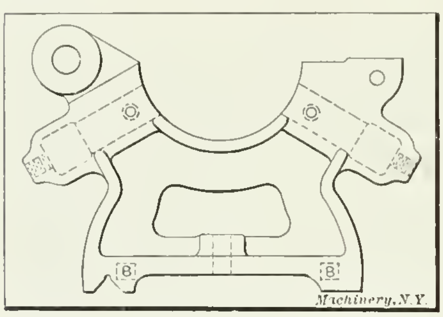


Fig. 5. Part of Steady-rest drilled in Jig shown in Fig. 6.

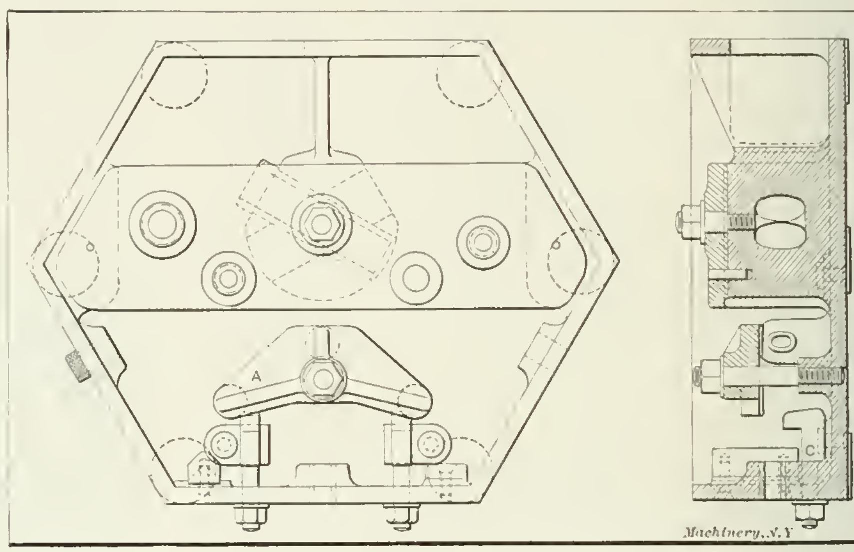


Fig. 6. Jig for Drilling the Holes in the Steady-rest Part in Fig. 5

are drilled at the same time. While this requires rolling the jig over and then back again for the other holes, this presents no difficulty, as the jig, although heavy to lift, will roll over its corners very easily.

It will be seen in Fig. 6 that the work is located in the jig on a V and a flat surface exactly as it will be located on the lathe shears when in use, and that clamping fingers and lugs are so placed as to hold the work securely without springing it. The large clamping bracket *A* has a three-point bearing, insuring a balanced clamping action. Lugs are provided on the work at *B*, Fig. 5, to locate against finished studs *C* in the jig. These lugs on the work are removed afterward. The hexagon sides of the jigs at the top are partly cut away in order to permit the end of the drill spindle to enter the jig, thus shortening the length of the tools required.

Fixture for Planing Tailstocks

In Fig. 8 is shown the general outline of the upper part of the tailstock used on the company's 14-inch Ideal and standard engine lathes. In Fig. 7 is shown a fixture used on the planer for planing the bottom surface and ends *A* and *B*, Fig. 8, of the tailstock. This fixture is rather out of the ordinary in its design. It is conducive to a high degree of accuracy, and at the same time makes it possible to finish the work at a rapid rate. As indicated in the engraving Fig. 7, ten pieces are planed at once, the total length of the

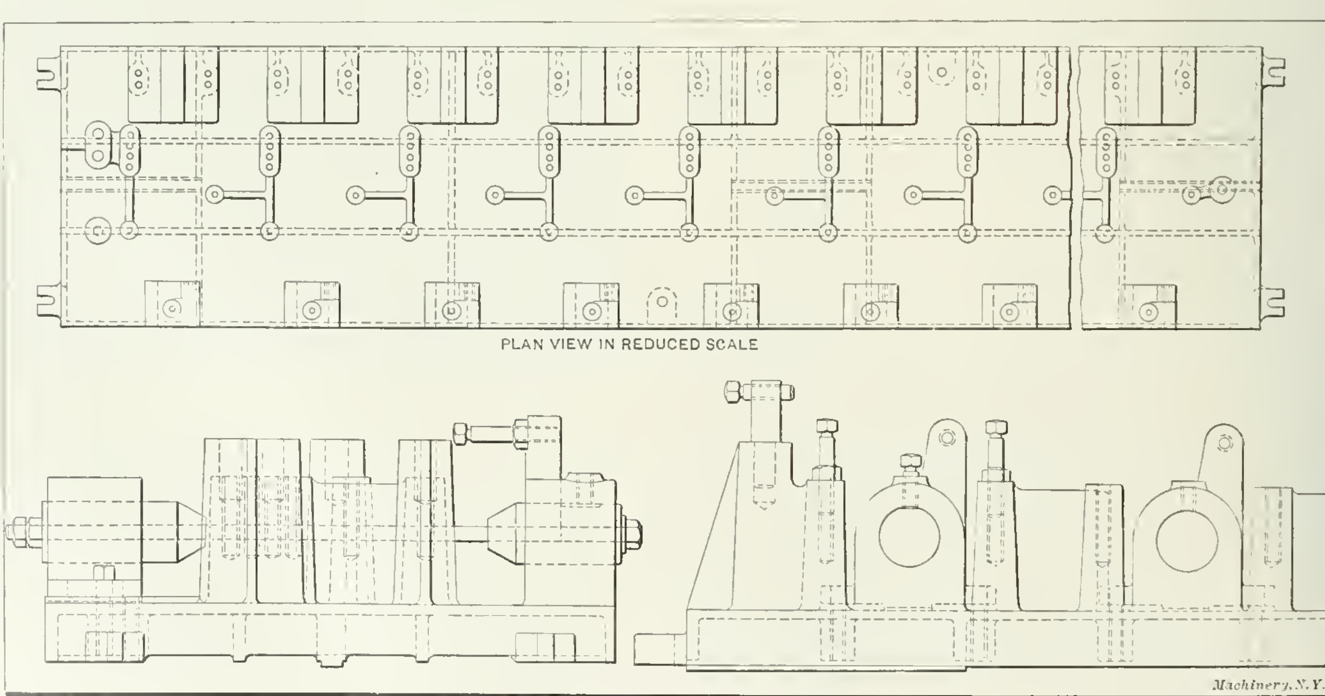


Fig. 7. Planer Fixture for Tailstock shown in Fig. 8

fixture being slightly over 10 feet. The tailstocks are located by the holes for the tailstock spindle, on cone centers, as shown, and are prevented from swinging sidewise by the square-headed set-screws, which can be adjusted to the different heights that may be called for by small differences in the castings. The fixture has a wide range, as it takes care of the tailstock for three different sizes of lathes—from 14- to 24-inch—provision having been made for changing the location of the clamping screws to suit the different sizes.

Drilling and Boring Fixtures for Gear-boxes

In Fig. 9 is shown the feed gear-box used on the company's 14-inch standard engine lathe. In Figs. 10 and 11 are shown the fixtures used in drilling and boring this gear-box. The baseplate shown in Fig. 10 is used for all sizes of the feed

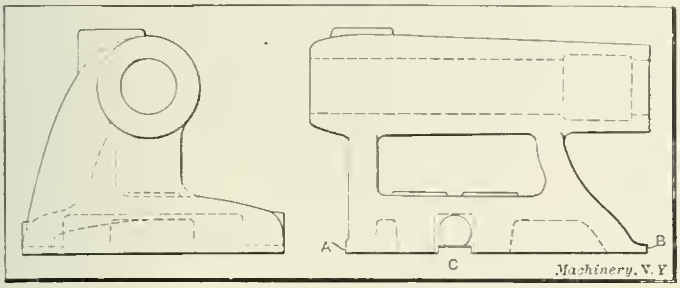


Fig. 8. Upper Part of Tailstock planed in the Fixture shown in Fig. 7

gear-boxes, but the main jig in Fig. 11 must, of course, be different for each size of lathe. The drilling and boring is done on a radial drill, and the baseplate in Fig. 10 is clamped onto the vertical side of the box-table of the machine. The jig in Fig. 11 is mounted on the baseplate by means of hole *A*, Fig. 11, which fits the projecting stud *B*, Fig. 10. The jig is thus free to swing about the stud in the baseplate, and when in operation, this makes it very convenient to use, as the holes from one end can first be drilled, and then the jig swung around and the holes drilled from the other end.

When in use, the cycle of operation is as follows: The gear-box is first clamped in place in the jig before it is mounted on the baseplate. It is located against the stops

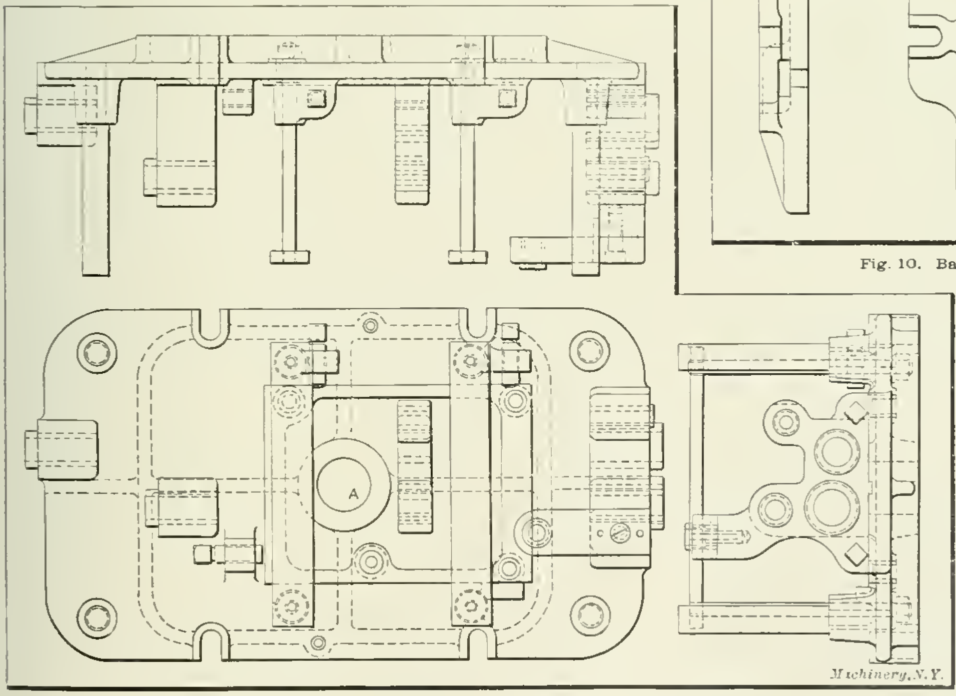


Fig. 11. Jig for Drilling and Boring Feed Gear-box in Fig. 9

in the main jig casting, and clamped by the bar clamps shown. Then the four holes *A*, *B*, *C* and *D*, Fig. 9, are drilled with the jig resting directly on the drill press table. Hole *E* is also drilled, but is finished later with a butt mill. As soon as these operations are completed, the jig is put onto the stud in the baseplate, it being located in the exact position by a taper dowel pin, and clamped by four T-bolts. The two holes at one end are now drilled, and then the jig is indexed around 180 degrees on the center stud, and the four holes at the other end are drilled. Such holes as require reaming are, of course, also reamed. A hole is provided on

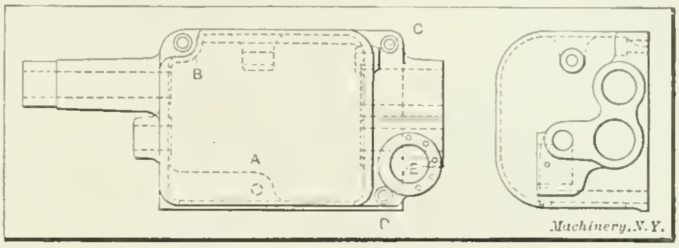


Fig. 9. Feed Gear-box drilled and bored on the Jig in Fig. 11

each side of the jig for the taper dowel pin, so that the jig can be easily located after having been indexed around.

Jigs and Fixtures for Friction Parts

In Fig. 17 is shown the friction driving device used on the 18-inch Ideal lathe built by the Springfield Machine Tool Co. In Fig. 12 are shown the more important parts used in this friction, together with an assembly view, and in Figs. 13 to 16 are shown some of the jigs and fixtures used for performing the drilling and milling operations on these parts.

The construction of this friction is of considerable interest. The two halves of the friction are expanded by means of a double toggle-joint, and heavy springs are provided at *C*, Fig. 12, so that the friction is released at once, and there is no

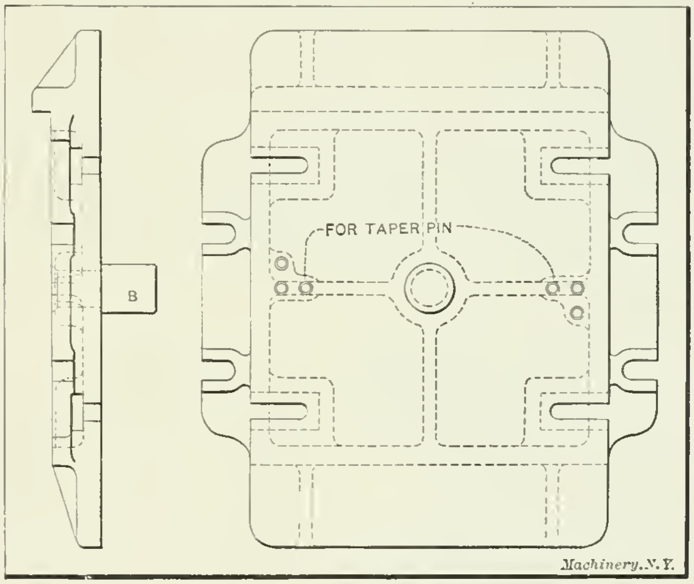


Fig. 10. Baseplate for Jig shown in Fig. 11

dragging of the contact surfaces after the expanding links have been released. The assembly view in Fig. 12, in conjunction with the halftone Fig. 17, gives a clear idea of the simplicity of the action of the mechanism.

The part shown at *A*, Fig. 12, is called the "cone friction shoe," and that shown at *B*, the "face gear friction shoe." There are, of course, two halves to each of these. They are identical in design, except that the face-gear friction shoe is a trifle larger than the other. The jigs for drilling the holes in these shoes are of the same design, and one of them is shown in Fig. 14. The hole at *C*, Fig. 12, is to be drilled and counterbored, and the holes *D*, for the expanding links, are to be drilled and rounded. The work is located and clamped in the jig as shown, and the depth of the counterbored hole in the work is gaged by a stop collar on the counterbore, which comes against the face of the projecting boss at *A*, Fig. 14.

In Fig. 13 is shown a milling fixture for holding the friction yoke shown at E, Fig. 12. This fixture is adapted to take three sizes of the yokes, the largest and smallest being indicated by dash-dotted lines in the engraving, Fig. 13. The

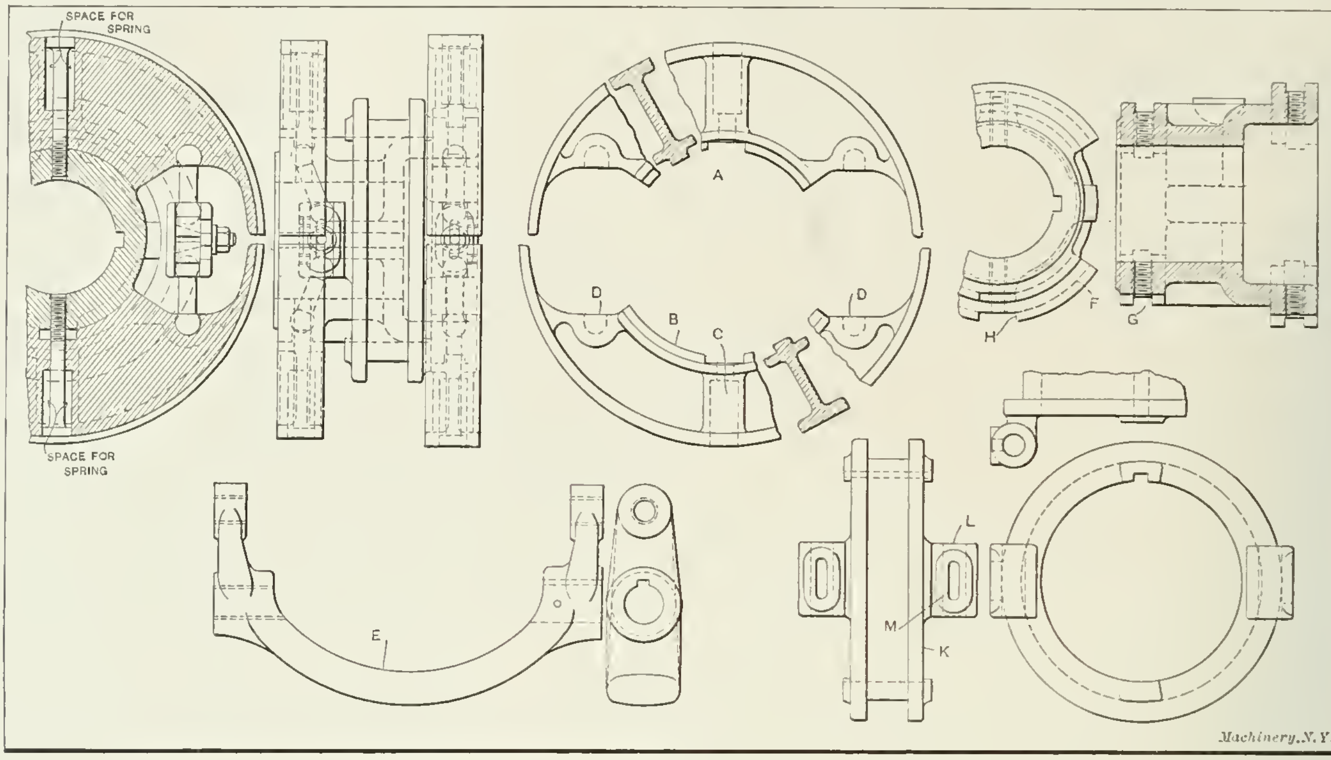


Fig. 12. Assembly View and Parts of Friction shown in Fig. 17

fixture is used on a No. 3 Brown & Sharpe milling machine, and four cutters in a gang are used to face surfaces A, B, C and D simultaneously. The yoke has had its hole drilled and tapped previous to being milled, and is placed on an arbor,

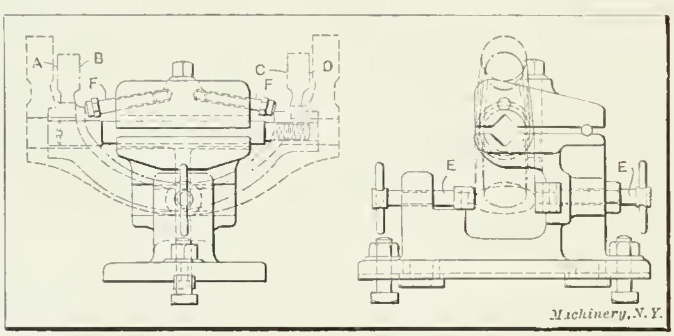


Fig. 13. Milling Fixture for Friction Yoke

threaded at one end and plain on the other, as indicated in Fig. 13. This arbor is then clamped in the fixture between two jaws, clamp screws E being provided for locating the yoke sidewise as shown. Screws F are provided to prevent

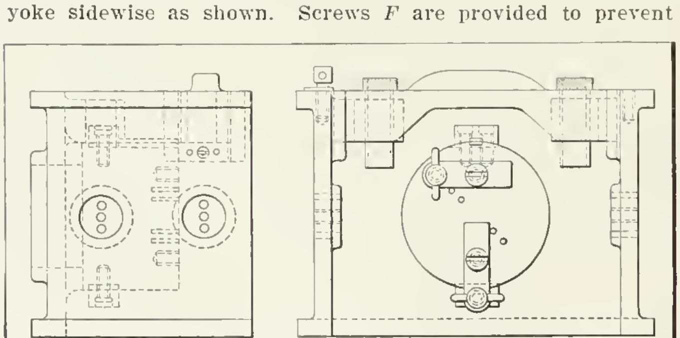


Fig. 15. Jig for Drilling Friction Sleeve

any inward springing action of the yoke while the cut is being taken.

In Fig. 16 is shown a jig for drilling the friction hub shown at F in Fig. 12. It is very important that the distance between the screw holes in the hub be correct. The hub is, therefore, located in the jig in such a manner that the groove G, Fig. 12, and not the end of the hub, becomes the gaging point. The stud passing through the jig locates the work centrally. The location sidewise, insuring that the drilled holes come exactly in the center of the grooves H, Fig. 12, is accomplished by means of a small locating member shown at A in Fig. 16, this member being clamped in place by knurled-head screw B.

In Fig. 15 is shown a jig for drilling the friction sleeve

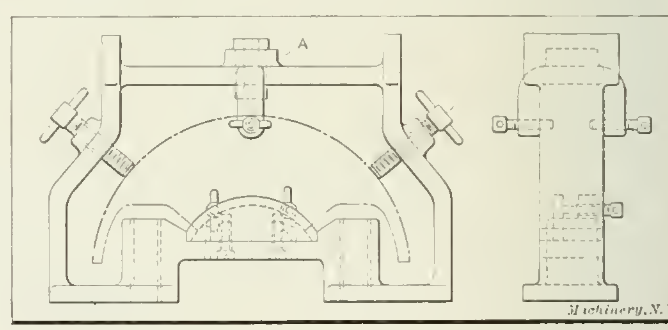


Fig. 14. Jig for Drilling Holes in Friction Shoes

shown at K in Fig. 12. In this jig four holes L are drilled from the top, and then the jig is turned over on its side and six holes are drilled, three in each of the two lugs on this

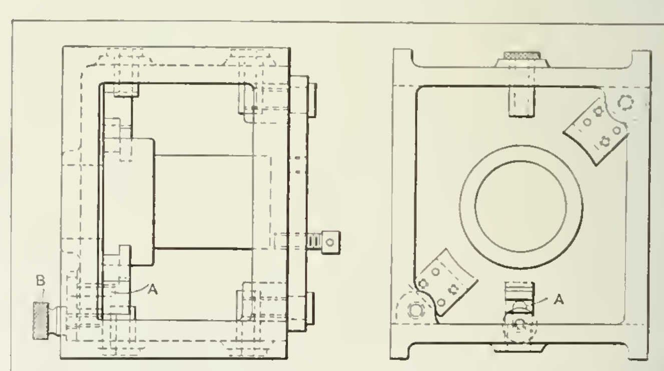


Fig. 16. Jig for Drilling Friction Hub

side, these holes being used for obtaining the oblong holes M, Fig. 12. The jig is then turned over and six holes are drilled similarly from the other side. As shown in Fig. 15, the center stud in the jig, upon which the sleeve is located, is provided with a key, so that the sleeve can be correctly

located by its own keyway. The work is slid in and out of the jig from one of the sides, the clamps by which it is held being of the swinging type, so that they can easily and quickly be turned to one side and then again returned to the clamping position.

The foregoing examples of the tools used in the Springfield Machine Tool Co.'s plant show the general character of the tools and the methods used, and give an idea of the care and thought that are given to the tool designing, at the same time indicating the degree of accuracy and interchangeability which the company aims to secure in its machines.

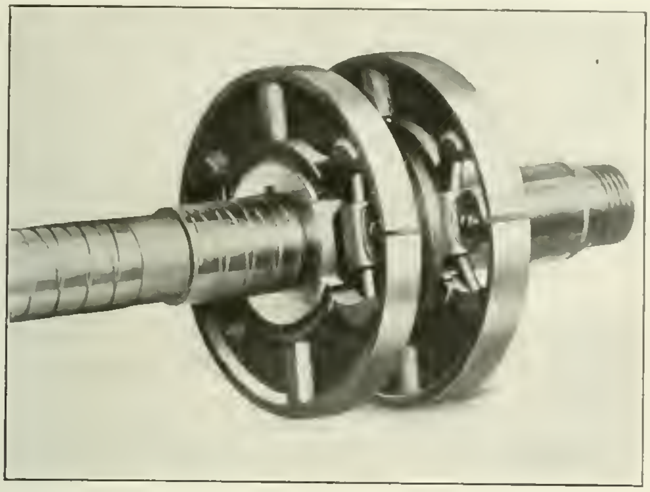


Fig. 17. Friction Driving Device used on the Springfield 18-inch Ideal Lathe

* * *

THE GEAR HOBBING MACHINE—A FUNDAMENTAL DEFECT

By GEORGE B. GRANT*

The spacing wheel of the hobbing gear cutting machine, on which it depends for accuracy, is at the same time the driving wheel for feeding the blank, and must rapidly wear out of truth.

T. B. Peirce, manager Grant Gear Works, Boston, calls attention to a defect of the gear hobbing machine that I have not seen in print. It appears to be fundamental, that is, not capable of being overcome by invention. Frequent repairing is the only remedy.

The defect has also wholly escaped the notice of the manufacturers of gear hobbing machines, so far as shown by my pile of circular matter. In fact, one of the circulars, with sublime assurance, claims that hobbed work is superior to the ordinary kind in the matter of accuracy of spacing. No such comparison can be made unless the hobbing machine is quite new and the disk cutter machine quite old and out of repair.

Peirce's objection is that the master wheel—the wheel that spaces the work—is also the driving wheel that hauls the gear blank under the strain of the hob while at work, and must wear rapidly.

The manufacturers of another form of gear cutting machine take great pains to show that on their machine the generating mechanism is independent of the cutting mechanism, so that the labor and strain of the cutter as it plows through the metal cannot affect the accuracy of the spacing or the correct form of the tooth.

The lead-screw of the engine lathe is a parallel example, for it hauls the screw-cutting tool into the work and is at the same time the spacing screw on which the accuracy of the work depends. Any inaccuracy of the lead-screw will result in a similar inaccuracy in the screw being cut, and the only remedy is to recut the lead-screw occasionally. The screw milling machine has a decided advantage over the screw cutting lathe on that point; its spacing screw turns very slowly and is used only once while the milling cutter runs the whole length of the work, while the lead-screw of the engine lathe is used as many times as the lathe tool is run over the work.

The master wheel of the hobbing machine makes one complete revolution every time the hob cuts around the work once, and that should be every twenty-fifth inch unless the machine is trying to catch up with its "brag" in the matter of output. If two machines, one an ordinary gear cutting machine and the other a hobbing machine, are both cutting gears in stacks six inches thick and with a feed of a twenty-fifth of an inch, then the master wheel of the hobbing machine will revolve one hundred and fifty times on the job and have to haul its work against the cut all the time, while the master wheel of the other machine will revolve once and do no feeding work. The effect on the durability of the spacing wheels needs no demonstration.

The precision required in a master wheel is so great that it must be repaired once in a great while, and it follows that the hobbing machine driving-spacing wheel must be repaired many times in the same period. The hobbing machine master wheel is generally driven by a worm or by a small pinion, and the contact is at a few points only, while the lead-screw of a screw-cutting lathe has a long nut and a surface contact that insures, comparatively, a much slower rate of wear.

Furthermore, the hobbing machine master wheel must be perfectly tight and true, for any looseness in its fit with its driving worm will show up as flats on the sides of the teeth of the gear being cut. The flats on hobbed teeth are of at least three quite different kinds, those due to the theory of the method, those due to the warping of the hob and to inaccurate sharpening, and those due to the looseness of the train of gearing that drives the master wheel.

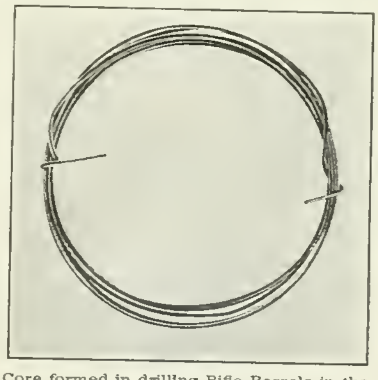
Flanders and Lees are exchanging opinions in the columns of MACHINERY. Flanders, better late than never, is showing up the ins and outs, particularly the latter, of the hobbing process, and Lees is defending it. Lees is bound to be defeated and is trying to side-track the discussion by pointedly asking Flanders if the cutter of his favorite gear shaper can be sharpened by grinding without changing its pitch. I am waiting to read what Flanders has to say, and would advise him to say nothing at all, and to remember, in future, that people who live in glass houses should not throw stones.

* Address: Lexington, Mass.

* * *

WIRE BY-PRODUCT OF DEEP-HOLE DRILLING

The illustration shows a coil of steel wire, 0.020 inch diameter and of uniform section throughout its length of about 30 inches, which is regularly produced in a manner unknown to those unfamiliar with rifle manufacture. The wire is a by-product, being the core left in drilling United States Government Army rifle barrels at the Springfield Armory. The drill used is of the common deep-hole variety having one cutting lip and a vee-slot in one side for the escape of chips, and tube for conveying lubricant under high pressure to the point of the drill. The depth of the vee is about 0.010 inch greater than the radius of the drilled hole and the wire core forms in the point of the vee-slot. The practice of drilling rifle barrels varies somewhat, some experts not being in favor of "drilling with a wire," while others follow the practice of the Springfield Armory in this respect.



Core formed in drilling Rifle Barrels in the Springfield Armory

* * *

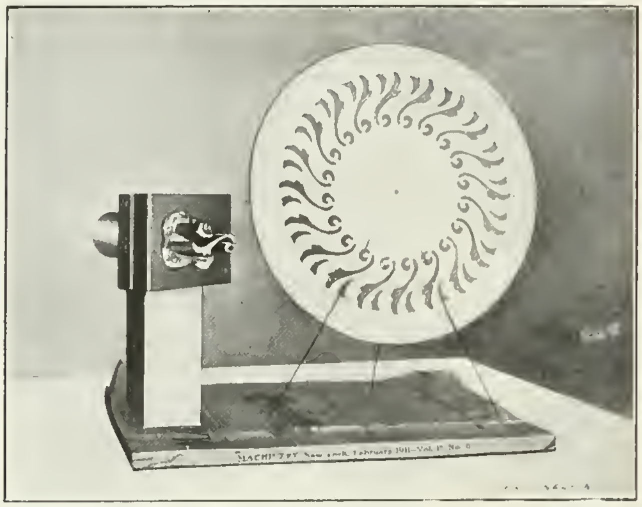
A Practical Problem: Say, cast iron costs three cents a pound, and a mechanic's time, counting overhead charges, is worth forty-five cents an hour. How much profit is there in saving two pounds of metal, if fifteen minutes more is required to machine the casting, because it springs and chatters under a heavy cut?

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A PIERCING PUNCH

The accompanying illustration shows a piercing punch made up of three separate pieces, which were secured in the holder in a novel manner. This was done by pouring type-metal around the base of the punches, and this metal, expanding when cooling, holds them securely. The three parts of the punch were shaped to their full length of $1\frac{3}{4}$ inch and fitted to the die, small grooves being chiseled crossways about



Three-piece Piercing Punch, secured in the Head by Type-metal

$\frac{3}{8}$ inch from the inner end, to prevent them from pulling out when punching. The three punches were then inserted in the die and squared up.

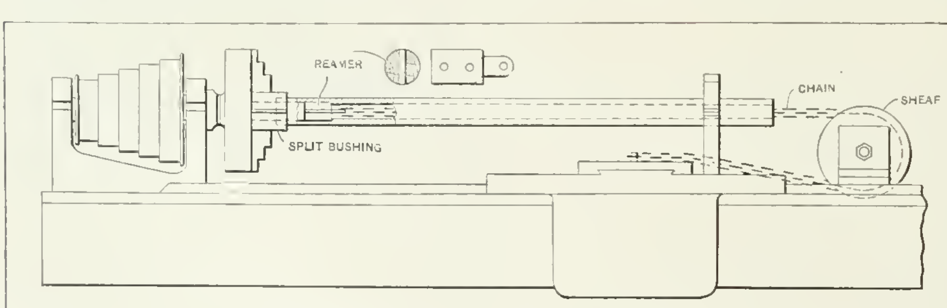
A piece of cast iron about $\frac{5}{8}$ inch thick was next drilled out so that it cleared the outside of the punches by about 3/16 inch. The holes were left in the rough with the exception of a slight chamfering to keep the type-metal from slipping out when punching. The cast-iron piece was then packed with parallels and molder's or buffer's sand, and the type-metal poured in.

This punch was used to cut Britannia metal and also German silver and brass disks, but through it all the punches remained solid in their head. A sample of the work produced is shown beside the punch in the illustration.

East Syracuse, N. Y. C. W. SHELLY

CHAIN-DRIVEN REAMER FOR BORING LONG PIPE

An interesting method for boring a cored cast-iron pipe, $2\frac{1}{2}$ inches in diameter and 5 feet long, in an engine lathe, using a very simple equipment, is shown in the accompanying



Chain-driven Reamer boring out Cast-iron Pipe

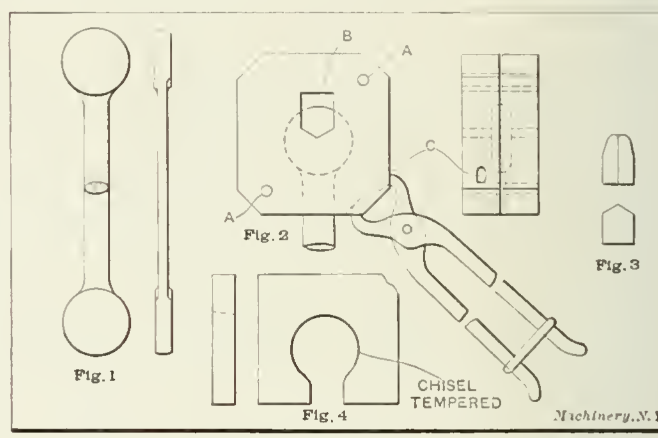
illustration. The pipe was bored by means of the old-style flat reamer, provided with wooden packing on the sides to keep it from chattering and held against the pressure of the cut and fed to it by means of a common link chain.

The pipe to be reamed was gripped in a split bushing held in the chuck and the outer end of the pipe was supported in the steadyrest. The split bushing in the chuck projected beyond the jaws and gripped the end of the pipe only. The inner part of the bushing was bored to the same diameter as the reamer and served to guide the latter into the cored hole. The chain was attached to the reamer and passed through the bushing and cored hole around a sheave mounted on an angle-plate at the outer end, and back to the lathe carriage, to which it was secured. When the lathe was started, the chain twisted until all the slack was taken up, and then the reamer began to operate, being drawn into the cut by the feed of the carriage. It was anticipated that the sand in the iron would speedily cut out the packing and dull the tool, but no such trouble was experienced.

This method of boring cylinders was introduced many years ago in a Western shop and has been in use ever since. A. F.

FORGING WRENCHES WITH A STEAM HAMMER

Mr. Cran's letter on forging wrench jaws in the March number of MACHINERY, brought to my mind a similar problem which may interest some readers of MACHINERY. I had been making double ended wrenches for some time in two dozen lots with $1\frac{3}{8}$ and $1\frac{5}{8}$ inch openings, respectively, by hand out of 1 by 4-inch soft steel pieces, which were left from another job. This method, however, was not satisfactory, and it was up to me to make them cheaper.



Figs. 1 to 4. Tools used for Forging Wrenches with a Steam Hammer

A blank was made, as shown in the engraving Fig. 1, and filed smooth and to the desired shape; then two pieces of soft steel were taken and hammered out to about $7\frac{1}{2}$ inches square and $2\frac{1}{2}$ inches thick. These pieces were then heated and the blank, Fig. 1, put in between them and hammered together, the blank making an impression in each piece. After working the blank, Fig. 1, into these hot blocks, the edges were brought up with a "bob" punch, and they were then put together for a final blow.

When the pieces were cold, they were taken to the drill press and the blank inserted in them. Then the blocks were clamped together and two $\frac{3}{4}$-inch dowel holes *A* drilled at the corners (see Fig. 2); through these holes tapered dowel pins were driven tightly into the bottom plate. A hole was then drilled through the top and bottom blocks and the oblong hole *B* chipped out to the proper shape. The hole in the lower block was made sufficiently large to let the punching and punch drop out easily. Two holes *C* were next drilled in the top block to fit a pair of tongues, as shown in Fig. 2, which enabled the operator to handle the upper block easily. The punch shown in Fig. 3 was then made. This was beveled at the top, as shown, and was made perfectly flat and square on

the bottom. Neither the punch nor the dies were hardened, but undoubtedly the punch would last a great deal longer if it were hardened.

The stock for the wrench was hammered out rough and the shank finished as shown in Fig. 1, then chopped off with a circular cutter, leaving nearly the exact quantity required for forming the ends. Some of the forgings, however, had fins on them in some places, so to overcome this a trimming die, 7/8 inch thick and 7½ inches square, as shown in Fig. 4, was made. This die was used in the steam hammer, and trimmed the fins off satisfactorily.

All the operations on these tools, with the exception of drilling the holes for the dowel pins and the hole for the punch, were done in the blacksmith shop, which is conclusive proof of what can be done in an emergency. The dies worked satisfactorily, and over 200 wrenches were produced by them while the writer was employed in that shop, and possibly as many more were put through the dies after he left.

Decatur, Ill. GEORGE COLES

A WIRING DIE

While MACHINERY is full of successful jobs that its readers have accomplished, not much is said of those necessary experiments which lead to the successful accomplishment of the problems in hand; it seems to the writer that it is fully as important to know what can't be done, as what can be.

A short time ago we had to wire a cover, but on account of the smallness of the wire in proportion to the thickness of the metal, considerable trouble was encountered. The material was sheet brass, 0.018 inch thick, and the wiring was 0.075 inch in diameter. The covers were first drawn to the right shape and length of body as usual, in single-action combination dies. Then the usual wiring dies, such as are illustrated in Fig. 1, were made, but their use was not a success, as the covers appeared as shown in the enlarged section; the metal instead of wiring at the top, curled back at the point *a* forming an inner shoulder.

To overcome the difficulty, the punch was bored out, as shown in Fig. 2, and a spring pressure pad inserted to prevent the bottom buckling. While this undesirable feature was eliminated, buckling occurred in the side at the unprotected section, between the pad and the punch, as shown at *b* in the enlarged section, Fig. 2. This, however, gave a clue to the

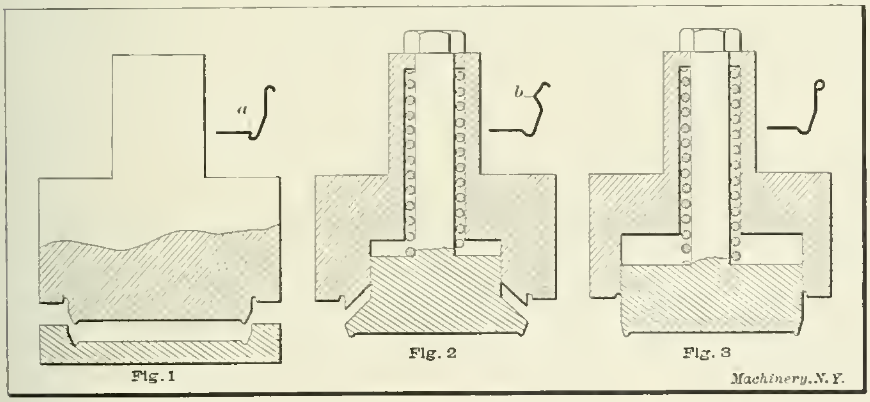


Fig. 1. Usual Type of Wiring Die showing Imperfect Work produced. Fig. 2. Modified Pressure-pad Wiring Die still producing Imperfect Work. Fig. 3 Pressure-pad Wiring Die producing Perfect Work

proper solution of the problem, which was to bore out the body of the punch still larger and introduce a pressure pad the full diameter of the inside of the cover. Preparing the punch in this manner, solved the difficulty, and a perfectly wired edge (see the enlarged section, Fig. 3) was produced. These experiments seem to indicate that shell stock under pressure has a tendency to buckle inward and not outward.

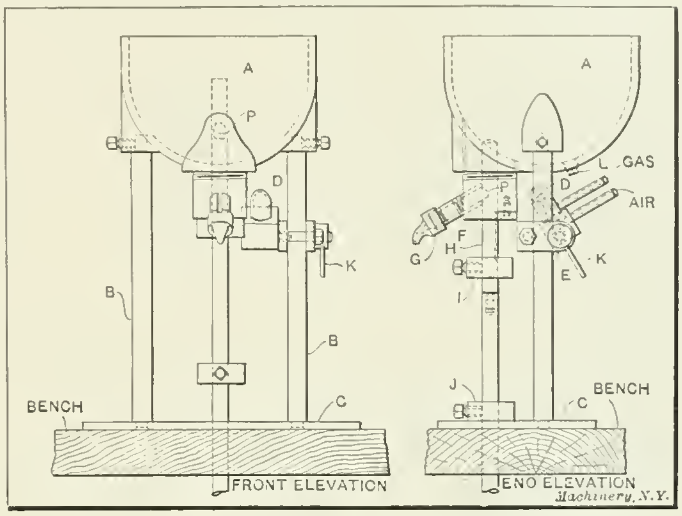
Springfield, Mass. C. H. WILCOX

[A sample of the work produced which Mr. Wilcox has sent to this office shows a perfectly wired edge.—EDITOR.]

A SOLDERING DEVICE

The accompanying illustration shows front and end elevations of a soldering device which is very convenient for light manufacturing purposes. This device consists mainly of a pot *A* held to two uprights *B*, the bases of which are riveted to a plate *C*, the latter being screwed to the workbench. Attached to one of the uprights *B* is a burner *D* which is held in a bracket *E*, so that it can be swiveled to any desired position, where it is locked with the wrench *K*. The construction of this burner is clearly shown in the illustration. Screwed into the bottom of the pot is a bushing *F*, into which the nozzle *G* is inserted.

A rod *H* passes up through the bushing *F* and into the pot, and a small groove or pocket *P* is cut in this rod *H*,



An Efficient Soldering Device for Light Manufacturing Purposes

for carrying the solder from the pot down to the nozzle. A slot is also cut in the rear of the rod *H*, and a plate, held on the bushing *F*, fits into this slot and prevents the rod from turning. The size of this pocket governs the amount of solder which will be removed from the pot at each movement of the rod. This rod *H* continues on down through the bench, and is attached to a foot lever by which the rod is operated. The rod *H* is made in two pieces, the upper portion of which can be removed so that various sized pockets which will hold the desired amount of solder can be used. Two washers *I* and *J* are held on the rod *H* by set-screws which limit the travel of the rod.

In operation, the burner is first set directly under the pot, so that the pot is heated and the solder melted. Then the burner is turned on the bushing *F*, keeping it warm, and preventing the solder from cooling in its descent from the pot into the nozzle. A plug *L* is screwed into the bottom of the pot, as shown, so that the solder can be cleaned out, and a 1/8-inch slot is also cut in the nozzle so that it can be cleaned out.

This device will be found very satisfactory, especially for soldering the wires in plugs for electrical purposes. With the ordinary soldering iron, this operation is difficult, as it requires a very small soldering iron to do the work so that the wire will not be burned when applying the solder. Using a small soldering iron means that the wire has to be heated more frequently than with a larger one, thus causing delay and trouble. With this device, the plug with the wire inserted in it is held directly under the nozzle, the foot-lever depressed, and the drop of solder deposited in the desired position without any further trouble. WILLIAM YOUNG

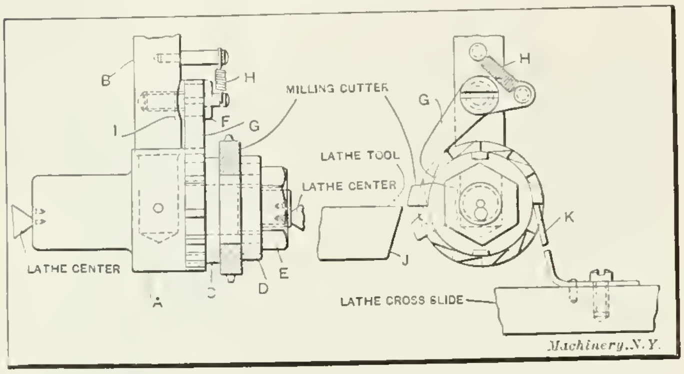
Hartford, Conn.

FIXTURE FOR BACKING-OFF MILLING CUTTERS IN THE LATHE

The accompanying illustration shows a simple device for backing-off milling cutters in the lathe. This fixture consists mainly of an arbor *A* to which is attached a ratchet-wheel and handle carrying a ratchet. The eccentric arbor *A* is free to rotate on the centers of the lathe, and is oscillated by the

handle *B*, the latter being held in a hole in the arbor by a pin. Held against the shoulder of the arbor by a nut *E* is a bushing *C* in which ratchet-teeth are cut corresponding to those in the cutter to be backed-off. The milling cutter is held against a shoulder formed on the bushing *C* by a spanner nut *D*. Attached to the handle *B* by a shoulder screw *F* is a pawl *G* actuated by a coil spring *H*. The shoulder screw *F* rests on a washer *I*, seated in the cylindrical handle *B*.

In operation, the milling cutter is placed on the bushing with its teeth in line with the teeth in the ratchet-wheel, the nut *D* tightened and the bushing placed on the arbor. The



A Simple Device for Backing-off Milling Cutters in the Lathe

bushing should be placed on the arbor with the centers in the same relative position to the cutter as shown in the engraving. As handle *B* is brought forward it carries the milling cutter as well as the ratchet-wheel past the lathe tool *J* held in the toolpost of the lathe, thus backing off the cutter. When the handle is retreated the ratchet-wheel, as well as the milling cutter, is prevented from revolving back by the spring *K* held to the cross-slide of the lathe carriage. Thus it can be seen that the arbor *A* does not make a complete revolution on the centers, but is only oscillated through a space of one tooth, the ratchet-wheel and cutter alone revolving around the centers.

A. F.

UNIVERSAL SHAPER ATTACHMENT

In Fig. 1 is shown an attachment designed by the writer for the special use of toolmakers when accurate work must be performed. An indexing case *A* is attached by a bolt *B* and a nut *C* to the clapper on the head of a shaper, the clapper being indicated by the dotted lines. The clapper must, of course, be rigidly secured in its box by a taper pin

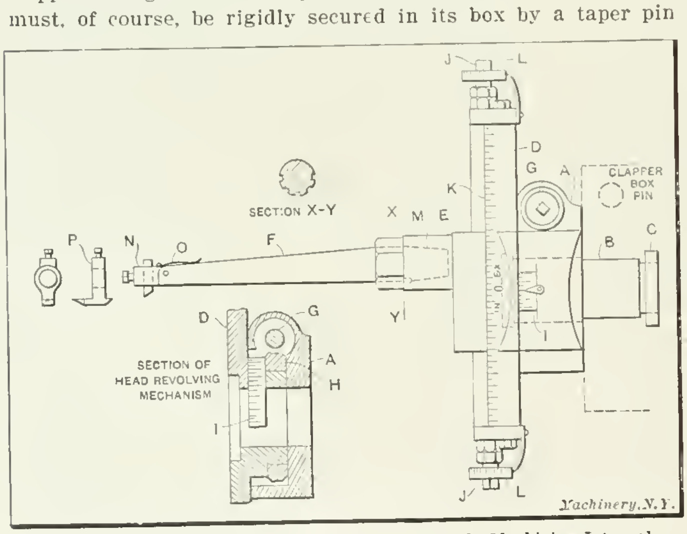


Fig. 1. Universal Shaper Attachment for accurately Machining Internal and External Circles of any Radius

near the lower end, to prevent the tool from jumping. On the front of this indexing head, there is a vertical slide *D*, to the front of which, in turn, is attached a sliding piece *E* which holds the projecting arm *F*. The vertical slide *D* has a circular adjustment to any position by means of the worm *G* and worm-gear *H*, better shown in the sectional view of the head-revolving mechanism in the lower part of the engraving. A graduated circular scale *I*, divided into 360 degrees, shows through an opening in the side of the containing box and has an indicator finger to mark off the number of degrees. When the head *D* is in a vertical position the pointer indicates zero on this circular scale.

The sliding part *E* on the front of the vertical head *D* is fitted to the latter by means of dovetailed grooves which are gibbed in the same manner as those attached to the vertical slide of a lathe or planer head. It is vertically adjustable through the square-threaded bolt *J* engaging with a nut in the sliding member *E*. The side of this vertical head *D* is graduated as shown at *K*, finer divisions being possible through the circular graduation on dial *L* at each end, an indicating finger showing the adjustment.

The tool arm *F* has a taper fit at *M*, in a projection on the front of the sliding member *E*; the section *X-Y* shows the keyways in this taper section, the reason for which will be explained later; this tool arm *F* may be removed from its taper fit by the nut shown. The tool proper is carried in a small clapper arrangement *N* on the outer end of the post *F*, and is retained in its normal position by the spring *O*.

Thus far the description has been purely constructional; the manner in which it may be very serviceably employed will next be considered. A piece *P* shaped as shown is slipped over the end of *N* for setting the tool, the latter being adjusted on the rear ledge of this piece. This piece *P* is so

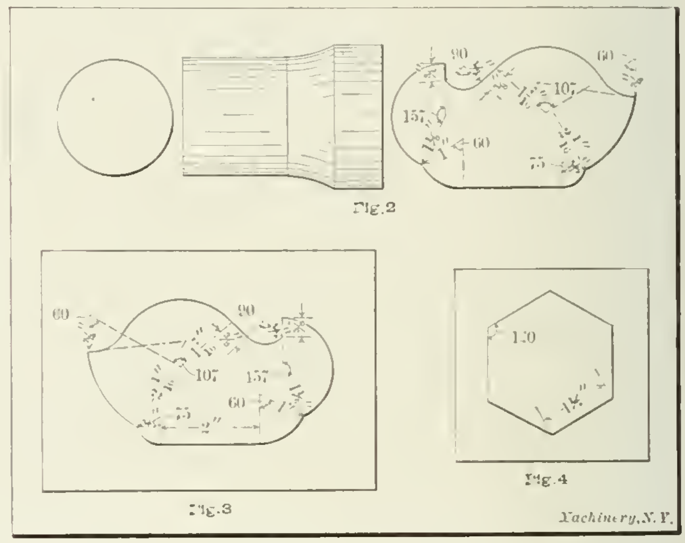


Fig. 2. Punch of Irregular Shape that can be produced readily by this Attachment. Fig. 3. Die corresponding to Punch, also made by Attachment. Fig. 4. Another Class of Work to which Attachment is adapted

made that when the tool is adjusted to its ledge, the tip of the latter will be in the same line as the center of rotation of the vertical slide *D* when the pointer on the scale *I* registers with zero on the scale *K*. The graduations *K* range in both directions "in" and "ex," as indicated. This means that in this position if the vertical head *D* be revolved the tip of the tool will be stationary. If the head *E* be lowered in the direction "in," when the head is revolved the tip of the tool will follow the path of an internal circle; whereas, if the head is raised above zero, the tool will form the part of an external circle.

It will be noticed also that the outer side of the collar *P* has a pointer so that when the head *E* is set to the right radius on the scale *K*, the whole attachment may be adjusted to follow a previously scribed circle on the part to be shaped.

A couple of applications of the use of this head for punch and die work will be shown. Figs. 2 and 3 show a punch and die of an irregular shape made up of circles and tangents; this attachment is peculiarly adapted to such work, inasmuch as it can be revolved through the entire circle, thus dispensing with the time-absorbing feature of resetting the work. As an example of the operation, consider the production of the die shown in Fig. 3. The outline is first scribed as is customary, and the cut-out portion is then roughed out in a drill press in the usual manner. It is then placed in the shaper vise on its lower edge, the two-inch side being first machined. In doing this, the head *D* is placed vertically and the sliding part *E* either set to ½ inch or to 1 inch for an internal curve. Consider it as set for the latter; this means that the head is low-

ered 1 inch. The cut is commenced from the tangent of ½ inch curve to the right for 2 inches, when the cross feed is disengaged and the circular feed by hand through the worm *G* introduced, revolving the head *D* through the necessary 60 degrees which completes that arc. The head is next adjusted for a 1⅛-inch internal circle, and by means of the scriber point of the piece *P* adjusted to take the 157-degree arc which can be nearly completed in this position. For the upright sharp corner, an angle tool must be introduced, when a vertical feed on the shaper head will form the vertical side. For the ½-inch curve the head is adjusted for a ½-inch external curve. The die would be made in a similar manner.

For machining parts such as that shown in Fig. 4 where the sides are straight, the tool bar *F* is adjusted so that its key fits into one of the side grooves shown in section *X-Y*, Fig. 1. The head is then swung over parallel with one of the sides of the cut to be made, when the work can be proceeded with as previously described.

From the description it will be seen that this attachment could also be used on planers, if made sufficiently strong. It is not, of course, intended for heavy cuts or for quick removal of metal, but for the purposes indicated and also for internal gear cutting, its use ought to prove advantageous in shops where special machinery for such purposes is not warranted by the amount of work to be produced. By this method no special milling cutters, etc., are required, as this one set of tools is applicable to all work.

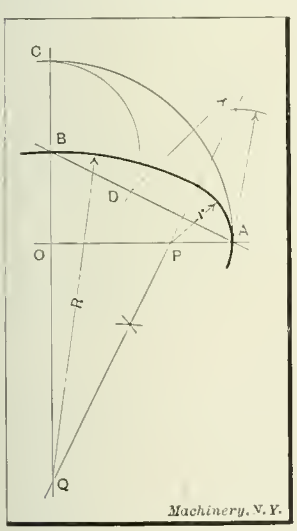
Clinton, Iowa. OLOF N. NORD

"A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION"

In looking over the pages of the March number of MACHINERY, engineering edition, the writer noticed the article, "A New Circular-Arc Ellipse Construction," by Prof. H. A. S. Howarth, in which is described a method for drawing an ellipse with only two radii. The method is certainly good, but one that is somewhat simpler and almost as accurate may be advantageously used for designing gear wheel and fly-wheel arms. This method is shown in the accompanying engraving and is so simple that an explanation is superfluous.

JOHN L. KLINDWORTH

Bellevue, Pa.



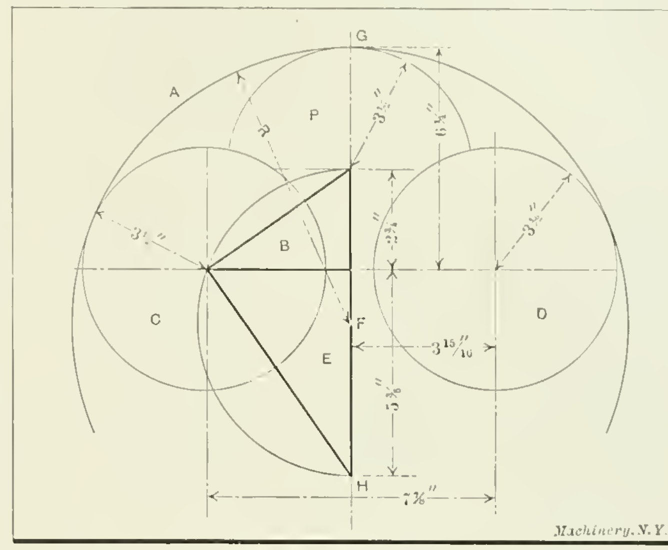
Circular-arc Ellipse Construction

[The construction is as follows: With center *O* and radius *OA* draw arc *AC*. With center *B* and radius *BC*, equal to *BO*, draw arc *CD*, cutting *AB* at *D*. With centers *A* and *D*, draw arcs of any convenient size as a constructional means of erecting a perpendicular on *AB* bisecting *AD;* this gives the centers *P* and *Q*. The lines *OA* and *OB* are the half major and minor axes of the ellipse.—EDITOR.]

"SOLVING A PRACTICAL PROBLEM BY SIMULTANEOUS EQUATIONS"

A simple method of solving the problem given by Mr. Howard Terhune under the title "Solving a Practical Problem by Simultaneous Equations," in the January number of MACHINERY, is outlined in the following: The diameter of each of the cylinders *C* and *D* is 7 inches; centers, 7⅞ inches apart, equidistant from the center line of large circle *A*. The distance from the center line of circles *C* and *D* to the top of the circle *A* is 6¼ inches; these figures are those given by Mr. Terhune. It is desired to find the radius of the large circle.

With a radius equal to that of the cylinders *C* and *D*, draw a circle *P* on the line *GH*, tangent to the large circle at *G*, and join its center to the center of the cylinder *C*. By bisecting this line and erecting a perpendicular on it, center *F* of the large circle is located. With *F* as a center draw a semicircle through the centers of *P* and *C*, cutting *GH* at *H*, and join this point to the center of *C*. This produces two right-angled triangles with a common side, and with only one side unknown, this being the vertical side of the triangle *E*, which, by proportion, is found to be 5.638 inches. Adding to this 2¾

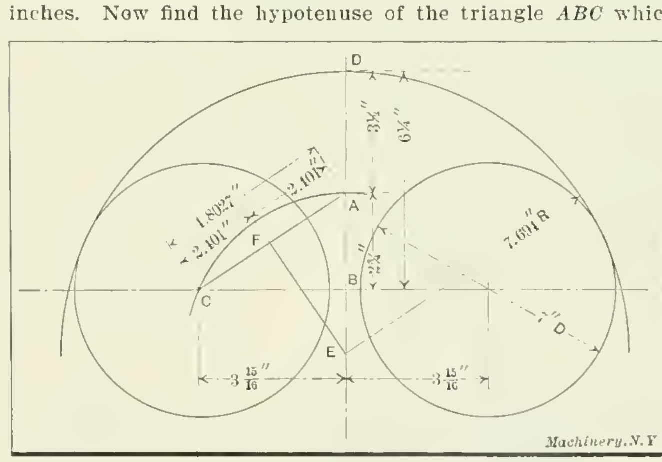


Solution of Problem by Proportion

inches gives 8.388 inches, the diameter of the large circle for a radius of 4.194 inches. The radius of the large circle is obtained from this by adding 3.5 inches, obtaining the answer 7.694 inches. The simplicity of the operation is apparent.

Buffalo, N. Y. JOHN C. STURM

The writer noticed in the January number of MACHINERY, under the title "Solving a Practical Problem by Simultaneous Equations," a very interesting problem by Mr. Howard Terhune, but fails to see where there is anything very difficult about it, for it can be solved by ordinary mensuration. For the benefit of those who might not have a knowledge of simultaneous equations, a solution is herewith presented. It is obvious that if a circle be drawn concentric to the one to be found and running through the centers of the two circles, the line *AD* will equal 3½ inches, and hence *AB* must be 2¾ inches. Now find the hypotenuse of the triangle *ABC* which



Solution of Problem by Proportion

is 4.8027 inches; bisect this hypotenuse *AC* at *F* and erect a perpendicular; this perpendicular will cross a center line at *E*, which is the center of the desired circle. Since the triangles *ABC* and *AFE* are similar, the distance *AE* may be found by proportion, thus

$$4.8027 : 2.75 :: x : 2.4014.$$

Therefore

$$x = 4.194 \text{ inches.}$$

Adding to this 3½ inches, gives 7.694 inches, the required radius.

JOSEPH B. ABELE

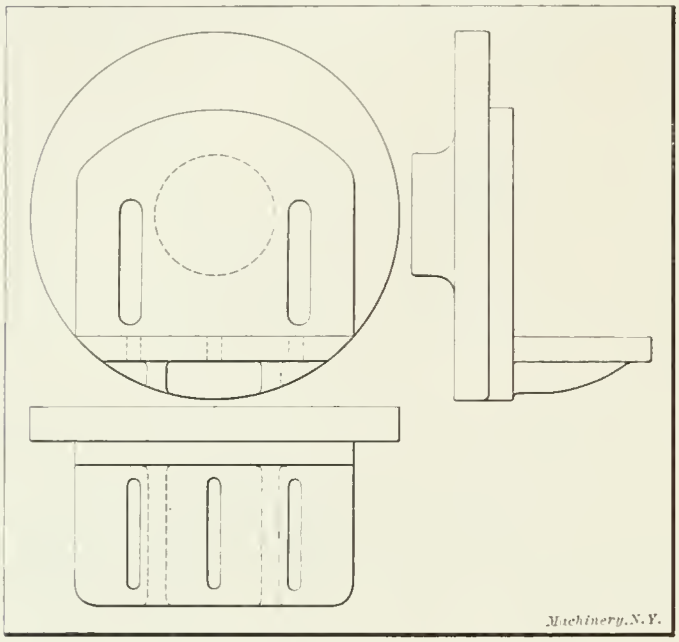
Clifton Heights, Pa.

IMPROVED ANGLE-PLATE FOR LATHE WORK

The article by Mr. C. R. Barton entitled, "Improved Angle-plate for Lathe Work," which appeared in the December issue

of MACHINERY, was read with a good deal of interest by the writer; however, it seems too bad that Mr. Barton did not go a step further and make his plate more useful. In the article mentioned, a statement is made to the effect that with this design of plate no balance weights are necessary; obviously this is incorrect, for no matter what shape the plate assumes, the weight is always off center.

To make the plate of more service, the writer makes it as

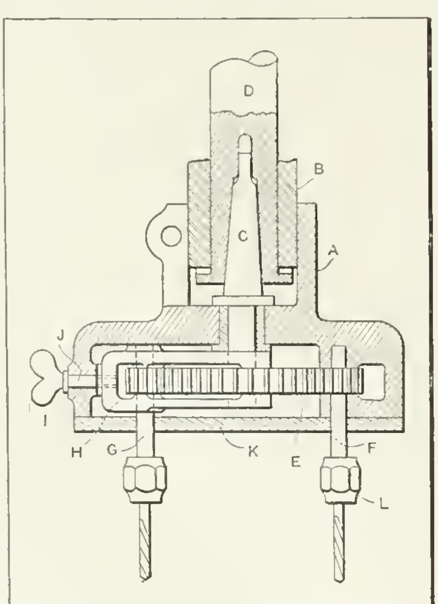


Improved Angle-plate for Lathe Work

shown in the accompanying engraving, which allows the same range as the one described in the previously mentioned article, and at the same time permits of greater width, larger work and more clamping surface. Incidentally, from the design it will be noticed that less balancing is required. P. H.

ADJUSTABLE TWO-SPINDLE DRILLING ATTACHMENT

The attachment illustrated is one that can readily be applied to any standard drill press, for use on jobs in which it is desirable to drill two holes at a time.



Adjustable Two-spindle Drilling Attachment

The construction is as follows: A casting *A* of the shape shown fits over the end of the sliding sleeve *B* of the drill press, and is split on one side and provided with a screw so that it may be securely clamped in position. A taper shank *C* is fitted to a socket in the drill-press spindle *D*. On the lower end of this, within the casting *A* is a large gear *E* meshing with pinions, as shown. Drill spindle *F* on one of these pinions is fixed in position, while spindle *G* on the other pinion is carried on radius arm *H*, which can be clamped in any desired location by means of the screw *I* passing through the slot *J*. Cover-plate *K* is also made with a circular slot to provide for swinging the spindle *G* into the desired position.

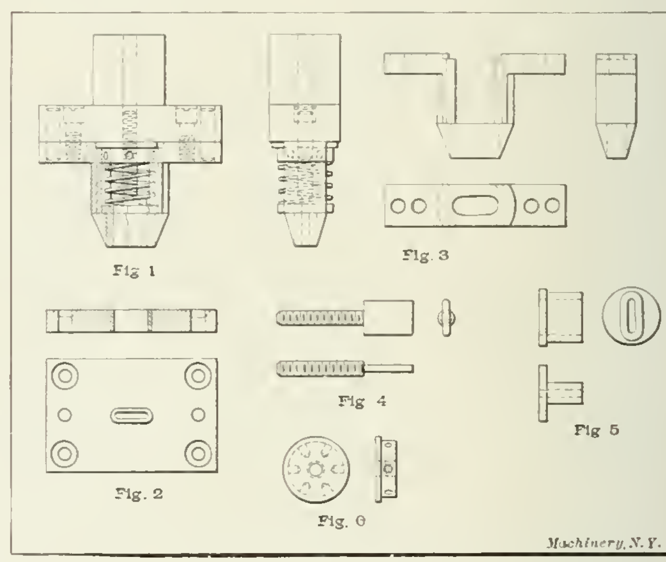
When the two spindles are 180 degrees apart the attachment has its greatest range. The spindles can, however, be brought together to a distance limited only by the size of chucks *L* or the driving pinions on the drill spindles. W. ALTON

PUNCH AND DIE FOR BLANKING AND PIERCING PAPER AND EBONITE

The accompanying illustration shows a simple and efficient punch and die for blanking and piercing ebonite, paper and materials of a similar nature. The blanking and piercing is performed at the same stroke, doing away with the use of a follow die, which is awkward to use on paper, or on ebonite, the latter having to be worked warm.

Fig. 1 shows the assembled punch, and Fig. 2, the die. The die is a brass plate with a center piece of the required size, made from tool steel hardened and driven into the brass plate. The center piece and the hole for it in the brass plate are made with a slight taper so that it can be driven in tight. This center piece is made to fit the piercing punch and is also made small enough on the outside, so that the blanking punch will come outside of it and strike on the brass plate. The die is fastened to a plain bolster-plate by screws and dowels.

The blanking punch, Fig. 3, is made of tool steel, to the shape shown, being bored and turned in the lathe, and the hole for blanking is worked out smooth and parallel. This hole is also lapped parallel after hardening. The blanking punch is attached to the soft steel shank as shown.



Figs. 1 to 6. Assembly and Details of a Punch and Die for Blanking and Piercing Paper, Ebonite, etc.

The piercing punch, Fig. 4, is made to size, hardened and lapped straight and parallel, and the threaded stem is made a snug fit in the hole in the shank, which is bored central with the blanking punch. The circular nut, Fig. 6, is fitted to the threaded stem of the piercing punch and is drilled as shown to permit of turning when the punch is assembled.

The ejector, Fig. 5, is next fitted, the round collar fitting the bored part of the blanking punch, and the other portion of it fitting the inside of the blanking punch proper. The inside of the ejector is fitted to the piercing punch. The ejector is hardened and lapped to a nice sliding fit all over. The spiral spring completes the tool. This spring rests on the ejector and returns it to its normal position after each stroke of the press.

In setting up the die in the press, the circular nut, Fig. 6, is revolved until the piercing punch projects about one-sixteenth inch beyond the face of the blanking punch. It is then easily entered into the die and the tool set up accordingly. When the die is clamped in the correct position, the nut is revolved again, but in the opposite direction, until the piercing punch is almost flush with the face of the blanking punch, leaving it projecting only a few thousandths. The press is set so that the face of the blanking punch just touches the brass plate when at the bottom of its stroke.

It will be seen that in operation the stock is pierced and blanked at the same stroke, the pierced scrap going through the die and the blanks being placed on the face of the die by the ejector. This design of die gives satisfaction, and can be applied to almost any shape of blank with any reasonable number of pierced holes. JETHART

MACHINING THE WRIST-PIN OF A SOLID STEEL CROSSHEAD

In a small jobbing shop with which the writer is connected, an engine came in recently to be overhauled and repaired. The crosshead was the only part that involved any particu-

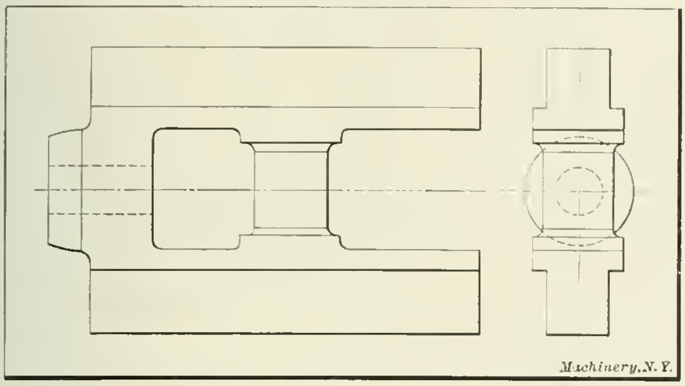


Fig. 1. Type of Crosshead to be machined

lar difficulty, for, as Fig. 1 indicates, it is a solid steel casting, the wrist-pin being a part of that casting, and not the customary inserted steel pin.

The necessary planer work was first performed, during

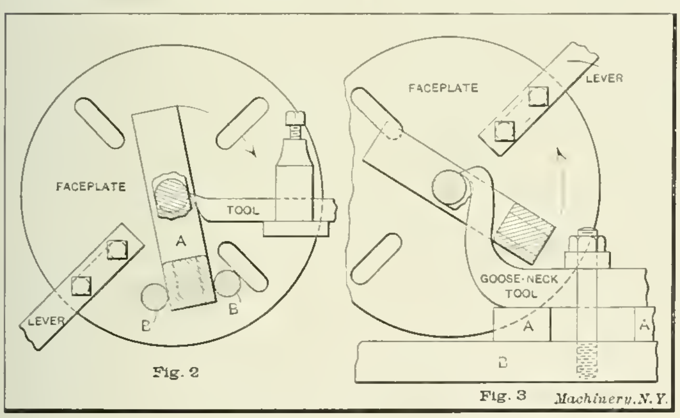


Fig. 2. Machining Open Side of Wrist-pin. Fig. 3. Machining Piston-rod Side of Wrist-pin

which operation the wrist-pin had flats planed on each side, equidistant from the center of the pin. This is shown by the crosshead in Figs. 2 and 3. The crosshead, with its wrist-pin thus flattened on each side, is centered in the lathe, as

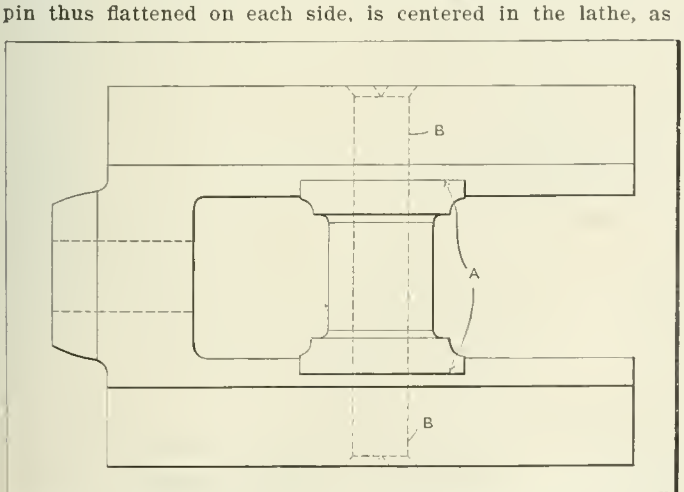


Fig. 4. Method of Repairing Worn-out Wrist-pin by Fitting in a New Piece

shown in Fig. 2 (*A* being the cross-sectional view) and secured there by pins *B* in the faceplate. The half of the wrist-pin toward the open end can then be machined with an ordinary lathe tool, turning the faceplate back and forth through a half revolution by the attached lever. In Fig. 2, the cut is just commencing, the motion being as indicated by the arrow.

A more difficult proposition presented itself in the machining of the piston-rod side of the wrist-pin, because of the confined space. The difficulty was overcome by the method indicated in Fig. 3. The crosshead is left on the centers as before, and a goose-neck tool is employed to do the work, as indicated. The tool was built up on blocks *A* of the requisite height and supported on cross-bridge *B*, bolted to the lathe carriage. In the position shown, the cut has just been completed, the whole requiring to be revolved back half a turn in the direction indicated by the arrow. An equally good way of revolving the piece would be to bolt the turning lever directly to the casting.

Fig. 4 shows a method once employed for repairing one of these crossheads when the pin had worn down too much to be re-turned. The pin was entirely cut out, and grooves such as those shown at *A* were machined; a pin of the shape shown was then inserted, the whole being held together by the long central pin *B*, which was riveted over at the ends to form a solid piece. H. E. WOOD

Newark, N. J.

LATHE ATTACHMENT FOR TURNING CIRCULAR FORM TOOLS

The attachment shown in Fig. 1 is fitted to the bed of the bench lathe directly in front of the headstock, and is used to "generate" the shape of small circular forming tools, such as are used on turret lathes and screw machines. This attach-

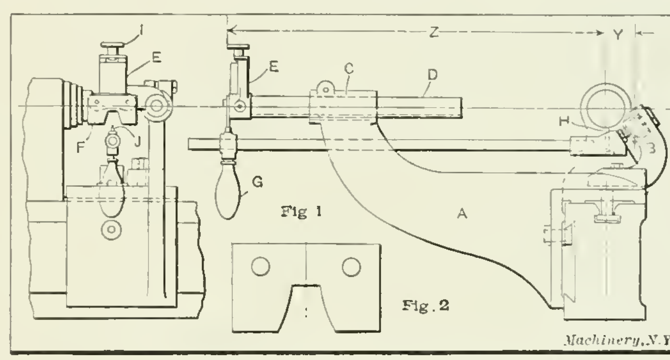


Fig. 1. Lathe Attachment for Turning Circular Form Tools. Fig. 2. Templet or Master Former used on the Attachment

ment can also be used for making forming tools of the fly-type used in backing off small gear cutters and work of a similar character. In the average shop, which is not equipped with special or elaborate tools for such work, this attachment will be found valuable, as it can be used for producing the

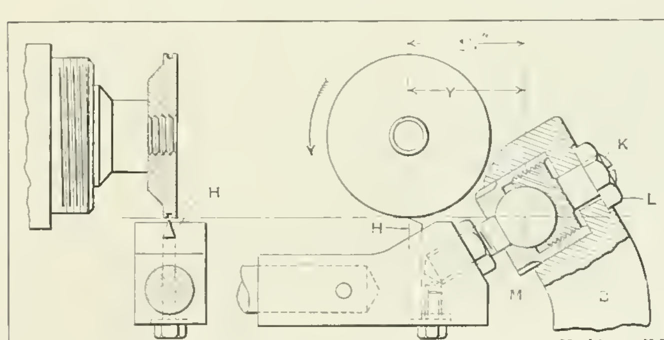


Fig. 3. Enlarged View showing Construction of the Socket Joint—Scale One-half Actual Size

most intricately shaped cutter quickly and at small cost; for instance, without some such device as this, the forming of a cutter for, say, a sixty-pitch gear is a very difficult proposition and, is in fact, impossible to do by ordinary means where very accurate work is required.

The construction of this attachment is shown in Fig. 1. Here the projecting arm *A* is shown bolted to the bed of the bench lathe, and upon this is fastened the fulcrum support or tool-holder *B*. The outer end of the projecting arm *A*

is provided with a clamp nut *C*, sliding through which is a rod *D* carrying an adjustable templet-holder *E*. The templet or former *F* is attached to this holder by screws. By sliding the rod *D* in and out of the arm *A*, the ratio between the distances *Y* and *Z* can be changed, or in other words, the dimensions on the cutter being formed can be reduced in the desired ratio to that of the templet. To obtain accurate results with this attachment, it is necessary to observe carefully that the center of the ball fulcrum, the cutting tool and the tool guiding point *J* are all exactly in line. If this is not the case error is likely to result, unless the handle *G* is held in a vertical position throughout the operation.

To illustrate the use of this attachment, take a practical example: Assume that it is necessary to make a cutter for a sixty-pitch gear. The templet, shown in Fig. 2, is laid out with the dimensions twenty times as large as those required on the finished cutter, on a piece of 1/16 inch sheet steel, as accurately as possible. Of course, the greater the accuracy of this templet, the more accurate will be the cutter produced; however, dimensions within 0.002 or 0.003 inch are close enough for all practical purposes, as this error would be reduced twenty times on the finished cutter.

In operation, the templet, Fig. 2, is fastened to the holder *E* as shown, and the rod *D* is so set that the distance *Z* is twenty times the distance *Y*, which in the construction shown in Fig. 3 would be twenty-five inches. Having previously mounted the cutter blank on the arbor in the lathe spindle, as shown in Fig. 3, the cutting tool *H* is set to the correct height. The templet *F* is then run down by manipulating the screw *I* (Fig. 1) until the tool will not take a cut from the blank, when the handle *G* is operated, and the point *J* kept in contact with the templet. Then when the tool is set so that it takes a light cut, the direction of the screw *I* is reversed, and the templet raised. The feeding of the screw *I* is continued until the desired shape is obtained on the work. The correct size of the blank can be obtained by means of an ordinary micrometer. The construction of this attachment is more clearly shown in Fig. 3, which shows a section of the ball-socket joint. The details of this are clearly shown and will not need description, except that it may be well to mention that the screw *K* is tightened until the ball does not move too freely in the socket; when this is tightened to the desired tension, the nut *L* is then tightened. A nut *M* is also provided on the shank of the ball, so that the distance *Y* can be changed if so desired. To the right of the illustration is shown the position that the point of the turning tool should have in relation to the form on the circular tool, when setting. C. T.

IMPROVED FORM OF MILLING MACHINE VISE

In designing milling machine fixtures for milling small light pieces, occasions often arise when it is preferable, from the point of economy, to use jaws of suitable shape, which can be attached to a standard vise, for holding the work. In this case the initial expense for fixtures is merely the cost of a pair of simple, removable jaws and a suitable cutter. On the other hand, a complete fixture for the same job is much more expensive; separate base casting, fixed jaw, clamp or movable jaw, and means for tightening, are required.

A set of jaws has the further advantage of requiring less storage space than would a fixture such as previously mentioned. However, vise jaws as commonly made have one great disadvantage from the fact that the direction of the cut is against the movable jaw. This has necessitated their use on small parts for light cuts only. The form of vise illustrated in this article shows a construction wherein this last objection has been overcome; it is so designed that the cut is against the solid jaw. The design is such that it could doubtless be adapted to many uses, and for that reason is described in detail.

A base casting, which is shown in detail in Fig. 2, is provided with the usual base-tongues for fitting the grooves of the milling machine, and may be clamped either crosswise or lengthwise of the table. For the former, the special clamp shown in Fig. 2 fits into slots *A* in the side of the casting. For lengthwise bolting, the end slots are used. Projections *B* on both sides of the base casting are drilled for 5/16-inch bolts *C*, which hold the stationary jaw face *D*. Recesses *E* in these lugs *B* are formed to receive the block *G*, which is held in place by the cover-plate *H*. This cover-plate *H*, together with the shield *I*, serves the additional purpose of preventing chips from getting into the mechanism. In block

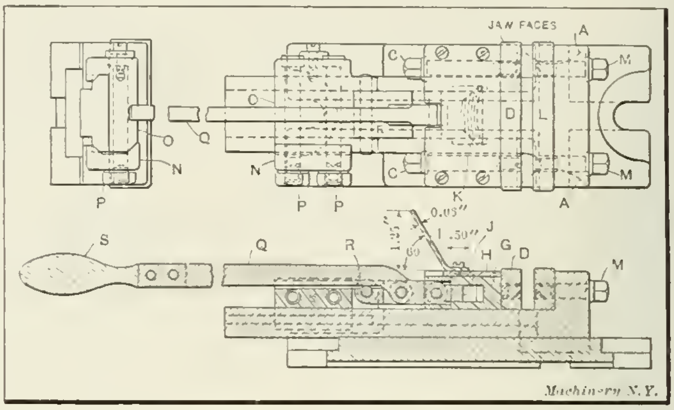


Fig. 1. Improved Form of Milling Machine Vise

G, there is a sliding member *J* which bears up against a spring *K*, the uses for which will be explained later. The movable jaw casting is shown in detail in Fig. 2. It has a jaw face *L* attached to it which is held in position by two screws *M*. Near the rear end of the sliding portion of this movable jaw, parts *N* and *O* are clamped by bolts *P*.

The operation of the vise is provided for by a toggle movement, the two links being *Q* and *R*, which are connected as shown by ¼-inch pins. All these parts are made of hardened tool steel, as most of the wear comes on these members. The link *Q* also serves the purpose of a lever and has a white metal handle *S* attached to it. It can be seen that by raising this handle, the toggle movement will lift, drawing the movable jaw to the right, for the insertion of the work. The heavy spring *K* previously mentioned provides for any inequalities in size in the different pieces of the same lot.

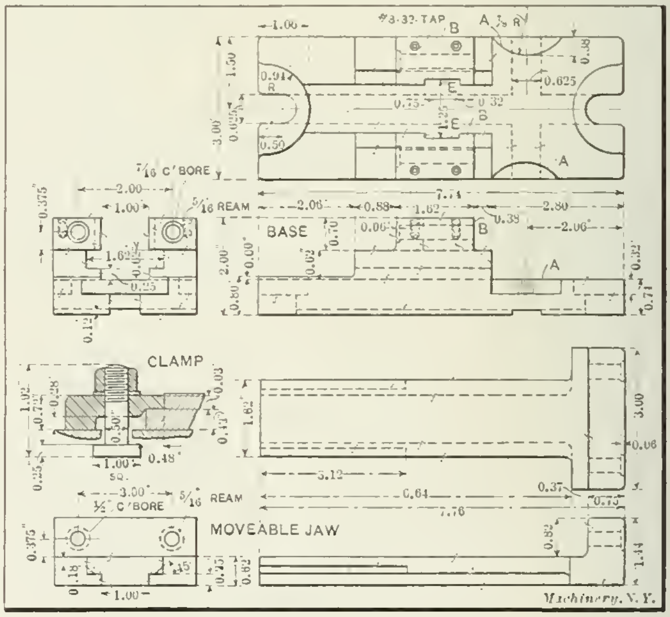


Fig. 2. Important Details of Vise

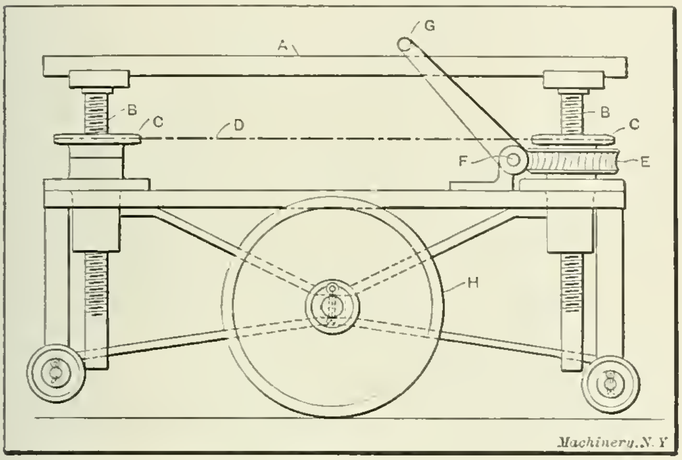
The jaw faces *D* and *L* can be made to any shape desired to suit the requirements of the piece being milled. The vise has quite a wide range of adjustment by changing the relative location of the jaws by means of the clamped pieces *N* and *O*.

Many of these vises are in use in the shop where this one was built and are giving very satisfactory and efficient service. DESIGNER

A HANDY SHOP TRUCK

The accompanying illustration shows a strong shop truck which is very convenient for carrying heavy pieces from the machine to the bench, or *vice versa*. As will be noticed, the table can be raised or lowered as desired. This makes it particularly advantageous for rapid production on a machine, as no time need be lost in stooping over and picking up the work.

The construction of the truck is practically self-explanatory from a study of the illustration. A table *A* is supported at its corners by four screws *B*, on each of which there is a sprocket nut *C*, an endless roller chain *D* passing around the



A Handy Shop Truck

four nuts. On one of these sprocket nuts there is a worm-gear *E* meshing with the worm *F* which, in turn, may be driven by the handle *G*, so that the table may be raised or lowered as desired. The main part of the truck, or what may be called the "frame," is supported on two wheels *H*.

The writer has seen a load of as much as four tons on one of these trucks, the screw mechanism being sufficiently strong to lift this weight. Our shops have had trucks of this kind in use for several years, and the results have been all that could be desired.

W. Alton

IMPROVED CENTERING HEAD

In using the regular centering head which belongs to a combination square it is impossible to draw a line except through the center of the work, and as it is often necessary to lay off a square in the center of a round piece, it would not be

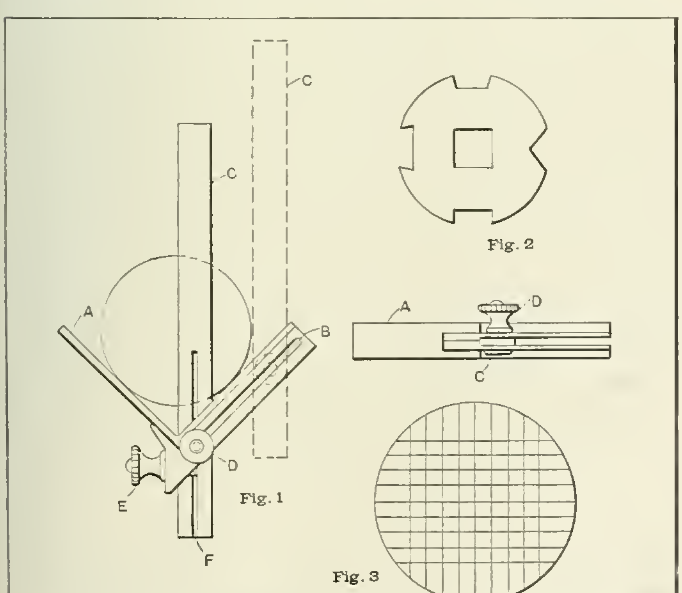


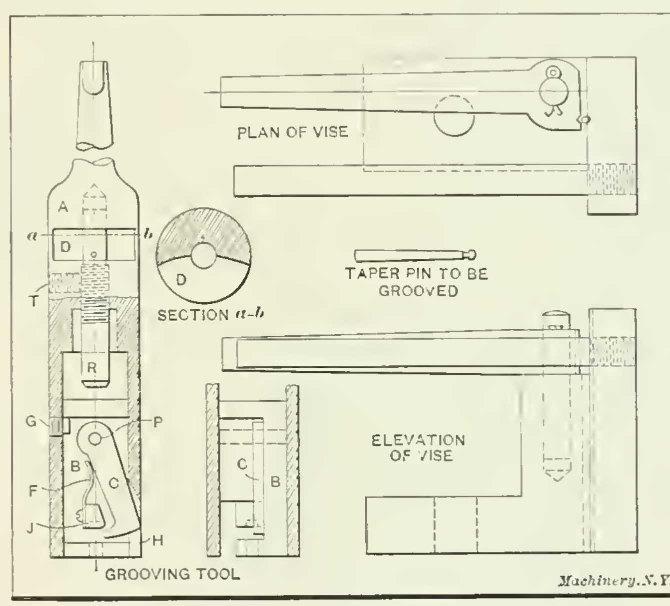
Fig. 1. Improved Centering Head. Figs. 2 and 3. Some of the Possibilities of the Improved Centering Head

possible to do it with the tool mentioned. Having had considerable laying out of this description to do, the writer devised the centering head shown in Fig. 1. This head is somewhat similar in construction to the ordinary combination centering head, but it is adjustable so that the blade can be set in any desired position. In the illustration Fig. 1, *A* is the head, in one arm of which a slot *B* is cut, thus allowing the scale to be set in a central position and also out a short distance from the end of the arm. The scale *C* is locked in the desired position by means of the thumb-nut *D* and when in a central position it is locked with the thumb-nut *E*, the screw in which has a heel on it operating in the slot *F*. This method of locking is the same as that used on the combination square. To keep the blade parallel to the center line, there is a diagonal line drawn on the blade which coincides with the inside face of the head, and the face of the head is also graduated in fractions of an inch. It is obvious that this tool cannot be set exactly parallel with the center line by means of this line drawn on the scale alone, but measurements should be taken from the line or lines previously drawn. In Figs. 2 and 3 are shown some of the possibilities of this head for laying out work. Of course the tool can be made more elaborate to answer other requirements, but the design illustrated herewith has given entire satisfaction to the writer.

San Francisco, Cal. Walter de Sanno

PIN-GROOVING TOOL

The tool illustrated was designed to cut the groove around the end of the No. 1 taper pin shown. Pins of this type without the groove are used by us in large quantities, and as on each engine only two of them require to be grooved, it was



Taper Pin Vise and Pin-grooving Tool

unprofitable to have the firms manufacturing the pins groove them as well. The grooved end is used to secure the loop of a coiled spring.

Previous to using this little tool, the operation was performed by securing the pin in a drill-press chuck, and filing the groove—an exceedingly slow method. In the tool under consideration, the body *A*, having a No. 1 Morse taper shank on its upper end, is bored out as shown to receive the block *B*, a coil spring around stop-pin *R* keeping the block in its normal position against screw *G*. The block *B* is of tool steel, turned to fit freely, and slotted to take a 1/8-inch cutter, which is pivoted at *P*, the cutting end of the cutter being rounded to correspond to the groove to be cut. Normally, it is held out in the slot *H* in the main body by spring *F*. Stop-pin *R*, which is threaded, may be adjusted by means of the pin holes exposed in the slot *D* in the side of the body. Set-screw *T* secures the stop-pin where desired.

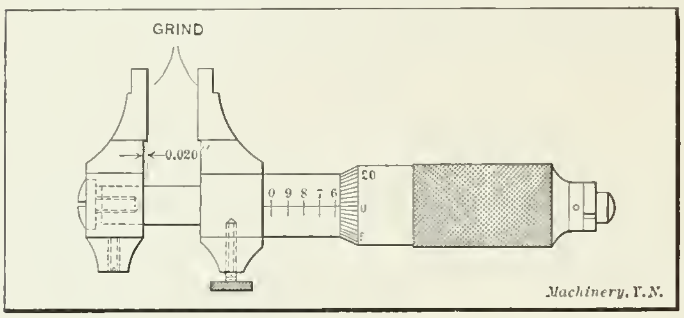
In operation, the tool held in a drill press, is lowered down on the pin held in the special device shown, until the top of the pin strikes stop *J*; further movement of the tool shoves up the block *B*, the cutter *C* striking the taper edge, and entering radially to cut the groove. This cut can be made to a predetermined depth by setting stop screw *R* as desired, preventing the upward movement of the block.

The vise is casehardened, and the pins are held by V-jaws; the vise is bolted to the drill-press table. A small projection in the jaw supports the pins, but when the handle is thrown back, they drop through the jaws and the table. This makes a quick-acting, positive vise. The speed at which the pins can be grooved is limited only by the time necessary to place the pins in the vise, this being the longest operation.

Freeport, Ill. D. O. BARRETT

CONVERTING AN INSIDE MICROMETER INTO AN OUTSIDE MEASURING TOOL

Anyone having an inside micrometer can easily convert it into an outside measuring tool, by simply taking off the jaws and grinding the hub end on both of them about 0.020 inch below the outer end or measuring surfaces, as shown in the accompanying illustration. After the jaws have been



Method of Converting an Inside Micrometer into an Outside Measuring Tool

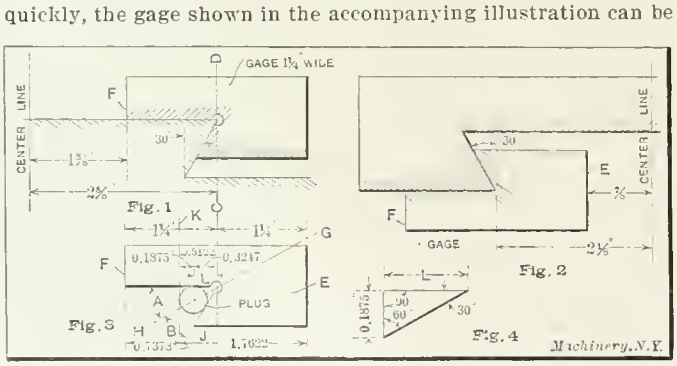
ground they are again assembled and opened wide enough to permit a saucer-wheel to be used for grinding the measuring faces. The face of each jaw is then ground by the saucer-wheel, care being taken not to remove any more material than is absolutely necessary to clean them up. The jaws in the micrometer can then be adjusted to their proper position. This tool will be found very effective for getting into places where an ordinary outside micrometer cannot be used. But, in using this tool for outside measurements it is necessary to subtract the thickness of the jaws from the reading on the thimble to get the desired dimensions.

New Britain, Conn. W. C. BETZ

[There is one serious objection to this change, however, owing to the fact that adjustment for wear can only be provided for in one direction; that is, if the caliper is adjusted to make readings for inside measurements it would show a still greater error when external measures are taken.—EDITOR.]

GAGE FOR MEASURING DOVETAIL SLIDES

Where a number of dovetail slides are to be measured to the sharp corner, and the dimension obtained accurately and quickly, the gage shown in the accompanying illustration can be



Gage for Measuring Dovetail Slides and its Application

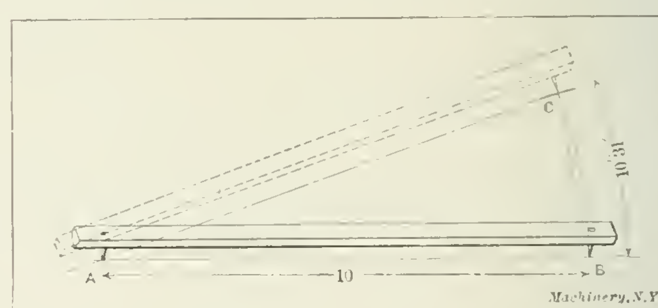
used to advantage. As all slides made in our works are 30 degrees, this gage is made to that angle. To obtain the dimension from the sharp corner of a dovetail to the center line as shown in Fig. 1, the gage is located on the slide as shown, and as the gage is made 1¼ inch from the sharp corner, the distance from the sharp corner can be easily obtained by simply placing an ordinary scale against the end *F* of the gage, and measuring the difference between it and the center line. In this case the difference between the end *F* of the gage and the center line is 1⅜ inch, so that the difference between the center line and the sharp corner on the line *C-D* is 1⅜ + 1¼ = 2⅝ inches. The application of this gage to the measuring of the top slide is shown in Fig. 2. Here the dimension is taken from the end *E* to the center line, which is found to be ⅞ inch; then the distance from the center line to the sharp corner is 1¼ + ⅞ = 2⅛ inches.

To figure out this gage or one of a different angle, take a plug gage, say ⅜ inch, set it in the dovetail as shown in Fig. 3, and measure the distance from the face of the plug or the line *J-K* to the face *E*. The line *H-G* bisecting the angle of the dovetail, which in this case is 60 degrees, makes the angles *A* and *B* 30 degrees. Then, as the radius of the plug equals 0.1875 inch, we now have a triangle as shown in Fig. 4, where it can be seen that *L* is the distance required. From "the law of tangents" in trigonometry, the opposite side of any right-angle triangle equals the side adjacent multiplied by the tangent of the angle. Then $L = 60$ deg. $\times 0.1875 = 1.732 \times 0.1875 = 0.3247$, and $1.250 + 0.3247 + 0.1875 = 1.7622$ inch, which is the distance from the face of the plug or line *J-K* to the face *E* of the gage; also $1.25 - (0.1875 + 0.3247) = 0.7378$ inch, which is the distance from the face *F* to the face of the plug or line *J-K*. This gage is made about 1¼ inch wide, of tool steel, and the faces *E* and *F* are ground to the correct dimensions. W. H. VOCKELL

Cincinnati, Ohio.

ACCURATELY LAYING OUT ANGLES

Having laid out property plans for factories and also drawings of machine parts where the angles were required to be drawn very accurately, the writer has found that protractors graduated to read to five minutes do not give sufficiently close results. Employing the old formula, "The sine of half



Simple Device used for Laying out Angles accurately

the angle is equal to half the chord," very accurate results can be obtained by means of the simple device shown in the accompanying illustration. A strip of wood, 10½ inches long, and ¼ by ⅜ inch or ½ inch section, planed perfectly smooth, has two needles forced into it exactly 10 inches apart, the points projecting about ⅛ inch. In laying out an angle, find the sine of half the angle that is to be laid out; multiply this by 10 (distance between points) and the result will be the length of half the chord.

Example: Lay out an angle of 10 degrees 32 minutes.

Half angle = 5 degrees 16 minutes.

Sine 5 degrees 16 minutes = 0.0917.

Half chord = 10 × 0.0917 = 0.917 inch.

Therefore

Chord = 0.917 × 2 = 1.834 inch.

Place the point *A* at the vertex of the angle with center at *B* and radius of 1.834 inch, draw an arc cutting the arc *B C* drawn by this beam at *C*; joining *A* and *C* gives the angle accurately at any place on the board without the assistance of a T-square. J. C.

* * *

A man's responsibility for work may end when a job passes his department, but his interest in it should reach a little farther to insure the best results.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BULLARD VERTICAL TURRET LATHE

A vertical turret lathe brought out by the Bullard Machine Tool Co., Bridgeport, Conn., is illustrated in Figs. 1 and 2.

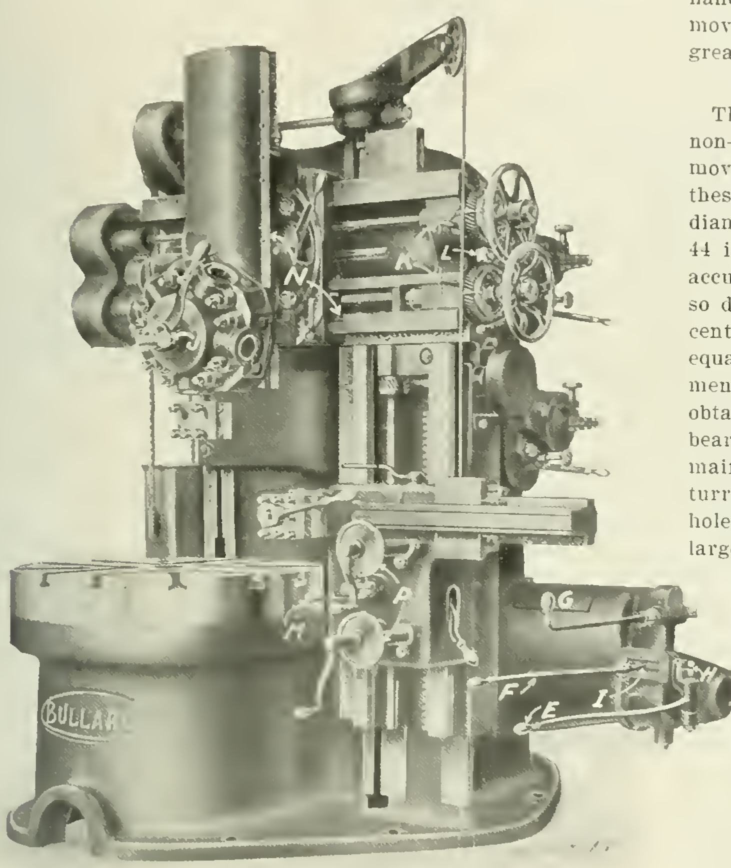


Fig. 1. Bullard 42-inch Vertical Turret Lathe

This machine is nominally a 42-inch size, but has a maximum capacity for stock up to 44 inches in diameter and will take work 32 inches high under the cross-rail. The table is driven through accurately planed bevel gearing and its spindle is of the standard Bullard type, having a large angular thrust bearing and vertical cylindrical bearings of large proportions to absorb the side strain. All the bearings are accurately and concentrically ground on a special machine designed for this purpose, and the entire spindle is immersed in oil which is supplied as will be explained subsequently.

The Speed Changing Mechanism

There are twelve speed changes for the table varying from 3.1 to 60 revolutions per minute. These changes are obtained through two systems of selective sliding gears and positive clutches, located as indicated by the letters *A* and *B*, Fig. 2. A multiple disk clutch is interposed between the main driving shaft and the primary speed change device, and the brake parts are integral with the driven member of this disk clutch. Both the clutch and brake are operated by lever *E*, the engagement of one disengaging the other. Any one of four primary speeds may be selectively engaged by lever *F*, and the secondary speed changes are obtained by lever *G*. By means of a positive interlocking device at *H*, the clutch must be released and the brake engaged before a speed change can be made, and a complete engagement of the gears for any speed is necessary before the brake can be released and the clutch re-engaged. This interlocking device does not interfere in any way with rapid manipulation, but it does serve as a safeguard against breakage due to careless handling. The number of table revolutions per minute can be instantly ascertained from a direct reading indicator *I*. All the controlling levers and handles are centrally located, which eliminates unnecessary movements on the part of the operator and is conducive to greater output.

The Vertical Turret and Side Heads

This machine has one swiveling vertical turret head and one non-swiveling side head, each of which is independent in its movement, both as to direction and amount of feed. Both of these heads can be operated simultaneously on work of small diameter without interference. The vertical head will face 44 inches, and it has a vertical movement of 27 inches. An accurate center stop is provided for the main head, which is so designed that the head can be carried 3 inches beyond the center. The swivel base of the main head has a diameter equal to the full width of the saddle, and an angular adjustment up to 45 degrees either side of the vertical center is obtained by a system of gearing. The turret slide has a broad bearing on the swivel base, and special provision is made for maintaining alignment with the center of the table. The turret is 16 inches in diameter and has five faces containing holes $2\frac{3}{4}$ inches in diameter. It is set at an angle so that large tools will clear the slide, and one turn of lever *J* indexes the turret from one face to the next. The turret holes have steel bushings which can be replaced readily should wear occur. The shanks of tool-holders, boring-bars, etc., are securely held in the turret holes by half boxes that are clamped against the bushings by the binder bolts shown. As no frictional binder is sufficient to resist the

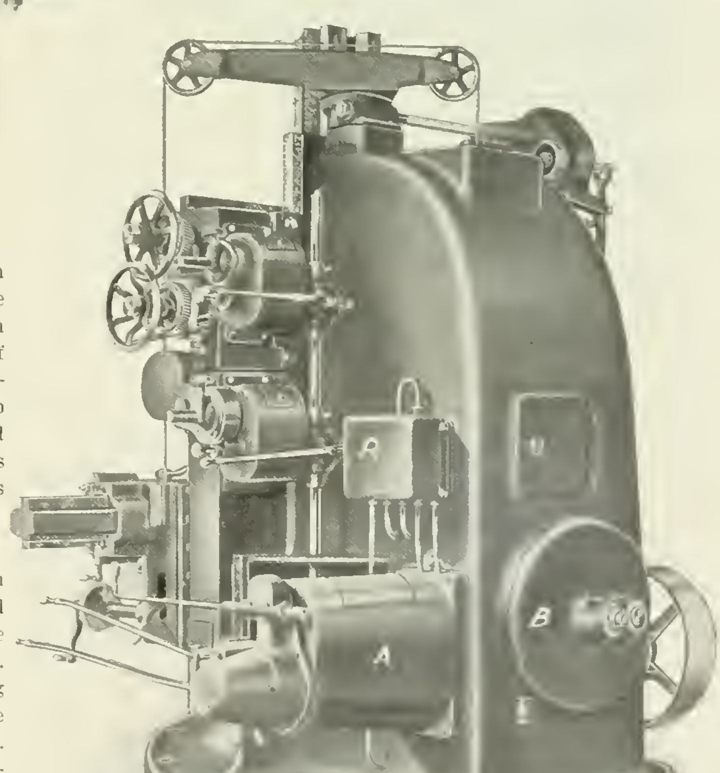


Fig. 2. Rear View of the Bullard Vertical Turret Lathe

twisting strain caused by heavy cuts, a pin of large diameter, located at the inner end of the turret holes, enters a slot in the bar and acts as a driver. The tool-holder can be par

tially withdrawn and disengaged from the driving pin to set a tool on the center. The vertical head can be rapidly moved in all directions by power, independently of the feed works or table drive, the control being by handles *K*, which are connected with friction gearing by rods passing through holes in the feed rod and screw. Vertical and cross motion in either direction can be engaged singly and simultaneously, the operating mechanism for each being independent, and a speed device prevents damage from careless handling. The side head has a vertical movement of 28 inches and a horizontal movement of 21 inches. A quick hand movement in all directions is provided and also means for making fine adjustments independently of the feed works. A four-face turret tool-holder on the side head obviates a constant changing of tools.

Feed Mechanism, Micrometer Dials, Stops, etc.

The feeding mechanisms for each head are entirely independent and there are eight changes, ranging from 1/96 to ½ inch in all directions. These changes are quickly obtained by turning the knurled wheel seen on the feed-box, and the amount of feed per revolution is indicated by an index-plate giving direct readings. The feed for the main head is engaged, disengaged or changed from vertical to cross or *vice versa*, by engaging a centrally-located drop worm *L* with the worm-gears on the end of the feed-rod and feed-screw. The feeding movement for the side head is engaged, disengaged or changed from vertical to cross or *vice versa*, by plunger-lever *M* located on

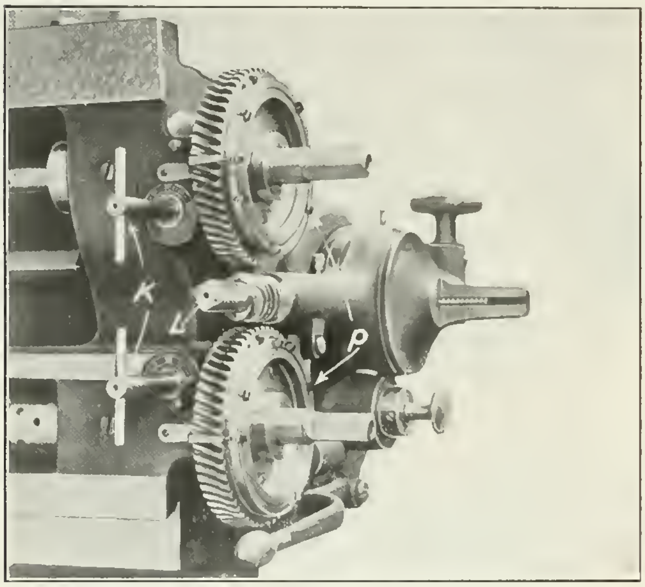


Fig. 3. Detail of Feed Gearing, showing Micrometer Dials and Observation Stops

the saddle. A safety device incorporated in each feed works, prevents the breakage of gears or mechanism through carelessness. Accurately graduated scales *N*, which facilitate setting the tools, are attached to the main turret slide and the cross-rail face. A scale is also attached to the tool-slide of the side head. Index dials with graduations indicating thousandths of an inch, are mounted on the feed-rods of both main and side heads. These dials are of large diameter, thus giving widely spaced graduations that are easily seen. Observation stops *P* (see Figs. 1 and 3) having numbers to correspond with those on the faces of the turrets, are adjustably mounted on the dials and are invaluable in the duplication of various sizes. As the rod and screw of the main head revolve rapidly when the power traverse mechanism is engaged, crank handles would be dangerous; therefore these have been supplanted by handwheels mounted on sleeves secured to the rod and screw. These wheels are free to make a partial revolution on the sleeves before becoming engaged with them. As the engagement imparts a hammer action similar to a hand tap on the end of a crank handle, a very fine adjustment is possible.

System of Lubrication

Special attention has been given to the lubrication of all working parts. The base of the machine forms an oil reservoir to which all oil is returned after passing through the various bearings and gear boxes. Submerged in this base and directly connected with the main driving shaft, is a gear pump which delivers the oil to a distributing reservoir *R*, Fig. 2, located on the outside of the column at such a height as to insure a free flow of oil through the ducts leading to the bearings and individual reservoirs in which the gears revolve. The excess oil pumped into this distributor is returned to the main reservoir by an overflow pipe. The ducts have oil sights that show the free flow of oil in two ways: First, by the size of the oil column passing through the opening if the pipe is clear, and second, by an overflow at the opening if the pipe becomes clogged. The construction of this oil sight is shown in Fig. 4. Fig. 5 indicates the construction of the table spindle and the method of lubricating this member as well as the table driving gear and pinion. Connection with the distributing reservoir is made near the lower end of the spindle, and the oil flows upward as indicated by the arrow, when the table is stationary, and is lifted from

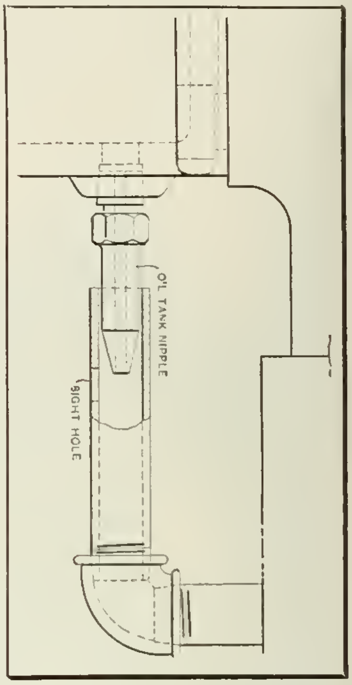


Fig. 4. Oil Sight for Distributing Ducts

the base by spiral oil grooves *g* when the machine is in motion. Two wide channels *G* at opposite sides (located 90 degrees from the elevation shown) convey the oil to the driving mechanism. The primary and secondary speed change mechanism, clutch, brake and main driving shaft journals are also lubricated from reservoir *R* by a flow of oil which remains constant as long as the driving pulley is running. The feed-change brackets, power-traverse brackets and rail-raising

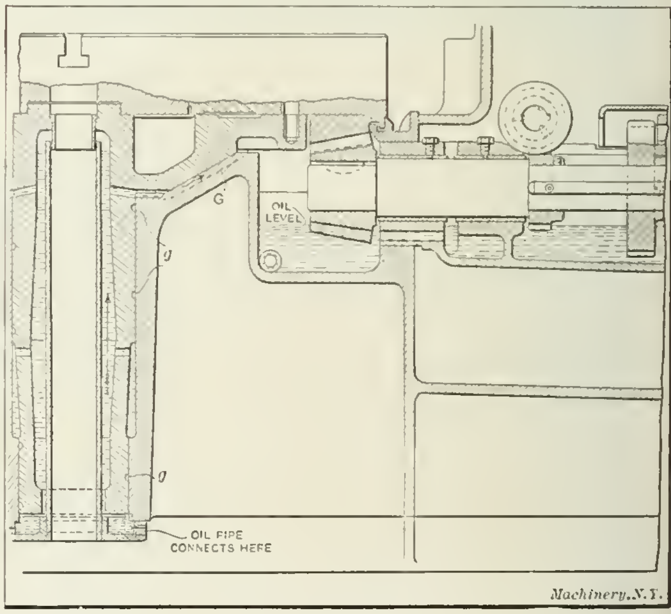


Fig. 5. Sectional View indicating Method of Lubricating Table Spindle and Driving Gears

bracket, which have a variable relation to the column, form a self-contained reservoir. The proper amount of lubricant is maintained at all points by oil level indicators. A complete equipment, including a pump, water-guard, pan and piping, for handling an ample supply of cutting lubricant can be furnished extra, if desired, and may be readily applied after installation.

Miscellaneous Features

The cross-rail has a wide face and a good bearing on the column to which it is secured by four bolts located at the ex-

treme points of the bearing. The side-rail has the form of an inverted letter L and is securely fastened to the column and bed. The guide bearing for the rails on the column and bed has great length in proportion to its width, thus insuring permanency of alignment in the vertical movement of these parts. The same type of guide bearing is provided on the cross-rail and side-rail for the saddles.

If the weight of a solid body of iron having a diameter and height equal to this machine's capacity were added to the weight of the table and spindle, the pressure on the angular thrust bearing of the table would be only 62.9 pounds per square inch, which is 12.1 pounds per square inch less than the maximum allowable pressure.

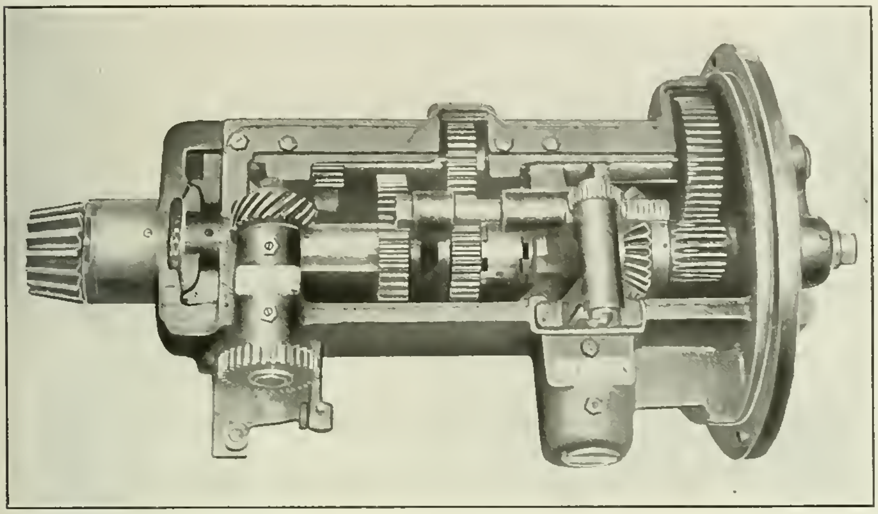


Fig. 6. Detail of the Speed-changing Mechanism at B, Fig. 2

Specially heat-treated alloy steel gears are used exclusively in the driving and feed trains of this machine, with the single exception of the table gear which is of such proportions that it cannot be successfully heat-treated. A special alloy, having exceptional wearing qualities in an unhardened state, is therefore used. All gearing is constantly immersed in oil and all high-speed journals are bronze-bushed and self-oiled. In the design of the machine, the safety of the operator has received careful attention. Counterweights and gearing are entirely encased, and crank-handles on rapidly moving power-operated parts have been eliminated.

A thread-cutting attachment for the vertical head, arranged for cutting eleven threads varying from two to sixteen per inch, can be furnished if desired. This mechanism is so arranged that the power rapid traverse may be used for returning the slide, and the thread-cutting feed again engaged without splitting the thread. When a motor drive is desired, a 10-horsepower constant-speed motor can be mounted on a bracket at the rear of the machine and connected with the driving pulley by a belt.

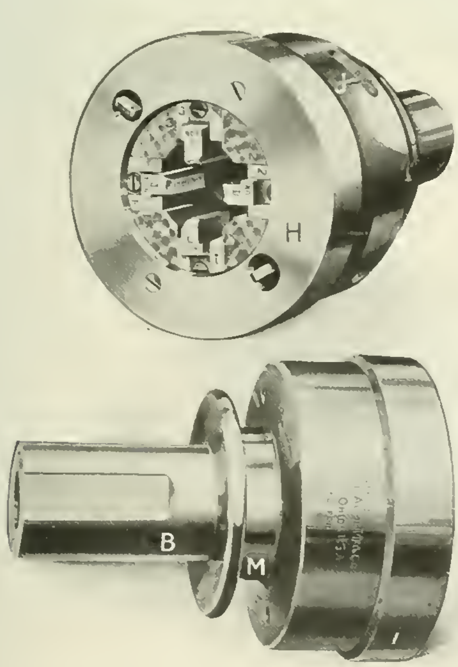


Fig. 1. National-Acme Opening Die for Screw Machines with Rotating Threading Spindles

NATIONAL ACME OPENING DIE

The opening die illustrated in Fig. 1 has been developed by the National-Acme Mfg. Co., Cleveland, O., for use on the Acme automatic multiple-spindle screw machine or other machines using revolving threading devices. The distinctive feature of this die is that it can be operated while revolving and it has been designed particularly for screw machines in which the threading spindle rotates.

The working parts of the die are enclosed within a body *A* (see Fig. 2). The head *B* holds the chaser blocks *D*, which have closing and adjusting cams milled on their outer ends that bear against the cam-operating blocks *C*. The chasers *E* are held in place by the screws *F*, as shown, and they can be removed without displacing any of the other parts. A liberal adjustment for size is provided in the cam arrangement on the chaser blocks. This adjustment is controlled by a very fine pitch screw, and the amount is indicated by micrometer graduations *J*, Fig. 1. The blocks holding the chasers, and the cam surfaces controlling the closing of the die, are hardened and ground, and the wide bearings on the cam surfaces hold the jaws firmly in position when the die is closed.

The two positions of the die are illustrated in Fig. 2, the view to the left showing it closed and the one to the right in the open position. It is operated by a shoe engaging groove *M*, which shifts the outer shell and tapering finger cams *C* with relation to the chaser blocks, thus causing the latter to move inward or outward as the case may be. The chasers are so designed that they cut practically a perfect thread without the use of a follow-up cam. No springs are connected to the parts on which the adjustment of the dies or the operation of the closing cams depends. Chips are prevented from entering the head by the cap *H* and the die may be thoroughly cleansed by simply removing this cap and washing it in oil compound.

This new die has comparatively few parts and these are so arranged as to make it very easily taken apart and reassembled. This, however, seldom becomes necessary as the cap covering the head prevents the entrance of chips; the

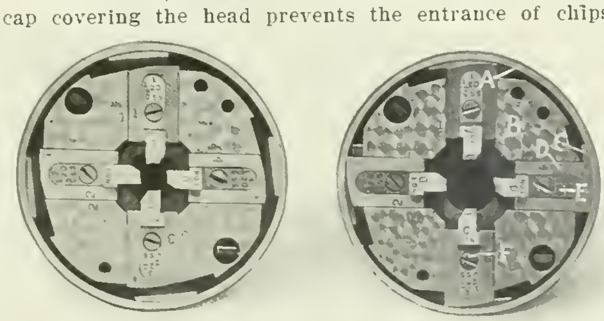


Fig. 2. National-Acme Die in the Closed and Open Positions

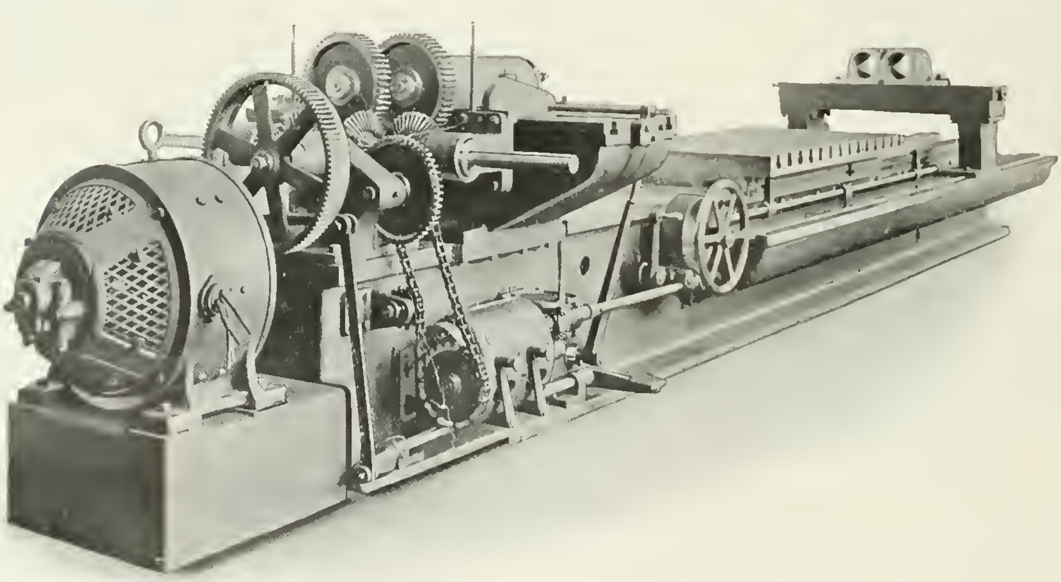
arrangement of the internal parts leaves plenty of room between them (excepting the faces of the cams and the surfaces they bear on) so that grit carried into the oil and other foreign substances can work into these clear spaces and out of the head through holes provided for this purpose in the sides. All parts of the die are made interchangeable so as to facilitate the reassembling or the replacement of worn and broken members. This company is prepared to furnish heads and chasers covering the entire range of screw machine requirements.

BEAMAN & SMITH TWO-SPINDLE ADJUSTABLE PORT-BORING MACHINE

The machine shown in the accompanying view was designed and constructed by the Beaman & Smith Co., Providence, R. I., for the purpose of boring the four valve ports in the cylinders of Corliss engines. Two ports are first bored simultaneously and then the cylinder is reversed for boring the remaining two. Holes from 3 inches to 9 inches in diameter and up to 6 feet in length, can be bored with the center-to-center distance varying from 8¾ inches to 37 inches.

To obtain accurate results when boring long holes, the boring-bars are revolved in one position and the work is fed (in either direction) past the cutters. The rigidity of this construction eliminates any inaccuracy due to the springing of the boring-bars. The feed mechanism can be reversed by the small lever seen at the right of the feed-box, so that the roughing cut can be taken in one direction, new tools inserted, and the finishing cut made as the table feeds back. The table has a quick-power traverse in either direction, which is operated independently of the spindle drive by a small motor at the rear of the bed. This quick traverse is controlled by the long lever seen below the spindle saddle, which operates friction clutches.

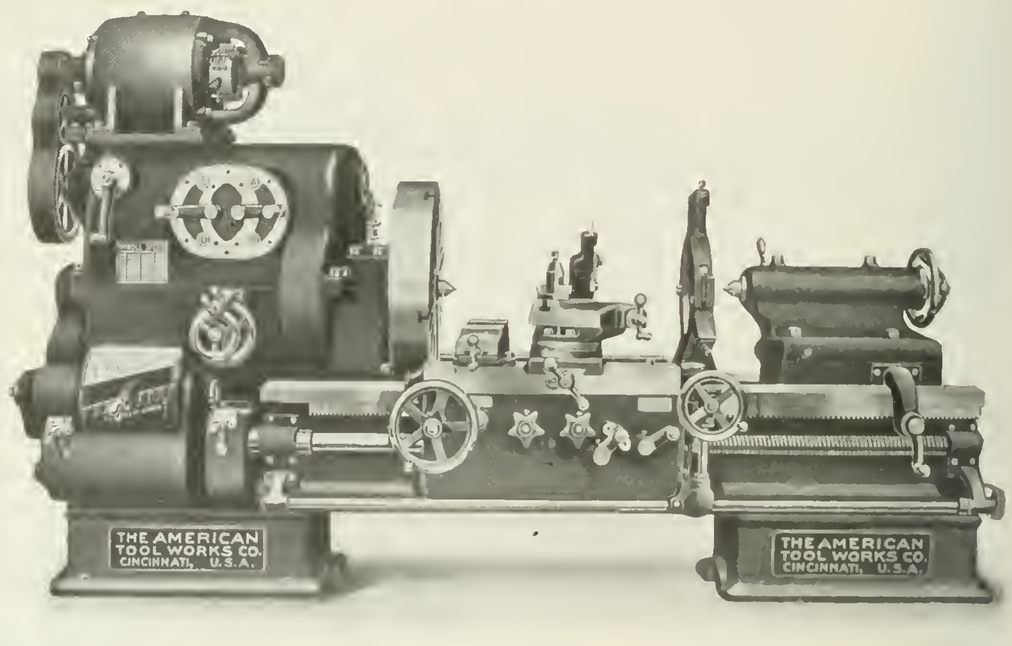
The spindles are driven by a 10-horsepower motor, which is geared directly to them with a reduction of 36 to 1. They run in taper bronze boxes and have an adjustment to compensate for wear. The adjustment of the driving mechanism for different center-to-center distances is provided for by transmitting the power from the large driving gear to a shaft located at right angles to the spindles. Each spindle head has a bracket attached to it and carries a bevel gear which slides on this shaft, and these gears transmit the power from the shaft to the spindle gears. This arrangement permits locating the spindles in different positions without interfering with the driving mechanism.



Machine built by the Beaman & Smith Co. for Boring the Ports of Corliss Engine Cylinders

The table has a working surface 36 inches wide by 6 feet long, and a travel of 13 feet 4 inches. It is operated by a screw of large diameter which engages a bronze nut. The thrust is taken by ball bearings and the mechanism is protected from dirt, chips, etc. The action of the table feed is made positive by gearing and a chain-driven feed-box. The feeding movement is transmitted from the gear-box to the feed-screw through a worm and worm-wheel which has an automatic trip on the table in either direction. A handwheel is provided for fine adjustment.

The boring-bars are fastened to the spindles by means of four bolts and a driving key for each spindle. The outer support for the bars is constructed in the form of a bridge, as shown, so that the table can pass under it. This support rests on projecting ways fastened to each side of the bed, and it has an adjustment of 14 feet along the line of travel. A brake is provided on the large driving gear, operated by a foot lever on the side of the bed near the feed-box. The weight of this machine, without the motors, is approximately 24,000 pounds.



American High-duty Lathe with Motor Drive and Geared Head

AMERICAN HIGH-DUTY LATHES

In the March number of MACHINERY, we illustrated a high-duty lathe built by the American Tool Works Co., Cincinnati, O. This company is now manufacturing in 30- and 36-inch sizes the new design shown herewith. The particular lathe illustrated is motor-driven, but the arrangement is such that it can easily be changed for a single belt drive by removing the motor and replacing the larger gear with a suitable pulley. Inversely, a motor can easily be applied to a belt-driven machine at any time after installation by attaching it to a finished pad on the headstock (provided for that purpose) and connecting the armature and headstock shafts with three gears, as shown. A constant-speed motor either of the direct or alternating current type may be used.

By means of the geared head on this lathe, twelve fundamental spindle speeds are available, varying from 6 to 275

revolutions per minute. The speed changes are made by manipulating the levers and handwheel seen on the front of the headstock, and an index plate on the head shows plainly how to locate the levers for obtaining different feeds. The speed changing mechanism is very simple, there being fourteen gears for producing the twelve variations. The gears are cut from the solid, and are tested for accuracy on a special machine. The teeth of the slip gears are machine rounded to facilitate meshing. The motor is under constant control, as the controller handwheel is mounted on the right end of the carriage where there is a dial to indicate how the controller is set.

The quick change gear mechanism of this lathe has all-steel gears and gives a very wide range of changes for feeding and screw cutting. Forty-eight standard changes are shown on the index plate with threads varying from ½ to 28 per inch, including 11½ pipe threads, and feeds from 5 to 280 per inch. An index plate located on the feed-box, directly over the sliding tumbler, shows how to obtain each thread and feed. The feed-box is a complete unit having two levers and a steel sliding tumbler which works in conjunction with a cone of eight steel gears. All these gears are of the Brown & Sharpe, 20-degree, involute, pointed-tooth type, which facilitates meshing when running at high speeds and eliminates any tendency of the gears to "ride."

The bed of this lathe is of deep section and thoroughly braced by cross-box girths located at short intervals throughout its length, and it is further strengthened by a web cast longitudinally through the center, which carries a rack for engaging a pawl attached to the tailstock. This bed is the company's drop V-pattern which gives additional swing and permits the use of a comparatively deep carriage bridge. The carriage has a continuous bearing of 44 inches on the V's and it is gibbed its full length in the rear. The apron is of the double type, giving all shafts a double bearing. Both longitudinal and cross feeds are reversed by a lever at the front of the apron. All the gears and pinions are of steel and are cut from the solid. The rack and pinion can be withdrawn from the feed rack when screw cutting, and a non-interfering device makes it impossible to engage the feeding and screw-cutting mechanisms simultaneously. The tailstock is very heavy, as the illustration indicates, and it is moved along the bed by a crank and pinion.

This lathe is also built with a 3-step cone and double back-geared head, a 4-step cone and single back-geared head, and a 4-step cone with triple geared head. The double back-geared head provides nine spindle speeds; the single back-geared design, eight spindle speeds; and the triple-geared type, twelve spindle speeds. The gears of the latter are of the slip type and are readily engaged from the front of the head by manipulating a handwheel which also automatically engages the direct spindle drive when the faceplate pinion is withdrawn.

A double friction countershaft giving one forward and one reverse speed is regularly supplied with these lathes, except when motor-driven. If a reverse speed is not required, an additional forward speed will be available. The regular equipment includes compound, steady, follow, and full-swing rests, a thread dial, countershaft for belt drive, and wrenches.

VARIABLE-BLOW POWER HAMMER

A variable-blow power hammer recently put on the market by the Welch Hammer & Machine Co., 1523 Williamson Bldg., Cleveland, O., is illustrated in Figs. 1 and 2. The distinctive feature of this machine is the method of transmitting the motion of the eccentric which actuates the helve, to the latter through a link mechanism by means of which the throw of the helve and the blow is varied at the will of the operator.

A swinging bracket which supports and pivots one end of the link segment, is balanced on bronze bushings that also form the main bearings of the driving shaft. This bracket is connected by means of two short links to the treadle. A hardened bearing block, accurately fitted to the slot in the link segment, has end bearings in two U-links that are suspended from the beam lever. The short ends of these U-links are connected by means of straight links, to points in the housings directly in line with the pivot point of the link segment at full stroke. Fig. 1 illustrates a 60-pound hammer (arranged for belt drive) with the link segment on the dead center. The pivot pin of the link segment is in perfect alignment with the center of the sliding block segment, when on the dead center, so that as the free end of the segment is oscillated

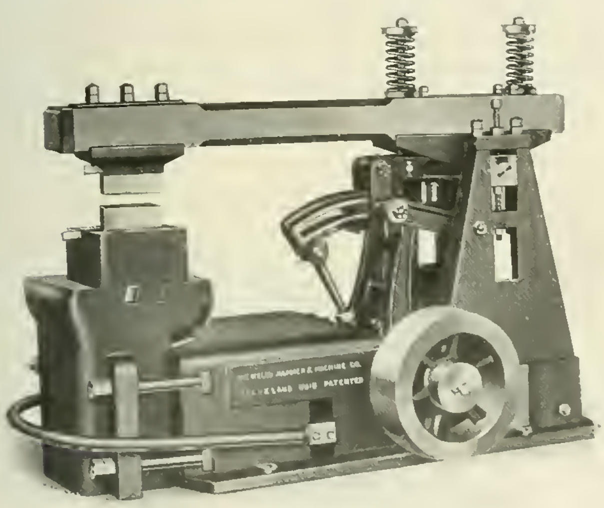


Fig. 1. Belt-driven Variable-blow Power Hammer, built by the Welch Hammer & Machine Co.

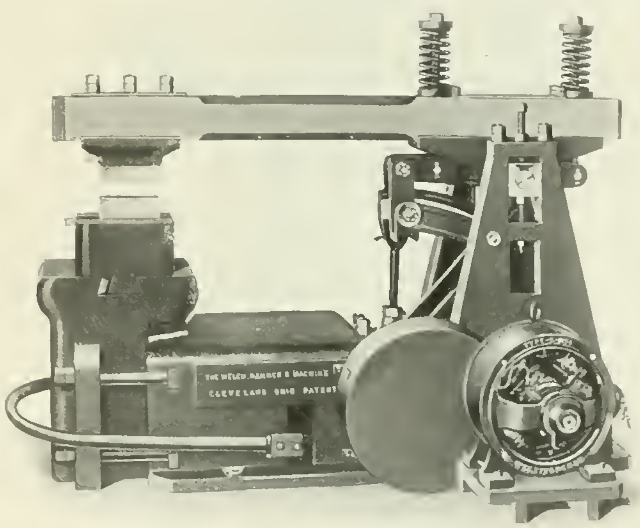


Fig 2. Power Hammer with Direct-connected Motor Drive

by the eccentric on the driving shaft, no motion is transmitted to the helve. The stroke or throw of the helve is therefore varied at the will of the operator from an absolutely dead position to the full stroke. The machine runs at a constant speed of about 300 revolutions per minute, and the advantage of being able to strike light finishing blows at high speed for a large class of work will be apparent.

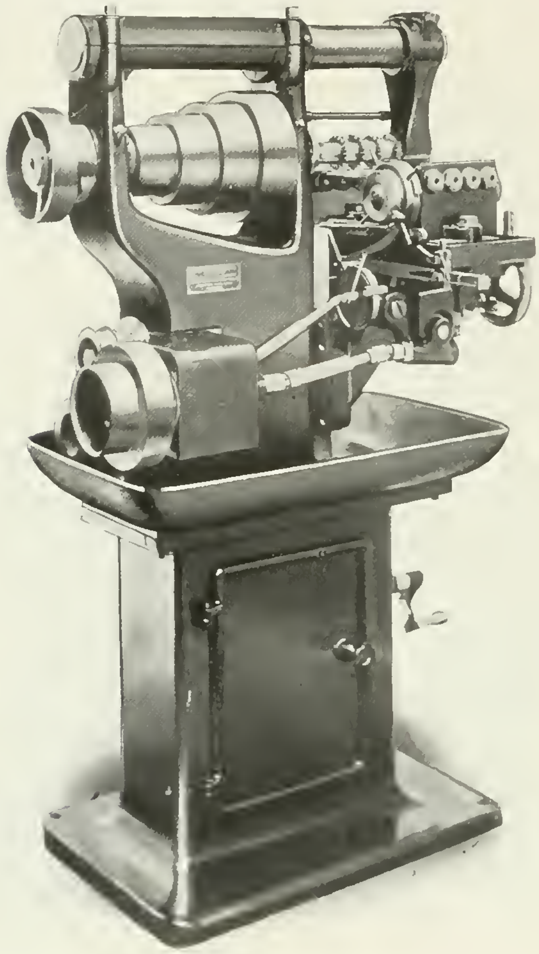
Fig. 2 shows the machine with a direct-connected motor drive, and with the link segment shifted to the position of full stroke. The flywheel for a belt drive and the motor and gearing for a motor drive, can be applied to either side of the machine, and the motor drive is applicable to all sizes and styles. A balancing mechanism located between the housings balances the swinging bracket and removes all weight of the helve from the link. The helve is balanced on a pivot shaft and beam lever by means of the coil springs seen on top of the helve. These springs are adjustable and keep the helve under tension, with the result that it vibrates like a spring and strikes an exceedingly sharp and snappy blow.

The proportions of this machine are very generous. The anvil weighs 1500 pounds, or twenty-five times the weight of the hammer head, and the complete machine weighs about 5000 pounds. All the links and other small parts subject to strain or shock are steel castings or forgings. The helve is made of seasoned hickory. This machine will be made in all standard sizes and in other styles with guided heads to suit all classes of work.

BICKFORD AUTOMATIC FLUTING MACHINE

The Bickford Machine Co., Greenfield, Mass., has designed a new automatic machine for fluting four taps or reamers simultaneously. This machine is built in two sizes, the one shown herewith being for work up to ½ inch in diameter, while the larger size, which is back-geared, will handle work up to 1½ inch in diameter and is furnished with a fixture for squaring the shanks of taps.

The action of this machine is entirely automatic after the work is placed between the centers, the carriage making



Bickford Automatic Fluting Machine for Taps or Reamers

the forward and return movements and the centers indexing at the proper time for the different flutes. The carriage returns at a speed five times as fast as it advances, and is arranged to stop automatically, if for any reason the indexing should be improperly done, and also at the completion of the work.

The method of returning the carriage makes use of a gear-box containing three sets of compound gears, by means of which, together with a sliding clutch, it is possible to reverse the direction of the telescope transmission shaft and worm feed. The ratio of the gears for the return is 5 to 1, as before stated, and a special device is used which throws the sliding clutch forward to the reverse gear without knocking or pause while the change is being made.

The indexing of the centers is accomplished by a short spiral gear cut in each spindle, which meshes with a spirally-fluted cross-shaft, carrying at one end an index collar with the necessary stops, etc., for determining its motions. Power is applied to this cross-shaft by means of a second collar mounted on it and connected by ratchet teeth to the index collar as shown. As the carriage advances, this second collar is revolved, and by means of a pull-spring and the ratchet teeth, a tension is put on the index collar so that when the carriage returns, a special device unlocks the index; the cross-shaft is then revolved, turning the centers and work. The opposite end of this cross-shaft carries a disk which has a number of flat places milled on its circumference to correspond with the number of flutes required. These flat places are arranged to just clear a stud set in a bar which operates the feed, and a part of the disk that is not milled will depress this stud and throw out the feed; or if the indexing is not completed, a full part of the disk between the flat places will also stop the movement of the carriage. Another feature of the feed mechanism is a disk carried at the end of the main feed-shaft, on the circumference of which are stops to operate a small universal shaft which, in turn, shifts the clutch in the gear-box.

The cutters are supplied with oil from a tank in the base of the machine. A geared pump is used which is driven from the feed shaft. As the speed of this shaft varies according to the size of the work being done, a cone drive is provided which will allow the pump to be run at nearly constant speed. The centers in the tailblock are actuated by heavy coil springs and operated by a curved lever of special design in such a way that it is not necessary for the operator to place his hands near the rotating cutters. The weight of the No. 1 machine is 1100 pounds, and that of the No. 2 size, 1800 pounds.

GEARED FEED FOR ROCKFORD DRILLING MACHINE

The Rockford Drilling Machine Co., Rockford, Ill., is applying to its line of drill presses of the 26-inch size and larger, a new geared feeding mechanism giving eight carefully-selected changes. Fig. 1 shows a 26-inch machine of the sliding-head type equipped with this geared feed, and Fig. 2 illustrates its construction.

By referring to these two views it will be seen that the drive is taken from the horizontal shaft at the top of the

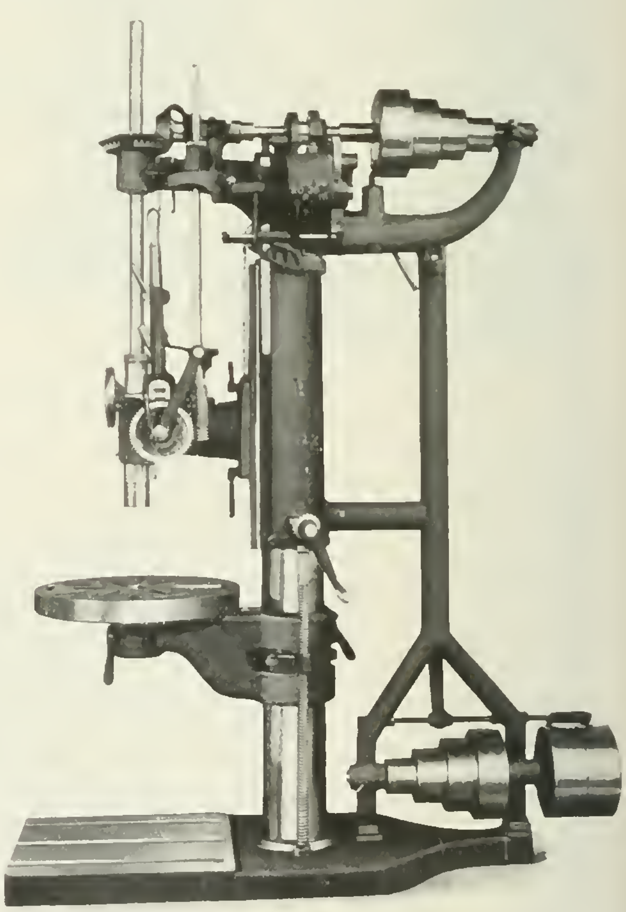


Fig. 1. Rockford 26-inch Drilling Machine with Geared Feed

machine. On this shaft there are two spur gears of different sizes which mesh with spur gears *A* (Fig. 2) on an intermediate shaft. The gears on the intermediate shaft are keyed and slide on a sleeve so that either of them may be brought into mesh with its mate on the top shaft, thereby giving two speed variations. The sleeve on which the sliding gears are mounted runs on a stationary shaft and has a pinion cut in

the end meshing with a tumbler gear *C* that can be engaged with any one of the four gears in the cone *D*. A hand-lever *E*, which is located at the side of the column and swings in a universal joint at its upper end, connects with an arm which carries the tumbler gear *C*. Lever *E* has a pin *e*, which, by engaging different notches cast solid with the frame, properly locates the tumbler gear for meshing with the various gears of the cone. This lever also passes through the shifter casting *G*, which has a forked end engaging the largest gear of the cone. When a change of feed is desired, lever *E* is lifted until the tumbler gear is disengaged from the cone; then by swinging the lever sidewise, the shifter casting slides the cone gears to the position required, after which the tumbler gear is dropped into its proper position.

As there are four gears in the cone, and two changes of speed are obtained through the sliding gears *A*, the total number of feed changes is eight. From the cone shaft, the feeding movement is transmitted through bevel gears to the vertical feed-rod. The guard or case which carries the cone gears is a part of the feed frame, and the various speeds are plainly marked on it in large figures as shown. A suitable pointer *p* is fastened to the shifter casting and extends close to the figures, thus showing the location of the gears and the resulting feed in thousandths per revolution of the spindle. The upper gears *A* are shifted by a lever *F* which extends down at the front of the machine. Letters *F* and *S* are placed above the two positions in which this shifter lever can be thrown, to indicate the fast and slow feeds and show the operator which of the sliding gears is in engagement. The feed can be entirely disengaged by placing this lever in a central or neutral position. The feed changes can be made when the machine is in motion.

The feeds obtained with this mechanism vary on the small machines from 0.006 up to 0.050 inch per revolution of the spindle, and on the larger sizes (28-inch and larger) from 0.006 to 0.083 inch per revolution of the spindle. The gears used in the construction are of ample width, and the bearings are long and well lubricated, thus making the mechanism strong and durable.

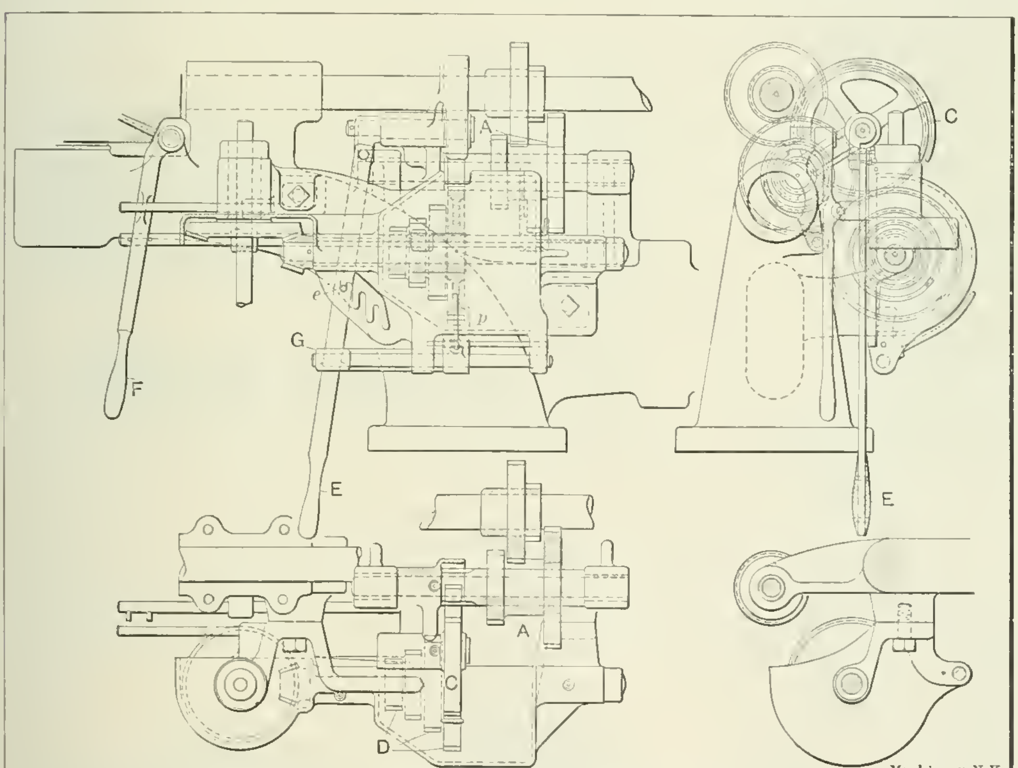


Fig. 2. Plan and Elevation of Rockford Geared Feeding Mechanism

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READY TOOL CO.'S ROUGHING TOOL

Everyone familiar with modern machine tools is aware of the constructional changes that have been made since the introduction of high-speed steel, modern machines being much heavier and more powerful than those formerly built. These powerful machines, however, cannot produce efficient results unless proper tools are used in them, and very often up-to-date machines, such as lathes, for example, are equipped with turning tools which, as to shape and size, are not in keeping with the design of the machine.

The Ready Tool Co., Bridgeport, Conn., has brought out the heavy design of roughing tool illustrated herewith, to enable the maximum efficiency of a modern lathe to be obtained, as this tool is especially designed for high speeds and fast feeds. The inserted cutter used in this roughing tool is formed, both as to contour and cutting angles, according to the standards adopted by Mr. Fred W. Taylor as the result of his extended experiments in the cutting of metals. (A series of articles "On the Art of Cutting Metals," by Mr. Taylor, appeared in MACHINERY from January to August, 1907, inclusive.) As all the grinding is done on top of the cutter, the contour, as well as the side and front clearances, is automatically maintained throughout the life of the cutter, and the side and back slopes are ground to the correct angles by the use of a grinding templet furnished with each holder.

Heavy Lathe Roughing Tool, made by Ready Tool Co.

The cutter, as the illustration shows, has teeth on the rear side engaging with corresponding teeth cut in the clamping block, which is tightened by a set-screw on the side opposite that shown, and has a shoulder at the top which keeps it in position. With this arrangement, the cutter is firmly held and it can also be adjusted easily in an upward direction as the top is ground away. The tool is so designed that the resultant pressure from the work is carried downward through the cutter and dog to the base, making it very rigid and eliminating any tendency to chatter or upset. A tool of this type does away, of course, with all dressing and forging as the worn-out cutter is simply replaced by a new one. The cutter is made of the best quality of high-speed tool steel obtainable, and it is given expert heat treatment in hardening, thus making it unnecessary for the individual consumer to be equipped with high-speed furnaces, pyrometers, and other apparatus.

An idea of the size of this new tool (known as "Style R") may be obtained from the following figures giving dimensions for the four different sizes that are made: No. 1R, $\frac{1}{2}$ by 1 by $6\frac{1}{2}$ inches; No. 2R, $\frac{5}{8}$ by $1\frac{1}{4}$ by $8\frac{1}{4}$ inches; No. 3R, $\frac{3}{4}$ by $1\frac{1}{2}$ by $9\frac{3}{4}$ inches; No. 5R, 1 by 2 by 12 inches.

From the foregoing description of this new roughing tool, it will be seen that the three factors essential to an efficient turning tool have been considered: The shape or contour of the cutting edge, the angles of clearance and slope, and the heat treatment.

TOLEDO SPOT WELDING MACHINES

Two designs of welding machines now being built by the Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, O., are shown in Figs. 1 and 2. The machine illustrated in Fig. 1 is operated by the foot-lever seen extending from the base. When this lever is pressed down, the dies are brought together to clamp the stock, and a slight pressure with the heel on the outside pedal turns on the current to complete the operation. When it is necessary to use both hands for placing the stock in the machine, this type of welder possesses many advantages over the hand-operated machine. Fig. 2 shows a design of welder that is especially adapted for stove and sheet-metal work, the extended horn making it possible to weld almost any part of a range without difficulty.

Metal sheets are joined by spot welding, as is well known, by electrically fusing or melting the metal at the point to be welded, and at the same time applying sufficient pressure to force the particles of molten metal together. The theory is that a poor conductor of electricity will offer so much resistance to the flow of the current that it will become heated, the degree of heat depending on the amount of current and the resistance offered. When making a spot weld, a large volume of

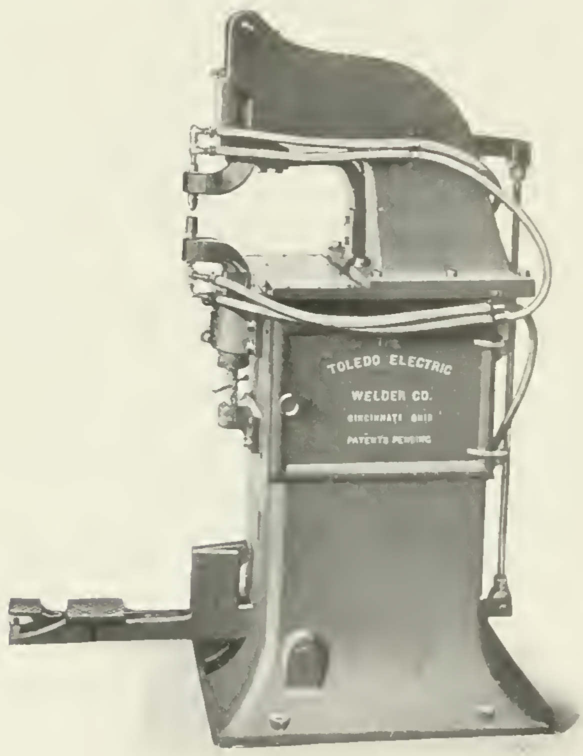


Fig. 1. Toledo Foot-operated Spot Welder

current at such low voltage that it cannot be felt with the bare hand, passes through a pair of copper die-points. The parts to be welded are placed between these points, and when the current is turned on, the pieces of steel offer so much resistance to its flow that they instantly become hot at a point opposite the copper dies. The hotter the steel becomes, the greater is the resistance and the current is forced automatically into the adjacent cooler parts until the temperature of all the metal in proximity to the dies is raised to the welding point. A slight pressure on the die-points then forces the molecules of molten metal together and they are perfectly united. This is done in an incredibly short time, only a fraction of a second being required for welding stock as light as 20 gage (0.0375 inch).

In operating the welder shown in Fig. 2, the stock is placed between the two copper die-points and clamped in position by pulling down on the lever, as shown. The switch is then closed by a thumb-latch on the lever and the weld is made in less time than one can tell about it, the electric current passing through the sheets and fusing the metal at a point or spot the size of a rivet. A special transformer is located in the base of the welder to reduce the voltage (220 or 440 preferred) down to that used for making a weld, which varies from 3 to 5 volts.

Several interesting examples of spot welding are shown in Figs. 3, 4 and 5. Fig. 3 shows a light piece welded to a heavier one, and also both sides of two sheet-metal pieces that have been spot welded. The pointed die leaves a slight indentation on one side, as shown, while the opposite surface is left smooth. Fig. 4 shows six pieces of sheet metal of varying thicknesses, which have been spot welded at one corner. The superiority

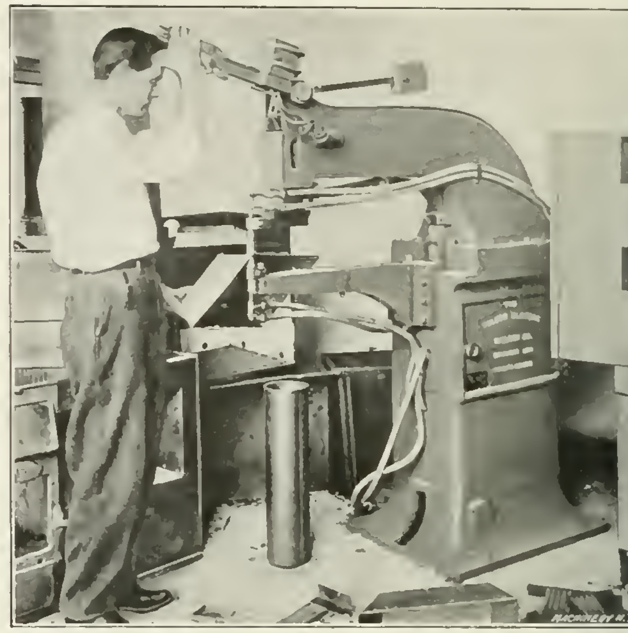


Fig. 2. Welder for Stove and Sheet-metal Work

of spot welding is indicated by the specimen shown to the right. An attempt was made to tear the pieces apart at the weld, which resulted in breaking out the metal around it, thus showing how perfectly the parts are fused together. Views showing both sides of a spot welded piece are shown in Fig. 5 to the left. In the center, sectional views of a spot welded and riveted joint are shown, which illustrates why a spot weld will stand 60 per cent more tensile stress than a riveted joint. In one case the two sheets are fused at the point where a slight depression is shown, and in the other, the metal is punched out for the rivet, thus weakening the sheet. To the right a

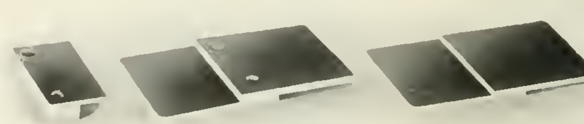


Fig. 3. Examples of Spot Welding

piece of galvanized iron is shown which has been hammered back in an attempt to break the weld apart.

A single-phase alternating current must be used for electric welding. If a two- or three-phase current is available, one

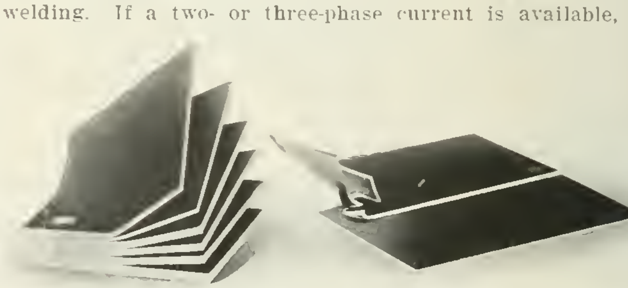


Fig. 4. Six Sheets joined by a Spot Weld—Test of Spot Weld

phase of the multi-phase system should be used. The voltage may vary from 110 to 500, but 220 or 440 volts is preferred. Any frequency from 25 to 140 cycles can be used. The expense for current based on the cost of 1 cent per kilowatt hour, will range from 1 cent to 3½ cents per 1000 welds. If the current costs from 3 to 5 cents, the cost per 1000 welds can be obtained by multiplying the price given in the accompanying table by the lighting company's rate.

No preparation of the stock is required for spot welding unless it is very rusty or scaly, in which case it will be found economical to clean off the rust or scale, as more current is used than on clean stock. Based on using fairly clean stock, the table referred to will give an idea as to the time and current required in welding different gages of sheet steel. There is a limit to the thickness of sheet metal that it is practical to spot weld. First, the copper rods which conduct the electric current can only carry a certain quantity of current without excessive heating. When sufficient current is carried over these copper rods or die-points to bring very heavy metal between them up to the welding temperature, the rods will become so hot they will soften and the points wear away so rapidly that it is not practical to use them for this kind of work. Second, it is necessary to have the two pieces of metal touch each other at the point where the weld is made. With very heavy stock, a slight kink or buckling of the metal will prevent the flat surfaces from making good contact. Stock as heavy as 3/16 or 1/4 inch can be welded, but the best results are obtained with 1/8-inch or lighter stock.

TABLE GIVING TIME AND COST OF SPOT WELDING VARIOUS GAGES OF SHEET METAL

Gages of Sheet Steel	Thickness in Fractions of an inch	Thickness in Decimal Parts of an inch	Approx. K.W. Capacity	H. P. at Dynamo	Time in Seconds to weld	Cost per 1000 Welds at 1 cent per K.W.
10	$\frac{9}{64}$	0.140625	18	25	1.5	$3\frac{1}{2}$
12	$\frac{7}{64}$	0.109375	16	23	1.3	3
14	$\frac{5}{64}$	0.078125	14	20	1.0	$2\frac{3}{4}$
16	$\frac{1}{16}$	0.0625	12	18	0.9	$2\frac{1}{2}$
18	$\frac{1}{20}$	0.05	10	15	0.8	$2\frac{1}{4}$
20	$\frac{3}{80}$	0.0375	9	14	0.7	2
22	$\frac{1}{32}$	0.03125	8	13	0.6	$1\frac{3}{4}$
24	$\frac{1}{40}$	0.025	7	11	0.5	$1\frac{1}{2}$
26	$\frac{3}{160}$	0.01875	6	9	0.4	$1\frac{1}{4}$
28	$\frac{1}{64}$	0.015625	5	8	0.3	1

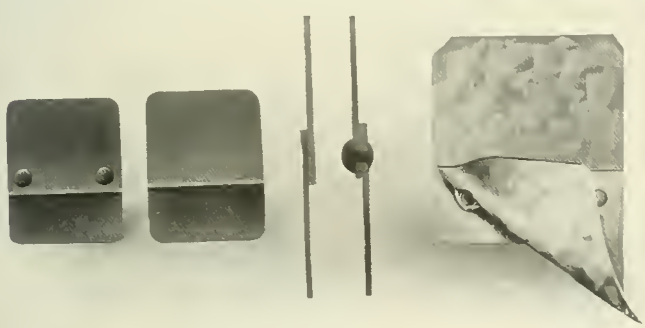


Fig. 5. Both Sides of Spot-welded Piece—Spot Weld and Rivet Joint—Test of Spot Weld on Galvanized Iron

Copper and brass cannot be spot welded for the reason that they are both good conductors of electricity and offer no resistance to the flow of the current. It is impracticable to weld cast iron, as there is no fiber to stock of this kind, and the metal will tear out at the welded spots. Galvanized iron can be welded, although the zinc will be burned off, leaving the iron exposed at the point where the copper dies come in contact with the metal. Heat has no effect on an electric weld and for this reason this process is largely used by stove manufacturers in making sheet-steel ranges and similar work.

It is not practical to make more than one spot weld at a time, as it is almost impossible to make a number of die-points bear on the stock with equal pressure, and the one die-point making the best contact will carry all of the current, which being concentrated at one point, tends to burn the metal.

To determine the tensile strength of spot welds as compared with riveting, ten specimens of hoop steel of the same size and measuring 1.12 by 0.035 inch, were subjected to tests at the Lunkenheimer Laboratory at Cincinnati, with the following results: Test 1 (see Fig. 6). Spot welded in one place—broke at weld with stress of 1625 pounds. Test 2. Spot welded in two places, also joined by two rivets—broke at rivets at 1555 pounds. Test 3. Spot welded in three places—broke outside weld at 2715 pounds. (Notice elongation of metal.) Test 4. Spot welded in three places, also three rivets—broke at rivets at 2055 pounds. Test 5. Solid lap weld—broke outside weld at 2720 pounds. Test 6. Butt welded—broke at weld at 2555 pounds. Test 7. Spot welded in one place and riveted once—broke at rivet at 990 pounds. Test 8. Solid lap weld—broke at weld at 2425 pounds. Test 9. Spot welded in two places—broke at weld at 2275 pounds. Test 10. Plain piece of hoop iron, not welded—pulled apart at 2690 pounds.

By comparing the tests made on the one and two spot welded joints with those having one and two rivets, it will be seen that in both cases the spot welds stood over 60 per cent more than the rivets. Comparison of the three spot welds with a three rivet joint, shows that the former test piece broke outside of the weld with a pull of 2715 pounds, while the rivets tore apart with 2055 pounds.

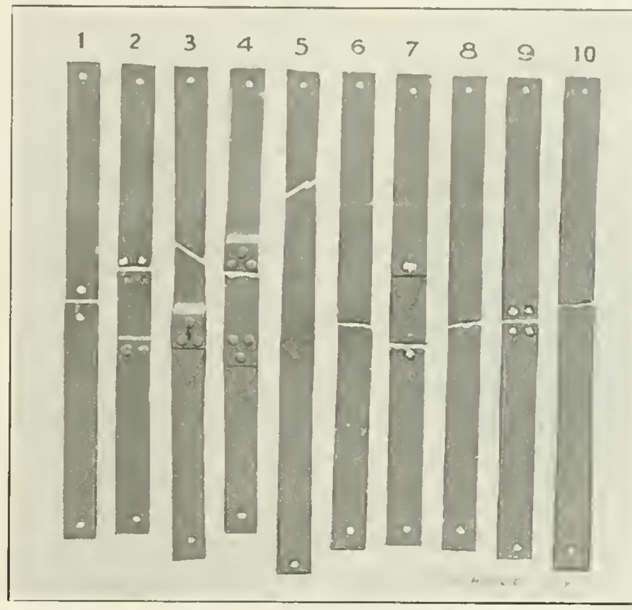


Fig. 6 Test Pieces joined by Spot Welding, Riveting, etc.

These welding machines can be furnished for operation either by hand, foot or power, and they are made with throat depths varying from 6 to 48 inches and in a variety of styles to suit almost any kind of sheet-metal work.

LANG VERTICAL MILLING ATTACHMENT

A number of views of a vertical milling attachment now being manufactured by the G. R. Lang Co., Meadville, Pa., are shown herewith. This attachment is designed for the horizontal, knee-type milling machine and it differs from the ordinary vertical attachment in being offset with relation to the main spindle, so that it can be used without interfering with the horizontal cutters. This arrangement makes the attachment applicable to such work as dovetailing and T-slotting, where the stock is first roughed out with a horizontal cutter and then followed up with an end-mill, as the cutters can be operated together and run in tandem.

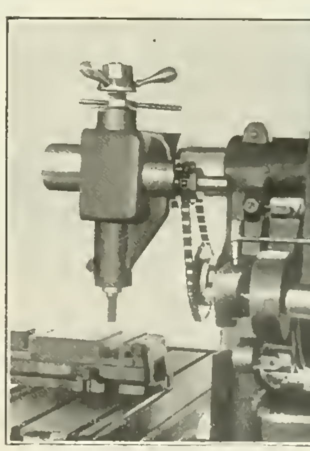


Fig. 1. Offset Vertical Milling Attachment

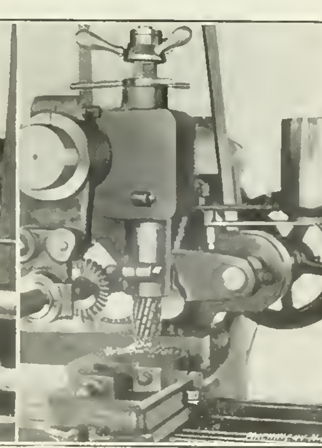


Fig. 2. Milling End and Side of Forging

The body of the attachment is clamped to the outboard bearing arm and the drive is by chain from the main spindle, as

shown in Fig. 1. This chain connects with a horizontal shaft that drives, through bevel gearing, the cutter spindle. The driving bevel gears are shown in Fig. 6, which is a front view with the protective cover removed.

This attachment can easily be placed on the machine or removed, it simply being necessary to loosen two clamping screws and unfasten a detachable link provided in the driving chain. The large driving sprocket is screwed on the spindle and it can easily be removed by a special wrench that fits holes in the side provided for that purpose.

Fig. 2 shows the application of the attachment for end-milling, and Figs. 3 and 4 illustrate its use for finishing the keyway in a shaft. A horizontal cutter is used first for roughing out the keyway, as in Fig. 3, and the vertical cutter in the attachment is then employed for end-milling the end of the keyway, as shown in Fig. 4. This operation is completed without changing the position of the milling machine table, as the attachment has 3 inches of vertical adjustment. This vertical adjustment is effected by a pilot wheel attached to the top of a threaded sleeve through which the spindle passes. By screwing this sleeve up or down, the vertical position of the spindle and cutter can be varied as desired. After the spindle is properly located, it is securely locked by the pilot nut shown just beneath the adjusting wheel.

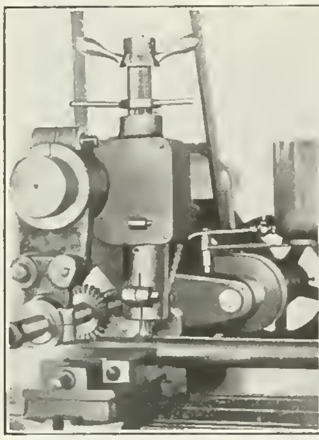


Fig. 3. Roughing out Keyway with Horizontal Cutter

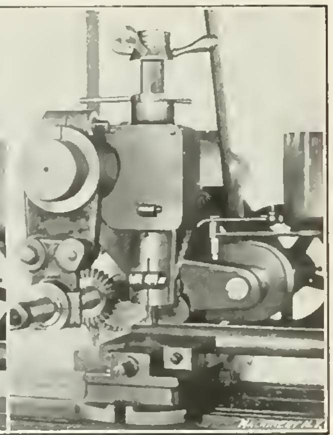


Fig. 4. Finishing End of Keyway with Vertical Attachment

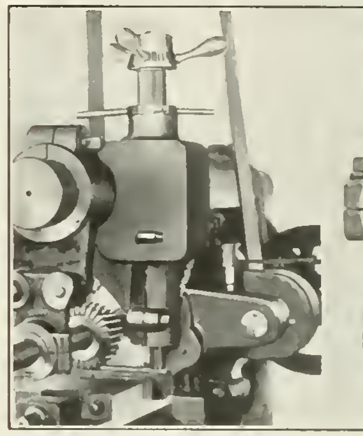


Fig. 5. Use of Attachment for Gang Milling

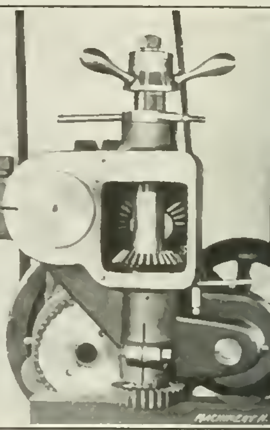


Fig. 6. A Surfacing Operation showing Attachment's Rigidity

Another application of this attachment is illustrated in Fig. 5 which shows a vertical end-mill being used in the place of a regular horizontal cutter, where three cutters are used in a gang. Fig. 6 indicates the rigidity of the attachment. The part being milled is cast iron and a surface 2 inches wide is being finished by taking a cut $\frac{1}{4}$-inch deep with a feed of 3 inches per minute, which was the maximum capacity of the driving belts for the milling machine. The spindle of this attachment is hollow throughout its length, so that a draw-bolt can be used for holding large cutters. These attachments are made for machines of all sizes.

VALLEY CITY GRINDING MACHINES AND BUFFERS

The Valley City Machine Works, Grand Rapids, Mich., has recently made several additions to its line of grinding machines and buffers. The illustration Fig. 1 shows a new grinding machine known as No. 24, which is larger and heavier than the grinding machines previously built by this company, though its constructional features are practically the same. The two-step cone pulley provided takes a $4\frac{1}{2}$-inch belt, and the cone steps are 6 and 7 inches in diameter, respectively. The size of wheels recommended for this grinder are 24 inches in diameter by 4 inches wide. The bearings, which are 10 inches long and $2\frac{1}{4}$ inches in diameter, are self-oiling and protected by collars at the ends, making them dust-proof. The distance between the wheels is 33 inches and the floor space required is 23 by 33 inches. The weight of the machine without wheels is 725 pounds.

In Fig. 2 is shown a new buffer recently brought out, known as No. 22. This machine is heavier than the regular types built, and a heavy brace has been provided over the top, between the bearings to insure rigidity. The loose pulley is provided with self-oiling bushes; the bearing boxes are self-oiling and provided with collars at each end, so as to insure dust-proof bearings. The pulleys are 5 inches in diameter by 5 inches wide, and each of the bearings, 7 inches long by $1\frac{5}{8}$ inch in diameter. The distance between the wheels is 39 inches; the size of the base of the machine, 22 by 17 inches, and the weight, 375 pounds.

Fig. 3 shows a combination disk grinder and buffer. On this machine the left-hand end is provided with an 18-inch disk and a tilting table the same as the company's regular No. 9 tool, disk and surface grinder. The right-hand end, however, has been remodeled, the ways for the knee have been removed, and a buffer head has been provided at this end. The interest-


Fig. 1. Velley City No. 24 Grinder


Fig. 2. No. 22 Buffer

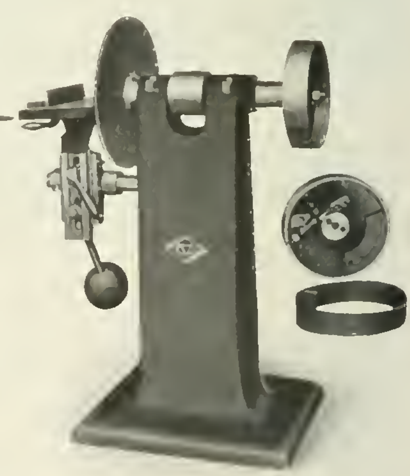


Fig. 3. No. 15 Disk Grinder and Buffer

ing feature of this buffer head is the efficient clamping device by means of which a strip of emery cloth can be securely held to the cylindrical surface and quickly changed, should a finer or coarser grade of cloth be desired. In the ordinary machine of this type the buffer head consists of a wooden pulley or disk having a leather rim attached to it, the emery being glued to the leather surface. On the machine shown in Fig. 3, the pulley is made of cast iron, and the clamping arrangement (shown in the line engraving, Fig. 4) is used for tightly binding the strip of emery cloth to the cylindrical surface of the buffer head. The gripping mechanism consists of two fingers *A* and *B*, between the ends of which the emery cloth is held. The cloth is laid around the rim of the pulley and then the ends of the strip are pulled into the slit *C* and clamped between the fingers by means of screw *D*. The cloth is then stretched by moving arm *B* in the direction of the arrow, and clamping it securely by the clamp-screw *E*. As arms *A* and *B* are pivoted at *F*, it is evident that the two ends of the emery cloth which are securely held between the ends of fingers *A* and *B*, will be pulled in and the strip of cloth stretched so as to come into close contact with the surface of the cast-iron rim.

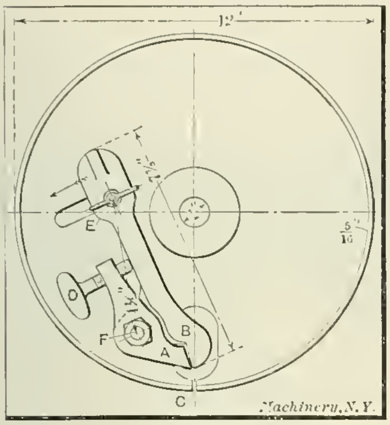


Fig. 4. Clamping Device on Polishing Head

Another improvement introduced on one of the company's machines is shown in Fig. 5; this is known as a reversible sliding table and is adapted to a No. 3 tool and surface grinder.

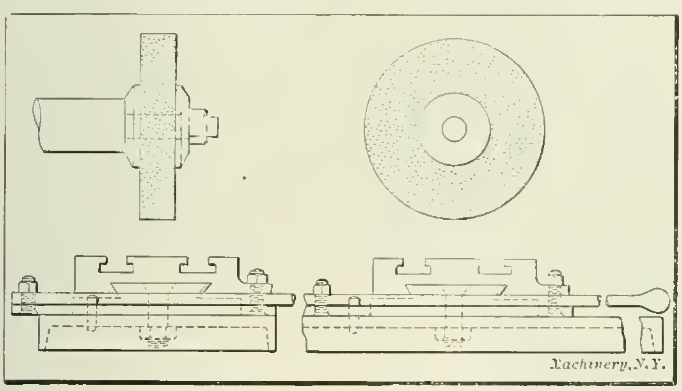


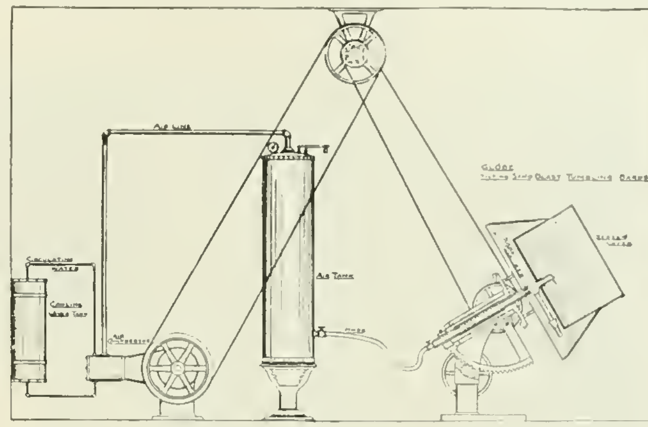
Fig. 5. Reversible Sliding Table for Tool and Surface Grinder

As indicated, this reversible sliding table is so arranged that it can be slid back and forth in either direction with relation to the wheel. It swivels on the main table on a bolt as shown. A taper pin and index holes in the main table are provided so that the reversible table can be set accurately in either position. The index holes, of course, are spaced 90 degrees apart. The table is moved back and forth by a lever pivoted at one end, and is fastened at its center to the table by a bolt.

GLOBE TILTING SAND BLAST TUMBLING BARREL

For cleaning rough castings, removing scale, burrs, and rust, or in the preparation of metals for machining, electroplating, galvanizing, tinning or japanning, the sand blast has proved economical and efficient. The tumbling of castings or metal parts in barrels is the most common method and has been used effectively for years, but where there are large quantities of work sand blast outfits are rapidly replacing the old method. In the tilting sand blast tumbling barrel, shown in the accompanying sketch (built by the Globe Machine & Stamping Co., Cleveland, O.), there have been combined the two methods of cleaning, namely, tumbling and sand blasting, and the result is a machine embodying the simplicity and cheapness of the tumbling barrel with the efficiency of the sand blast.

The operation of the outfit is as simple as that of an ordinary tumbling barrel. The contents can be watched closely while the barrel is in operation and the tilting feature allows the barrel to be readily emptied or adjusted to give more or less violent tumbling. The sand blast barrel requires no large sand reservoir or conveying machinery. The sand is drawn by suction from the sand chamber and discharged against

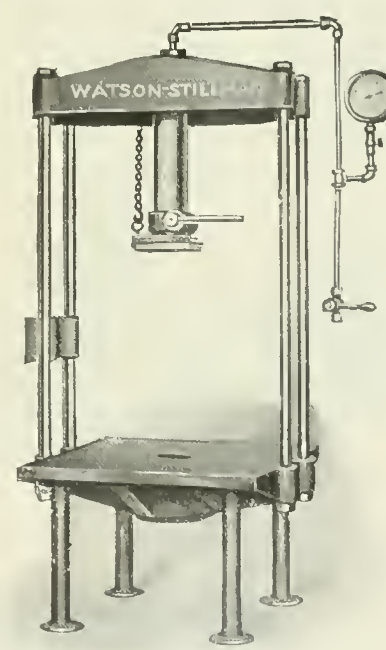


Tilting Sand Blast Tumbling Barrel built by Globe Machine & Stamping Co.

the work; it then drops through the perforations of the barrel into a sand chamber to be used over again. This barrel is not suitable for large castings, but for small work which can be readily tumbled. The outfit is inexpensive and has proved satisfactory in service. One man can easily operate from six to ten barrels.

WATSON-STILLMAN HYDRAULIC PRESS

The Watson-Stillman Co., 192 Fulton St., New York City, has added to its line another hydraulic press especially designed to conform to the demands of automobile work, which is also useful for general machine shop work. The weight shown on the left side counterbalances the ram which can be adjusted independently of the pump by means of a rack, pinion and lever arrangement. A hole through the platen permits the work to be projected or forced through. The capacity of the press reaches its maximum of 30 tons under a hydraulic pressure of 6250 pounds per square inch, which may be produced by using either a hand or belt-driven pump attached to the pipe shown in the engraving. The length of the ram stroke is 18 inches and its diameter is 3½ inches. Considering the capacity and size, the illustration gives the impression that this press is very light, but it is made strong by ribbed construction of the platens, and high grade material is used throughout. The press is raised to a convenient height from the floor by four legs.



Hydraulic Press designed for Automobile Work, etc.

HARRINGTON MULTIPLE DRILLING MACHINE

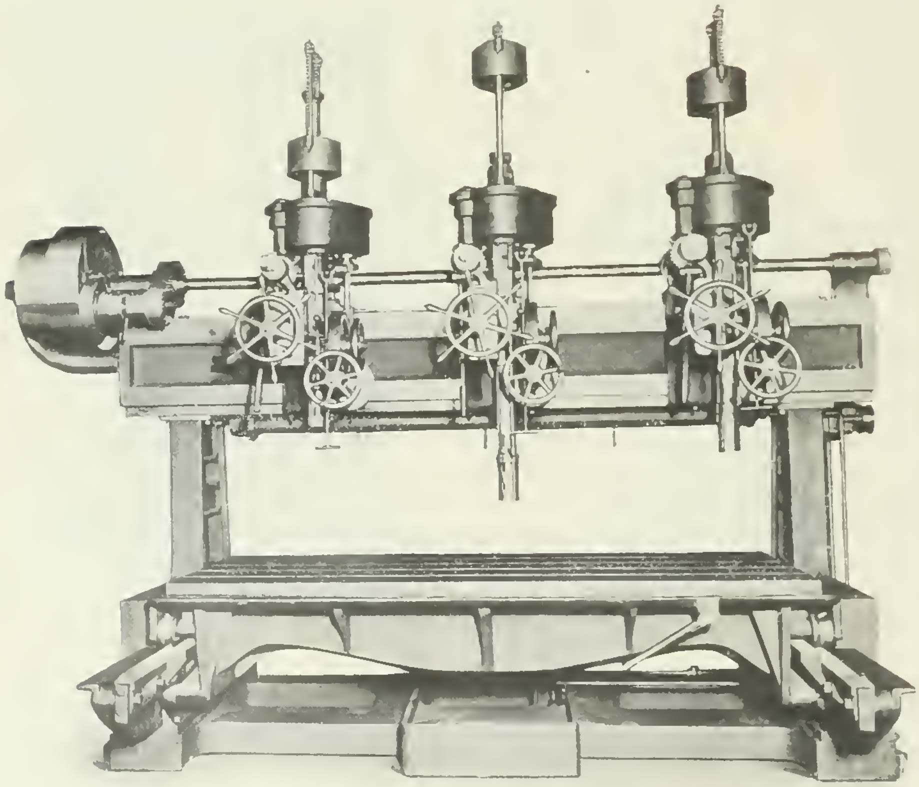
Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., are making a multiple drilling machine that is especially adapted

for the rapid drilling of holes in flue sheets or similar work. This machine will drive three 1¼-inch high-speed drills in steel, and its noteworthy features are the ease with which the table and spindle heads are adjusted in and out, and the convenient arrangement of the operating handles.

The spindle heads are made of steel castings to keep down the weight and they have an independent in-and-out movement on the arms by hand-operated levers. The arms are traversed laterally along the cross-rail by a large handwheel operating through a rack and pinion. The table, as the illustration plainly shows, is mounted on rollers, thus giving an easy adjustment, and it is moved by a ratchet lever at the front, which operates pinions engaging with racks at both ends. There is a binder lock which holds the table securely in any position. If desired, a stationary table can be furnished, in which case it is rigidly bolted to the uprights and no base is used.

The spindles of this machine are forged of high carbon steel, have a large diameter in the sleeve, and are equipped with ball bearings for spindle thrust and also under the counterweight yoke. The counterbalance operates directly on the spindles and is constant in all positions. The feed, which is independent for each spindle, is operated entirely by gears and there are three changes. An automatic trip, by positive clutch on the feed worm shaft, and a wheel for hand feeding, are provided. The worm-wheel is disconnected for quick return of the spindle, by a positive toothed clutch on the handwheel.

The drive is by belt from an overhead countershaft, to a two-step cone-pulley connecting with a horizontal shaft which transmits the power through miter gears to a shaft on each arm and thence through miter and spur gears to the spindle. The two-step cone-pulley, in conjunction with the back-gears,



No. 14 Multiple Drilling Machine, built by Edwin Harrington, Son & Co.

gives four spindle speeds. When a motor drive is required, this can be arranged by belting a variable speed motor on the floor to a single pulley on the horizontal shaft. All mating gears in this machine are alternately of steel and bronze and have teeth of coarse pitch.

The cross-rail is of heavy box section, has a wide face for the arm saddles and a wide bearing on top of the uprights. The latter are very rigid and carry the runways and traverse racks for the table. The base by which the uprights are supported, is provided with a tank for the overflow oil, which is pumped to a long delivery tank under the cross-rail by an oil pump forming part of the equipment.

Some of the principal dimensions of this machine are as follows: Surface of the table, 7 feet 2 inches by 3 feet 4 inches; minimum distance between the spindles, 18 inches; maximum distance between end spindles, 8 feet; in-and-out movement of the spindles, 6 inches; vertical traverse of the spindles, 15 inches; maximum and minimum distances from spindles to table, 27 and 12 inches, respectively; in-and-out movement of the table, 3 feet 4 inches; clear opening between uprights, 9 feet 2 inches; range of spindle speeds, from 50 to 150 revolutions per minute; range of feeds per revolution, from 0.0036 to 0.0108 inch; and weight, 18,800 pounds.

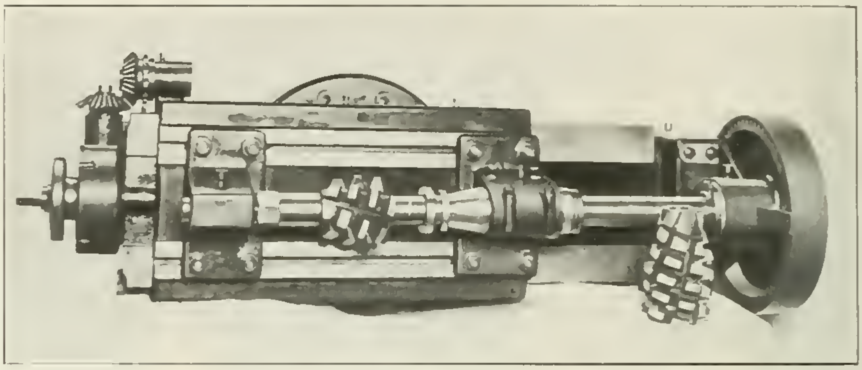


Fig. 1. Worm-wheel Hobbing Attachment for Gear-hobbing Machine

WORM-WHEEL HOBBING ATTACHMENT

As is well known, there are a number of different methods employed for cutting the teeth in worm-wheels. A very common way is to first gash the blank and then use a hob for finishing the teeth. This process only requires an ordinary milling machine, and it is the one followed in most shops for making worm gearing of small size. Another method sometimes used is to gear the hob and work positively together so that previous gashing is not required. This method is quicker than the one first mentioned, but requires a special machine or attachment. A third method which produces the most accurate teeth, and which is the least expensive as regards cutting tools, is what is called the "fly-cutter" method. This method requires a special machine or attachment, but is the best one to use when accurate and silent-running gearing is required.

There are two reasons why a higher degree of accuracy is obtainable by using a fly-cutter: In the first place, it produces the teeth by a generating action, and secondly, it can be ground accurately to size after hardening, thus eliminating the inaccuracy frequently found in a hob which has distorted in hardening. When many gears are to be cut, the bar with a fly-cutter is frequently replaced by a taper hob which is gradually fed tangentially by the work from one end, thus completing the teeth as it is fed past the center of the worm-wheel. This method is also an accurate one because the full size teeth at the back end of the hob are not in action until the final finishing of the worm-wheel, so that their shape is preserved much longer than is possible in an ordinary hob. Another advantageous feature incident to both the taper hob and fly-cutter methods is that the distance between the center of the work arbor and the cutter spindle is fixed at exactly

the distance between the axes of the worm and worm-wheel, there being no feeding in of the fly-cutter or taper hob towards the gear, but merely a feeding of the cutting tool tangentially by the gear.

An attachment for cutting worm-gears either by a fly-cutter or a taper hob, has recently been placed on the market by Schuchardt & Schutte, Cedar & West Sts., New York City. This attachment, shown in Fig. 1, is used on the regular gear-hobbing machine sold by this firm, this machine, without the attachment and provided with the regular cutter head, being used for hobbing spur and spiral gears. It consists of a duplicate head which is provided with a cross-feed. When it is desired to use a fly-cutter or a tapered hob for generating a worm-gear, the regular cutter-head is taken off the machine and the head with cross-feed is substituted. Power is given to the cutter arbor through the same train of gears that drives the hob mandrel of the regular head. The same chain that furnishes the vertical feed motion to the regular cutter-head

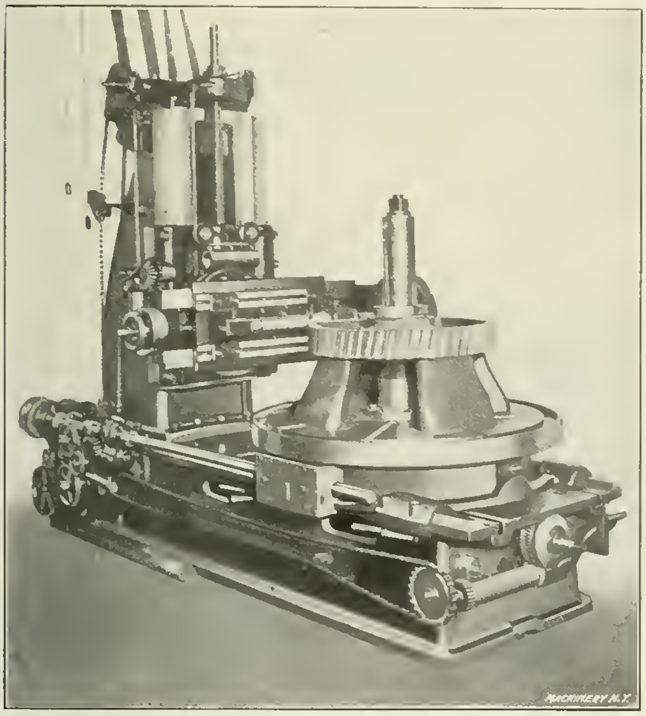


Fig. 2. Attachment applied to a Gear-hobbing Machine

controls the cross-feed on this special head. All that is required is to lengthen the chain and permit it to pass over two idlers, as can be seen on the left-hand side of the machine. This furnishes a direct cross-feed motion to the hob mandrel

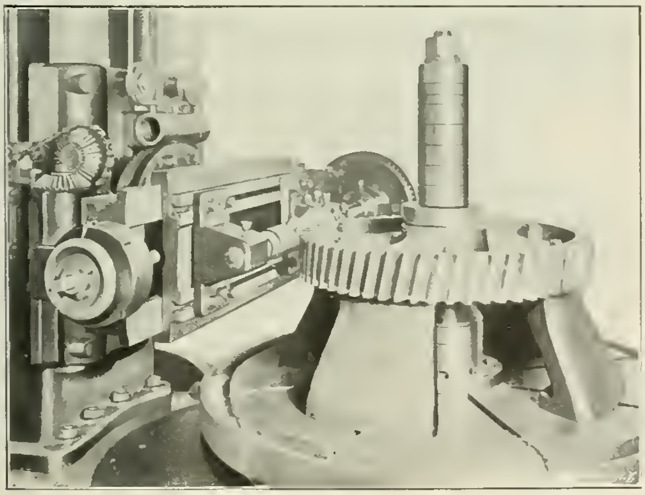


Fig. 3. Worm-wheel Hobbing Attachment equipped with Fly-cutter

or cutter-bar. The amount of this feed may be reduced or increased, of course, to suit the characteristics of the material of the gear blank.

The differential gearing that is used when cutting spiral gears to compensate for the angle of spiral while feeding the hob down past the work, gives the required compensation for the motion of the taper hob or fly-cutter as it feeds past the worm-wheel; thus no complications are introduced in this machine as regards the gearing, the gearing of the regular machine meeting all the requirements. The differential gearing, by means of which the compensating movement is effected, is of the Pfauter patent and was described in the April, 1908, number of MACHINERY, in one of a series of article on gear-

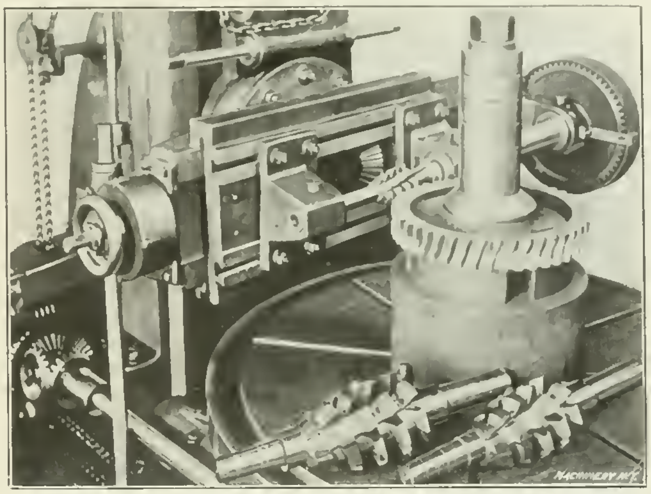


Fig. 4. Hobbing a Worm-wheel with a Taper Hob

cutting machinery, which extended from January to August, 1908, inclusive. The method of cutting worm-wheels by generating was treated in detail in the June, 1908, number of MACHINERY, engineering edition.

The addition of this attachment to the Schuchardt & Schutte machine furnishes a simple and accurate means for producing worm-wheels that will run in perfect mesh with the worm. A worm-wheel hobbed with a straight hob is satisfactory only when the angle of the hob thread is very slight, as in a single-thread hob of large diameter. When the angle of the thread increases, the straight hob leaves ridges on the sides of the teeth at the bottom, and the worm bears on spots when in service—at least until the ridges have worn down. The cost of a hob is, of course, also very much greater than that of a fly-cutter—the cost frequently being ten times as much—and for this reason the fly-cutter method of producing worm-gears, is practically the only one permissible when only a few large worm-gears are to be cut. As already mentioned, for a large number, the taper hob method is preferable.

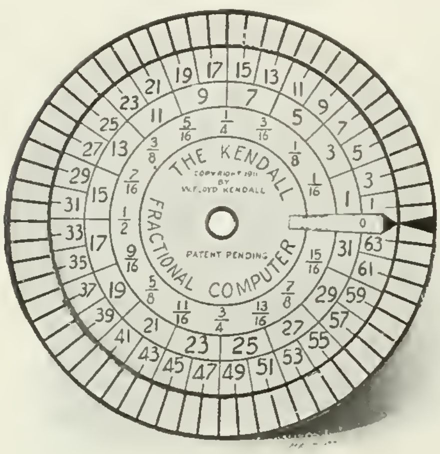
A machine with this equipment has recently been installed at the works of the A. B. See Electric Elevator Co., Jersey City.

KENDALL COMPUTER FOR ADDITION AND SUBTRACTION OF FRACTIONS.

The Kendall fractional computer is a device designed to facilitate the addition or subtraction of fractions, so that this part of mathematical work can be done in a minimum of time. It is very simple, and consists of two cardboard disks joined by a brass eyelet. The lower and larger disk has sixty-four equally spaced lines representing 64ths of an inch, and the upper disk has three sets of graduations as shown. The outer circle of figures represents the numerators of 64ths, the next circle 32nds, and the inner circle has the fractions fully expressed. The upper disk is free to revolve and contains a slot through which the fractions and their decimal equivalents on the lower disk can be seen.

When computing with this device, the slot is placed first over the zero mark on the lower disk, as shown. If two fractions are to be added, that line on the lower or "result" disk that is opposite one of these fractions on the upper or index disk is noted, and the slot of the index disk is moved opposite that line. The line on the lower disk opposite the fraction to be added is then noted and the slot is again moved opposite this second line; the sum of the two fractions will then show through the opening. For example, to add 7/64 to

9/32, the slot of the index disk must first be moved opposite the line on the lower disk that coincides with the figure 7 of the 64ths circle. The position of the 9 in the 32nds circle is then noted, and the slot turned to that position, as shown by the coinciding mark on the lower disk. While these changes of the index disk are being made, the points on the lower disk to which it must be turned can easily be marked with the finger. By proceeding in this way, any number of fractions can be added, but care should be taken to add 1 to the result each time the slot in the index disk passes the zero mark or makes one complete revolution.

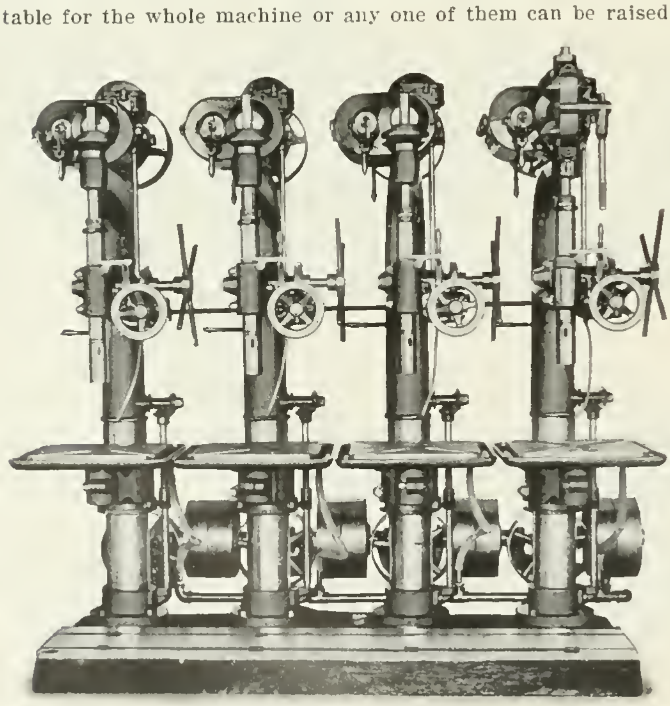


Kendall Fractional Computer

When subtracting, that line on the lower disk opposite the fraction to be subtracted from, is placed opposite the fraction to be subtracted; the difference is then read through the opening. This device should prove of special value to draftsmen and others frequently engaged in mathematical work. It has been placed on the market by W. Floyd Kendall, West Haverstraw, N. Y.

SIBLEY FOUR-SPINDLE DRILLING MACHINE

A four-spindle high-speed drilling machine now being built by the Sibley Machine Tool Co., No. 8 Tutt St., South Bend, Ind., is illustrated herewith. This machine has four individual square tables, as the engraving shows, that are located close together so that they can either be used as one table for the whole machine or any one of them can be raised


Sibley Four-spindle High-speed Drilling Machine

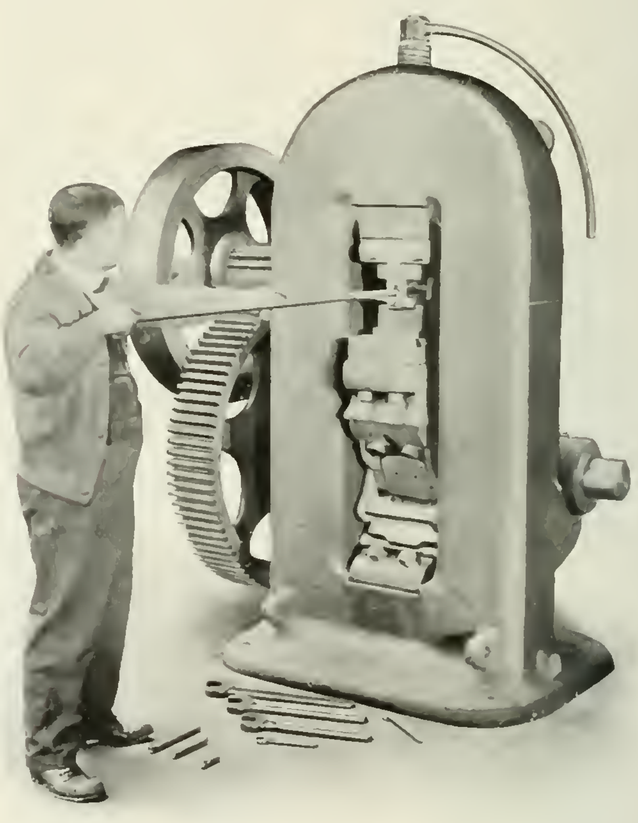
or lowered to accommodate different sized jigs. Each spindle is also independent from the others in operation and has a separate quarter-turn countershaft, instead of a single-pulley drive for all four spindles with connection through friction clutches for each machine. This method of driving was selected as the best for delivering the full amount of power to each machine, and it also eliminates all troubles that may arise from the use of friction clutches. Lubricant is supplied to all four spindles from a large tank by a geared pump driven from one of the countershafts. After being used, the lubricant returns to the tank through drains in each table.

The general construction of this machine is similar to the company's standard high-speed types. The operator can take care of all four spindles without being obliged to go back of the machine or even to the side for any speed changes or adjustments of any kind; the machine can be started and stopped, speed and feed changes made and the spindle returned, from the front. The usual geared tapping attachment is fitted to the fourth spindle. This type of machine is built in two- and three-spindle styles also.

FERRACUTE PRESS FOR HEADING STAY-BOLTS

The Ferracute Machine Co., Bridgeton, N. J., is now building a press fitted with dies by means of which a square head is formed on a boiler stay-bolt blank at one stroke of the machine. If desired, the press can be modified to form the head and cut the blank from the bar at the same stroke.

The accompanying illustration shows one of these machines. The design is very compact, the frame being a solid casting


Ferracute Press for Heading and Cutting-off Stay-bolts

with only 14 inches between the columns, thereby reducing to a minimum any spring in the frame when the press is in action. The stroke of the press is 2 inches, the ram being forced upward by steel toggles that are actuated by a 6-inch steel shaft in the rear. The head to which the upper die is attached can be adjusted downward as much as ½ inch, by means of a wedge adjustment operated by a bolt and lock-nut. The bolt seen at the top of the press keeps the head firmly up against the frame, and the spring shown has sufficient tension to take the weight of the head when operating the wedge adjustment. The forming dies are V-shaped, and there is an adjustable gage at the back of the press so that bolt blanks of various lengths may be cut off.

The flywheel on this machine weighs 1100 pounds, is 40 inches in diameter, and runs 180 revolutions per minute, producing at that speed 30 strokes per minute. The total weight of the press is over 16,000 pounds and it gives a pressure of 400 tons. The illustration shows the operator in the act of making ⅞-inch stay-bolt blanks from a steel bar of that

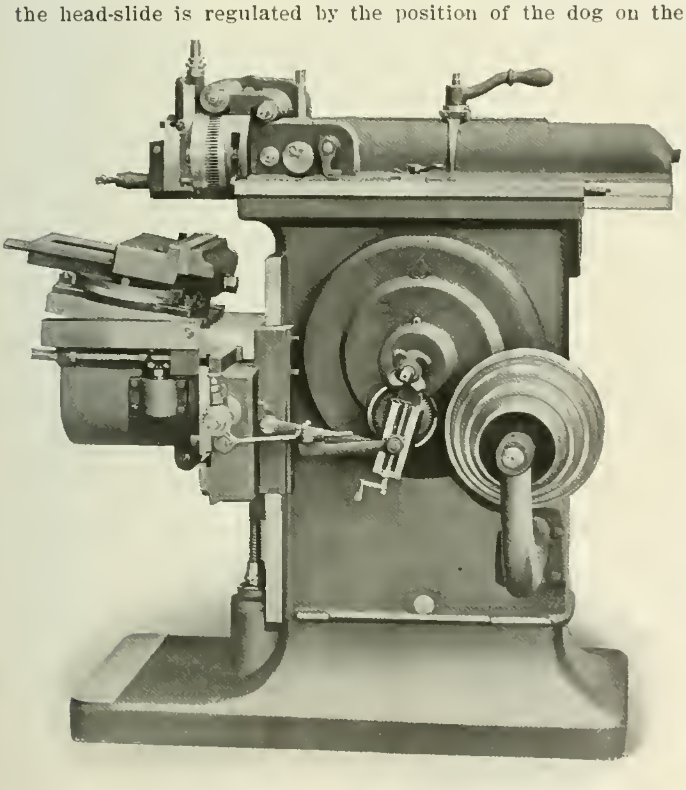
diameter. This press is supposed to run continuously. The company for whom it was built formerly headed their bolt blanks in a slotter, producing about one per minute, the blanks having been previously cut off from the bar by another operation. Inasmuch as the Ferracute machine performs both operations at the rate of 30 per minute, a fair idea of the saving effected may be obtained.

STOCKBRIDGE UNIVERSAL SHAPER

The Stockbridge Machine Co., Worcester, Mass., has recently brought out a 16-inch single-geared shaper equipped with special attachments that make it possible to meet practically every requirement in the way of shaper work found in the tool-room or in connection with die-making. The special features of this new design are: the power rotary feed; automatic feed for the head-slide either up or down; automatic stop for the down feed; and swiveling or rotary knee.

The power rotary feed for the head, or the concave attachment, is mounted on the top of the ram and the head is revolved by a worm and worm-gear. The worm is connected by a train of gears to the pawl seen on the side of the ram, and this pawl is reciprocated by a dog which is adjustable along the ram gib. By adjusting this dog, the throw of the pawl can be varied and consequently the feeding movement to the head. The worm can be turned in either direction, and the construction is such that the head can be rotated by hand when desired. The head can be locked to the ram, when not in use, by means of two bolts located on each side.

The automatic stop for the down feed of the head-slide will be found of advantage in producing duplicate parts. It prevents the tool from feeding down too far and spoiling the work, and also allows the operator to attend to other work while the machine is running. The amount of automatic feed for the head-slide is regulated by the position of the dog on the



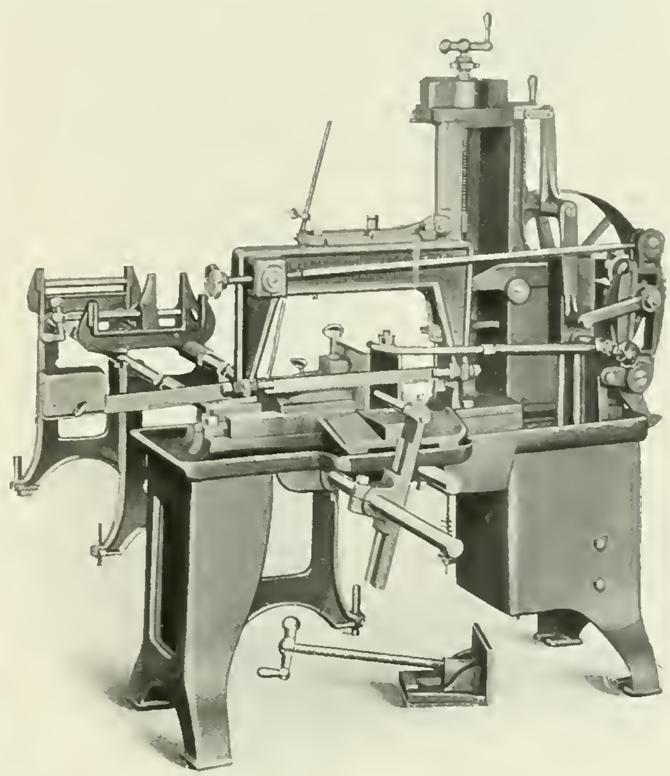
Stockbridge Universal Shaper for Tool-room and Die Work

ram gib. A micrometer graduated to thousandths of an inch is provided on the feed-screw and can always be set to the zero position.

The swiveling or rotary knee has two working sides and is revolved by a worm and worm-gear through an arc of 90 degrees in either direction. One side is made to tilt for planing angles, which is especially useful in die-making. All the feeds and adjustments on this machine are within easy reach of the operator. The Stockbridge patented two-piece crank is used, giving a quick return of 3.5 to 1 (which is maintained for short strokes) and an even cutting speed throughout the length of the stroke. The shaper has a maximum stroke of 16½ inches; the vertical travel of the knee is 16 inches, and the horizontal travel is 20½ inches. The ram has a 26-inch bearing in the column, and the machine weighs 2000 pounds.

"MARVEL" HIGH-SPEED AUTOMATIC HACKSAW

The Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill., has added to its line of hacksaw machines a size known as the "No. 5," which is entirely automatic in its operation. After a piece is cut off, the bar is fed forward and a new cut started, all automatically and without stopping, this operation being continued until the bar is cut up.



Armstrong-Blum No. 5 High-speed Hacksaw with Automatic Stock Feed

The stock is clamped in a vise which travels along the double track at the rear of the machine. When a piece is cut off, the saw rises and at the same time the vise opens. When the saw is up out of the way, the stock-feeding attachment draws the traveling vise and the bar forward until the end of the bar is stopped by the adjustable gage shown; the saw then starts down, the vise closing at the same time, and a new cut starts. The time required for this cycle of operations varies from ten to fifteen seconds.

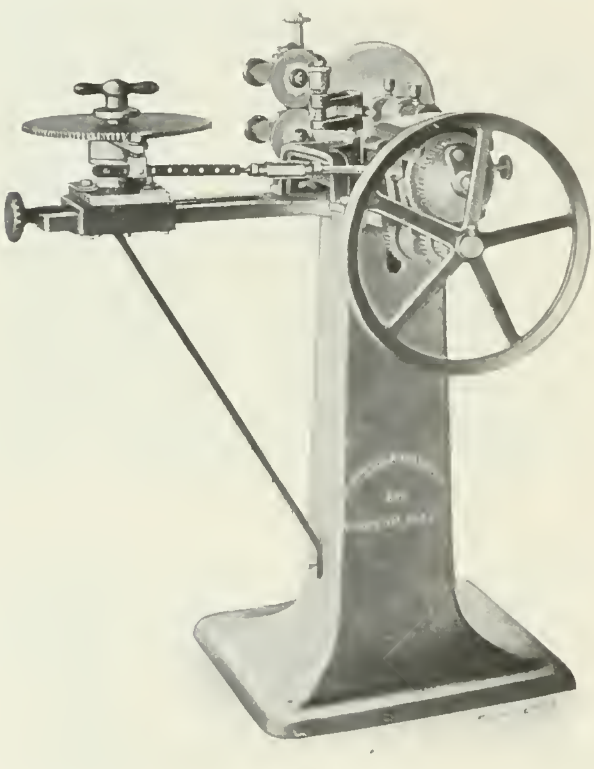
The saw frame always moves horizontally, and it is actuated by a crank-lever which imparts a smooth, even cutting stroke to the blade and gives a quick return. The entire blade can be used by shifting the saw frame by means of a right- and left-hand screw on the connecting-rod; this adjustment can be made with the machine in operation. The stroke of the saw can be changed from 4 to 6½ inches by means of a shifting bolt in the crank. The chuck or vise has liberal dimensions, the jaws extending out flush with the saw-blade. This vise will take stock up to 8 inches, and it can be shifted forward or back or swiveled either to right or left for cutting to an angle. In a slot in the saddle back of the machine there are two dogs, the upper one of which may be set to stop the cut at any desired depth. Any pressure on the saw-blade can be obtained by means of a friction disk at the top of the screw. The saw cuts on the draw stroke and lifts free of the work on the return.

This machine is provided with an overflow tank and a reliable plunger pump which gives a steady stream of compound on the saw-blade. This pump, which is immersed in the bottom of the tank, can be removed with all its connections by simply removing two cap screws. An idea of this machine's

cutting speed may be obtained from the following examples representing the performance of an ordinary hacksaw blade: Time for cutting 1-inch round steel, 3/4 minute; 2-inch steel, 2 1/3 minutes; 3-inch, 5 minutes; 4-inch, 7 3/4 minutes; 5-inch, 13 minutes; and 6-inch, 24 minutes. Duplicate pieces are cut to the same length in this machine, and the automatic feature effects a considerable saving of time and labor. It is furnished, if desired, without the stock-feeding attachment.

NUTTER & BARNES AUTOMATIC SAW SHARPENER

The Nutter & Barnes Co., Boston, Mass., has brought out an automatic saw sharpener that is adapted to the forming of Brown & Sharpe patent, relieved teeth for cutting soft metals, or for plain saw gumming. The special feature of this machine is that it will sharpen, back off, and form a relieved tooth at one setting, and in the same time as required for plain gumming. The four different operations necessary to form one relieved tooth are performed by means of cams and gears at each advance of the main gumming-wheel, and from 40 to 50 saw teeth can be formed per minute, the number depending on the diameter of the saw.



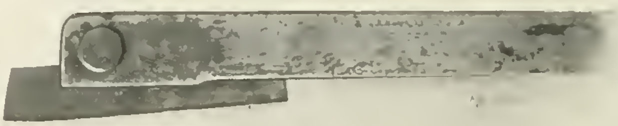
Nutter & Barnes Automatic Saw Sharpener

The saw is indexed by a disk, 12 inches in diameter, having the same number of teeth as the saw being sharpened. The function of the gumming-wheel is to gum, sharpen the face, back-off, and regulate the two lengths of saw teeth, the narrow alternating teeth being 1/64 inch longer than the full width teeth. The two 4-inch narrow grinding wheels shown, bevel and form the clearance of the alternating bevel teeth on the beveled part. As the wheels are gradually withdrawn and the saw starts to revolve, the proper clearance is given to the bevel. In the same way, the full-width as well as narrow teeth, receive their regular backing off from the corner of the beveled wheel; that is, while the teeth are revolving past it.

The different numbers of teeth in saws, and the variations required in backing them off, are obtained from an adjustable feed cam in which holes are located in the proper position to receive an index pin carried in an arm on the cam shaft, each hole being marked for the different numbers of teeth in saws of various diameters. This machine will also sharpen the face and form the gullet of a plain straight saw-tooth, and in this case the indexing is also regulated by a plate having the same number of teeth as the saw being sharpened. These machines are built in two sizes—for saws ranging from 12 to 20 inches in diameter and from 12 to 36 inches, respectively.

LANG TOOL-HOLDER

The G. R. Lang Co., Meadville, Pa., is now manufacturing a new form of tool-holder which differs from the maker's regular holder in that the cutter is set at an angle so that the cutting edge projects beyond the side of the holder proper. This allows the tool to be used in a corner and for facing a shoulder, without the necessity of swinging it around to an angle with the work. This feature especially adapts this style of holder to

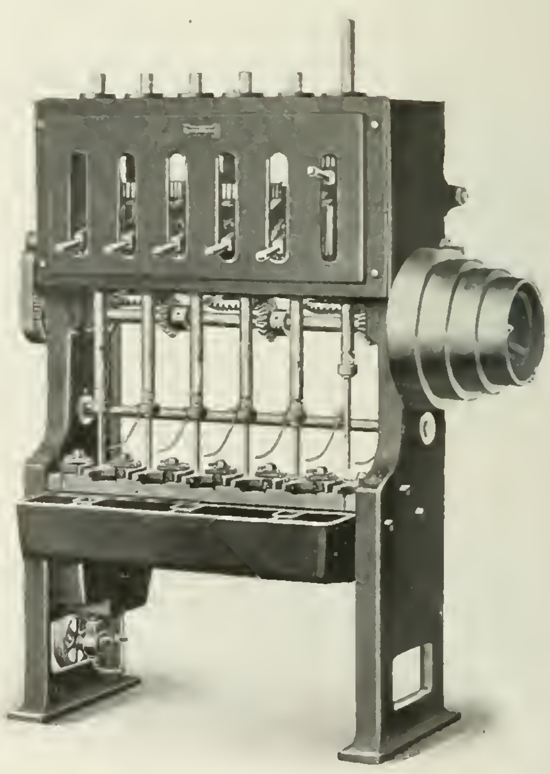


Tool-holder made by G. R. Lang Co.

vertical boring mills and turret lathes equipped with toolposts that can only be swung to a fixed position. The triangular form of cutter is used in this holder the same as in the company's regular type, and the method of holding the cutter is also similar, there being a notched clamping bolt which engages and binds the cutter. These tools are not intended to take the place of the maker's other style of holder, but rather to supplement it, the two types being adapted to practically all the work done with solid tools.

NATIONAL SEMI-AUTOMATIC NUT-TAPPING MACHINE

The National Machinery Co., Tiffin, O., manufacturer of bolt, nut and forging machinery, has perfected a new design of semi-automatic nut-tapping machine. With this tapper, which we illustrate herewith, rough hot-pressed nuts are tapped as readily as cold-punched nuts, and the objections to the entirely automatic tapper, because of "sticking," etc. when



Semi-automatic Nut-tapping Machine, built by the National Machinery Co.

small burrs are encountered on rough hot-pressed nuts, is overcome.

The tap spindles are raised and lowered automatically, and the machine "sets the pace" for feeding. The operator does not experience fatigue, as on the foot-lever tapper, due to treadling, and he is enabled easily to keep pace with the machine throughout the entire working day, and secure the maximum output. It is claimed that the output secured with this machine is from 60 to 80 per cent greater than is possible

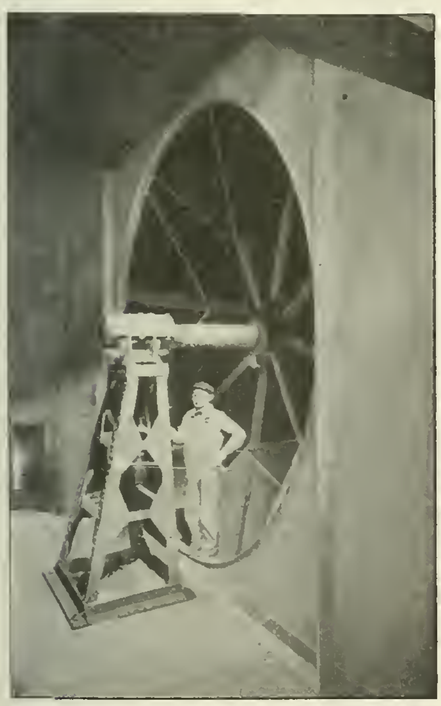
with the foot-lever tapper. The revolutions of the tap spindles, per raising and lowering, can be varied to correspond to the number of threads on the tap being used. This eliminates "non-productive" tapping time (tap running idle in the nut after it is tapped) and quickens the "pace" for feeding set by the machine. The variations in the revolutions of the tap spindles are secured through a single-lever quick-change speed box on the cam-shaft.

The raising and lowering of the tap spindles is accomplished by six three-step cams carried on a horizontal shaft in the rear of the spindle housing. These cams engage hardened steel rolls carried in the spindle levers. The cam-shaft shifts laterally so that the various cam faces or steps can be engaged, and in this way the "staying" or resting time of the tap, when raised, can be altered to meet the needs of the operator for feeding the machine and emptying the taps. The life of the tap, also, is longer, as a rule, than if used in the foot-lever tapper, as the cam movement causes the tap to lower gradually, and it does not drop into the hole with the weight of the spindle back of it, causing it to bind and resulting frequently in broken taps, stripping of the threads, etc.

An automatic socket is provided which allows the tap to be removed or inserted while the machine is running, and ejects the tap automatically when the shank becomes filled with tapped nuts. This new design is built in 1-inch capacity with six spindles, and 1½-inch capacity with ten spindles.

LARGE BUFFALO FAN

What is said to be one of the largest fans ever constructed has recently been made by the Buffalo Forge Co., Buffalo, N. Y. This fan is over 32 feet high, and it is being used in connection with a heating, ventilating and air conditioning system, supplying 25,000 cubic feet of air per hour to every employe in the new mill of the Sharpe Mfg. Co., New Bedford, Mass. This is the largest individual yarn mill in that city, and the company has given particular attention to the hygienic conditions. The air is washed before entering the mill, to remove all the dust, dirt and foreign matter, and make it absolutely clean. The arrangement is such that during the winter months the air can be heated to any desired temperature, there being independent regulation on each floor. Provision is also made for cooling the air, so that in the hottest days of summer the temperature throughout the mill, even in the spinning-room where the machinery generates an immense amount of heat, is from 15 to 20 degrees cooler than is possible with ordinary window ventilation. The volume of air that this large fan handles to achieve these results, reaches the astonishing total of 20,000,000 cubic feet per hour. The conditions obtained with this installation are as nearly ideal for a mill of this kind as it is possible to make them.



Mammoth Fan built by Buffalo Forge Co.

LANGELIER SWAGING MACHINE WITH A PNEUMATICALLY OPERATED HOLDER

The accompanying illustrations show a swaging machine manufactured by the Langelier Mfg. Co., Providence, R. I., that is arranged with a holder in which the feed of the work into the disks and the opening and closing of the chuck are operated by compressed air.

Fig. 1 shows this holder in position ready for use, and Fig. 2 shows it swung to one side in order to permit the removal and entering of dies and the inspection of the swaging parts of the machine. The holder consists of a cylinder, hinged to the cover of the swaging machine and supported at its outer

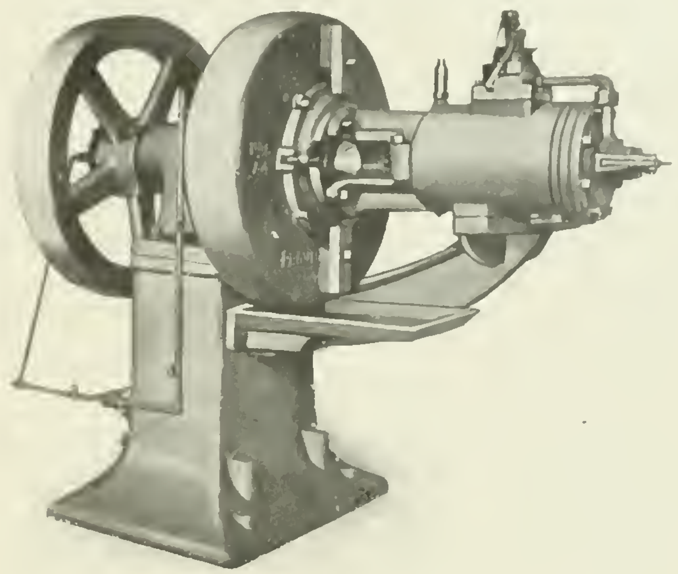


Fig. 1. Langelier No. 5A4 Swaging Machine, with Pneumatic Holder in Position for Use

end by a rail on which it rides when swung to the side. The main or cylinder piston actuates the feeding of the work into the dies and also its withdrawal, and an auxiliary piston operates the opening and closing of the chuck. These two pistons act independently of each other and both are controlled by a specially designed triple-action valve shown on top of the cylinder. The construction of the oscillating part of this valve is such that it compensates for wear and maintains a uniform pressure on its seat. The hand- and thumb-lever shown is used for operating this valve, the hand-lever controlling the feeding of the work into the dies and also its

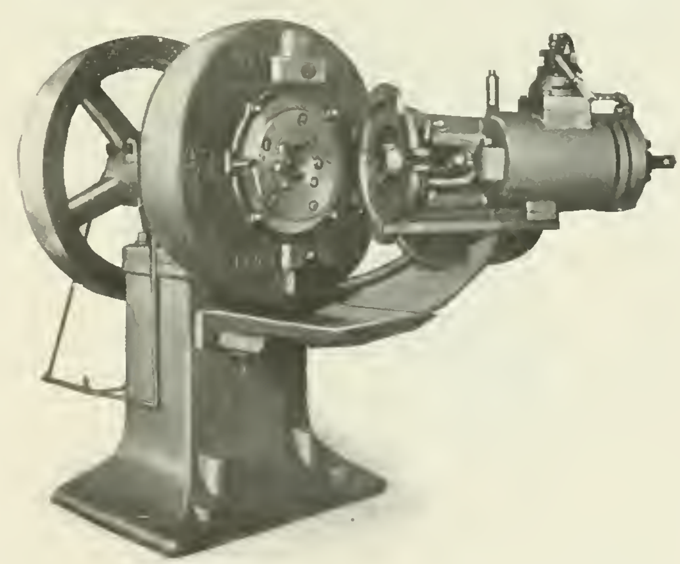


Fig. 2. Pneumatic Holder swung to One Side

withdrawal, and the thumb-lever, the closing of the chuck. The chuck used is of the spring type.

The releasing of the chuck is automatically effected by the movement of the piston at the extreme end of its outer stroke by coming into contact with a piston valve provided for this purpose. By means of a trip lever on the end of the cylinder head, the chuck can be released at any part of the stroke. The inlet and outlet air connections are located in the rear of the valve.

An interesting example of swaging performed by this machine and holder, on brass tubing, is shown by the line illustration Fig. 3. To accomplish this work, it was necessary to use a separate chuck and pair of dies for each of the three operations illustrated, and also a swaging arbor for the second and third operations in order to obtain the thickness of wall as indicated by the outer and inner diameters. The brass tubing was cut into lengths as shown by the blank and the first operation reduced the diameter 5/16 inch. No swaging arbor

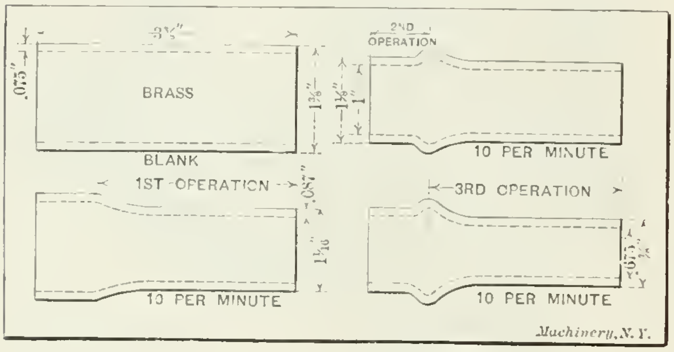


Fig. 3. Example of Swaging Operations performed on Machine illustrated in Figs. 1 and 2

was used in this operation as it was necessary to obtain as thick a wall as possible. The second and third operations show a reduction of ¼ inch and this swaging was done on an arbor located between the dies in the swaging head. The number swaged per minute, as indicated in the illustration, represents the actual performance, the time including the chucking and ejecting of the work.

MUMFORD CORE-BENCH JOLT-RAMMING MACHINE

The Mumford Molding Machine Co., 30 Church St., New York City, has added to its line the core-bench jolt-ramming machine shown in the illustration. This machine is particularly adapted to the ramming of deep cores of small dimensions made on the bench. It can be placed on a concrete pier, iron post or even a wooden one and affords a place on the core bench where any core adapted to such treatment can be rammed better and more economically than by hand. The starting and stopping of the machine is controlled by a knee-

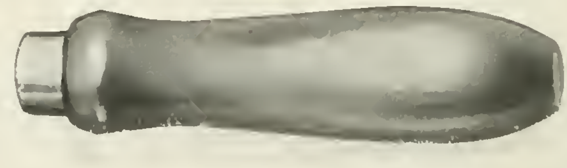
Core-bench Jolt-ramming Machine built by Mumford Molding Machine Co.

valve under the bench so that both hands of the operator are free for handling material and core boxes.

While the rated lifting capacity of this machine is 300 pounds, with 80 pounds air pressure, it is more particularly adapted for small slender cores which, with the boxes, sand and all, weigh only a few pounds. The valve of this machine is simply a plug of casehardened machinery steel, having a 3/16-inch vertical stroke. Notwithstanding the simplicity of construction, the economy in the use of air is said to be superior to the more elaborate valve mechanisms. The table of this machine is 15 by 20 inches, the plunger is 3 inches in diameter, and the finished shipping weight is 325 pounds.

PAPER FILE HANDLE

The file handle shown in the accompanying halftone is made entirely of paper, excepting the steel ferrule at the end. The advantages of this paper handle are, that it will not split and is practically indestructible. A file tang is also held more firmly than in a wood handle, and tangs of a larger



Indestructible Paper File Handle

size than that for which a handle is intended, can be driven in without danger of splitting. The paper handles are cheaper than those of wood, and they can be obtained in various sizes. This new handle has been placed on the market by Schuchardt & Schutte, Cedar & West Sts., New York City.

NEW MACHINERY AND TOOLS NOTES

Knurling Attachment: Rivett Lathe Mfg. Co., Boston, Mass. Tailstock knurling attachment having a shank that fits the tailstock spindle and a slide with radial adjustment carrying two knurls. This slide is adjusted by a thumb-screw, and the shank of the tool is hollow to admit the work.

Core Machine: Midland Machine Co., Detroit, Mich. Jolt-rammed, roll-over core machine. Special design for making regular and special cores of various shapes and sizes. This machine is built in two sizes. It has a rise of 10 inches, which makes it possible to handle a large variety of work, both as a molding and core-making machine.

Pipe-Threading Machine: Williams Tool Co., Erie, Pa. Twelve-inch pipe-threading and cutting off machine driven by direct-connected steam engine mounted at the rear and transmitting its power through machine-cut gears. With the exception of the change in the drive, this machine is similar to the No. 5 pipe-threader built by this company.

Furnaces: Tate, Jones & Co., Pittsburg, Pa. Three types of heat-treating furnaces, including a pack-hardening, case-hardening and annealing furnace; a semi-muffle furnace particularly adapted to hardening and annealing high-speed and carbon steel cutters, etc.; and a tempering bath that can be equipped with bath pots shaped to meet varying requirements.

Centering Attachment: Rivett Lathe Mfg. Co., Boston, Mass. Lathe centering attachment having a shank that enters the tailstock spindle, and a swiveling member that carries a drill and countersink. The pivot of the swiveling member is so located that either the drill or countersink can be brought into alignment with the spindle, the correct position being obtained by positive stops.

Pipe-Threading Machine: Murchey Machine & Tool Co., 4th & Porter Sts., Detroit, Mich. Single-head, motor-driven, semi-automatic, pipe-threading machine, similar in its general construction to the No. 2 double-head machine built by this company. The die-head is the maker's automatic opening type, and the capacity ranges from ½- to 2-inch pipe. This machine can be furnished with or without a motor.

Drilling Machine: Prentice Bros. Co., Worcester, Mass. Twenty-six-inch, geared-speed, large, upright drilling machine. All the bearings of this machine excepting those for the feed works are ball bearings, there being fourteen annular and one thrust ball bearing. The general design of this machine is similar to that previously built by this company. The advantage of the new construction is in the saving of power and increase of capacity.

Electric Welding Machine: Toledo Electric Welder Co., Cincinnati, O. Small machine designed for butt welding stock ranging from No. 16 gage wire to ¼-inch round iron or steel. The time required to place the stock in the jaws and complete a weld, is from three to five seconds. When welding small stock, the amount of current used can be reduced by a regulator which forms part of the equipment. This machine weighs about 100 pounds.

Cutting, Forming, and Horn Press: F. S. & G. L. Brown Machine Co., Baltimore, Md. Press having a bed or knee adjustable vertically on the frame or column to any desired position by means of a crank connecting through bevel gears with an elevating screw. The bed, when positioned, is rigidly clamped to the column. This type of press is also made with a hole through the frame in which a horn can be fitted, thus making a combination cutting, forming, and horn press.

DEPARTMENT PLAN MACHINE TOOL ARRANGEMENT ON BASIS OF PRODUCT*

By C. B. AUEL†

It will almost invariably be found that in the original design and lay-out of small and medium-sized manufacturing concerns, the tool equipment has been so arranged as to group together operations of a like kind, such as milling, planing, drilling, boring, screw machine work, etc.

The reasons for this are: (1) that for each of the principal machining operations, there is frequently but a single expert and in order to make the best use of this talent, no other scheme is permissible; and (2) that centralizing machines of a kind tends to decrease the number required for a given output. As a result of these there follow logically: (3) accuracy and speed in workmanship; (4) uniformity in methods; (5) economy in floor space; and (6) minimum distribution of power.

Under this method of production, a shop may be said to be divided into two portions, *viz.*, "feeder" and "assembly," the "feeder" sections making the parts from the raw materials and delivering them either to storerooms or to "assembly" sections where they are assembled into the complete apparatus preparatory to test and shipment. There will, in general, be a number of "feeder" sections, entirely independent of one another, and there may, likewise, be one or more "assembly" sections. A production, planning or routing department usually determines the manner in which orders are to be brought through, arranges delivery dates, keeps track of the orders as they progress through the shop, and exercises general supervision over production.

The East Pittsburg plant of the Westinghouse Electric & Mfg. Co., was operated, until about three years ago, along lines which may be said to have been departmentalization partly on a basis of tool equipment as outlined and partly on a basis of product during which time it met conditions fairly satisfactorily.

However, in any growing manufacturing concern, there comes a time when the advantages of the preceding arrangement are more than offset by the difficulties incident to its successful operation. The increase in volume of the semi-finished parts passing from "feeder" to "assembly" sections, with the accompanying increase of clerical and other work and the multiplication of foremen and superintendents concerned in the manufacture of any one class of product, results in delays and increased expenses of various kinds which cannot be overcome, nor can the recurrence of them be prevented. Perhaps the greatest drawback to such a scheme is the inability to fill orders promptly. This is especially apparent during periods of business depression when quick delivery is of greater importance than at any other time. The amount of stock on hand is then usually lowest and, accordingly, a larger percentage of apparatus requires to be built from the ground up to fill customers' orders. Under these circumstances, it becomes imperative to place so-called "rush," "forfeiture" and other orders of a like nature in a class by themselves and to conduct them personally, as it were, through the shop. In the doing of this, though, other orders are relegated to the background with consequent disastrous results, particularly in the matter of dissatisfaction on the part of the customers for whom such orders are intended. Of course, the greater the volume of these special orders, the greater the ensuing confusion and delay in connection with other orders, so that this method of procedure is not a solution of a difficult problem but simply a makeshift—a temporary expedient—to be abandoned as quickly as some more rational method presents itself. Another vital difficulty, perhaps equal in importance to that already mentioned, is the matter of divided responsibility, no one individual being primarily responsible for any complete piece or class of apparatus. Such being the case, it is exceedingly difficult to make even an attempt to ameliorate or to improve conditions which are known to need attention, for the reason that there seems to be no proper place at which to commence the betterment work.

As a result of these conditions and without going any more minutely into an analysis of the difficulties, it is reasonable to assume that in consequence of shipments being delayed and responsibility divided, "work in progress" and "stocks," raw and finished, will be high, and such proves to be the case.

Investigation Leading up to Adoption of New System

Recognizing that methods of manufacture which had in the past been satisfactory for their needs, were proving inadequate to handle the increasing volume of business, for the reasons already stated, the Westinghouse Electric & Mfg. Co. spent considerable time in investigating the methods of other large companies in similar lines of business with the result that it was believed advisable to modify the original scheme in favor of so-called "factory departmentalization"; that is, to divide the plant into a number of separate units, as self-contained as the nature of the work of each would permit; in other words, to treat the units like independent factories, as it were, housed together under the same roof for mutually advantageous purposes, yet buying from and selling to one another their various commodities as circumstances seem to make desirable. A scheme of this kind naturally causes a number of duplications of the organization and equipment. While this is so, it does not necessarily involve any material increase in either, since the change is more in the nature of a rearrangement of the existing equipment and organization, with the addition here and there of a few tools which, under the original plan, were used in common by two or more departments. Even this may be avoided to some extent by assigning such tools to the department requiring them most, and permitting the other departments to have their work done on requisition.

In introducing this scheme in the East Pittsburg works, it was deemed advisable as a precautionary measure to put it into effect in but one department only, further progress along this line to be dependent wholly upon the results obtained in it. This was accordingly done and with very gratifying results, almost from the very beginning. It was found, as anticipated, that among other advantages, shipments were facilitated and "work in progress" and "stocks" decreased, all to a very marked degree.

Comparing the routine in this particular department under the original and the modified plans, in the original the work was performed by twenty-two sections located in thirteen independent departments; in the plan as modified, the same work is now done by thirteen sections in seven independent departments. But this by no means emphasizes the difference even in the routine, for the reason that under the modified plan authority for an entire line of product is vested in a single individual, who, therefore, is enabled to exercise his discretion as to the raw and partly finished items to be carried. By a judicious selection of these, he has at all times a certain amount of stock on hand and is thus, to a large extent, not dependent in the matter of deliveries on the other sections outside of his authority which supply him with materials.

In consequence of the excellent showing made in the department selected for trial, departmentalization was gradually extended throughout the plant until now the work has been almost completed. Though not yet perfected, some of the details still requiring to be straightened out here and there, the general results have been a confirmation of those obtained in the department in which the scheme was first tried.

Of course it is hardly practical to carry this departmental idea into all sections; for example, in pattern shops and foundries, or in certain other places where either the work or the equipment is very special; neither has it been deemed wise to include disk grinding or polishing on account of the deleterious effect of the dust and fumes on other machines in the vicinity, though certain work of this kind is being done in some of the departmentalized sections where facilities for carrying off the dust and fumes have been provided.

Departmental Arrangement under the System

As at present arranged, there are in the works eight fairly self-contained departments as follows: (1) Railway, mining and crane motors; (2) power—for large generators and

*Abstract of paper presented before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 19, 1911.

†Assistant manager of works, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

motors; (3) control—for railway and industrial control apparatus; (4) detail—for switchboards and accessories; (5) small motor—for small power motors; (6) transformer; (7) locomotive; (8) industrial—for medium-sized motors. Besides these, certain "feeder" sections still continue: coils, punchings, blacksmith, cabinet and pattern-making, screw machine, foundries, etc. With respect to the screw machine section, it may be stated that this has been departmentalized to some extent, though the greater portion, for the manufacture of such parts as are made in large quantities and carried in stock by the central stores, remains unchanged. Regarding the other "feeder" sections, it is possible that some of them may in due course be departmentalized, without necessarily changing their present geographical location; but simply by assigning a certain proportion of the floor space and the tool equipment in each, to every one of the already departmentalized units.

Advantages of System

Summarizing the various advantages, they may be said to include: (1) centralizing of authority in the production of each class of apparatus; (2) decrease in time required to fill customers' orders; (3) increase in output in a given period; (4) decrease in "work in progress" and in "stocks"; (5) saving in floor space; (6) decrease in handling of materials; (7) decrease in clerical labor; (8) decrease in indirect expense or overhead burden; (9) increase in individual initiative; and (10) healthy competition between similar sections and departments.

In the matter of accounting, departmentalization has been carried even further than it has with the manufactured products, for every part of the works, whether a "feeder" section or a completely departmentalized unit, is now self-contained in this respect, making a total of fifty-three such units in all. These, being comparatively small, permit the ready compilation of the transactions of the preceding month, so that all intersectional and inter-departmental accounts are therefore balanced on a monthly basis. A further advantage of this feature is that each unit has its own percentage of indirect expense or overhead burden, figured on its total productive labor, which percentage is changed from time to time as circumstances seem to warrant. Order costs are compiled by the "feeder" sections and departments themselves. It may be stated that it is not the aim to show either a profit or a loss in any of the sections or departments so that when either of these conditions arises, the overhead percentage is altered accordingly. Every month each of the units in the works is provided with a set of charts or curves giving a continuous record of its performance in total productive labor, total expense labor and total expense materials, the expense items being also segregated along various helpful lines, all shown directly in dollars and cents, and many as a percentage of total productive labor as well. This percentage is considered as a measure of the expense labor and material efficiency.

* * *

AMERICAN MUSEUM OF SAFETY GRANTED A CHARTER

Friends of the movement for prevention of accidents in shops, mills and factories, workmen's compensation and improvement of industrial employment conditions generally—in short, the conservation of human life—will be glad to learn that the American Museum of Safety, New York City, has been granted a special charter of incorporation by the Legislature of New York State. The Museum of Safety is now in the same class with the Metropolitan Museum of Art and the American Museum of Natural History, both having special charters from the state.

The Museum has an interesting and valuable collection of protective devices in the Engineering Building, 29 West 39th St., New York, for many classes of machinery and working conditions. When it is considered that over 500,000 workers are annually killed or incapacitated by industrial accidents the importance of this practical philanthropic work will be appreciated. A conservative estimate of the yearly loss in cash wealth, due to these accidents alone, is $250,000,000.

DEPARTMENT PLAN MACHINE TOOL ARRANGEMENT ON BASIS OF EQUIPMENT*

By F. C. KENT†

Inasmuch as the product of some concerns is diversified, and machine tools used for one class of product would not be suitable for the manufacture of another class, this discussion on the merits of the departmental plan of arranging machine tools upon the basis of equipment as against the plan based upon production, would be applicable in its entirety to only about eighty per cent of our manufacturing establishments.

My earlier training in the metal work industries has been with the department plan of machine tool arrangement upon the basis of production, and the transition to an enthusiast of the department plan of machine tool arrangement upon the basis of equipment has been gradual.

It may be interesting to note that I have had a variety of subjects upon which to try out this proposition, *e. g.*, cheap metal specialties, bicycles, motor vehicles, electric locomotives, coal mining machinery and general jobbing and contracting work. The quality of workmanship and material has varied from the roughest to that of the very highest grade, and the weight of the finished product has ranged from a few pounds to many tons.

Some of these concerns were very thoroughly organized upon the basis of the product plan, but in every case where a change has been made to the basis of equipment there has been a decided increase in profits, together with a marked increase in wages of both productive and non-productive labor.

The remark that this is the age of specialization in the machine shop is true, but how many of us comprehend the truth? Manufacturers are just beginning to resolve into first principles the various manufacturing processes of their finished product. They have yet to apply this analysis with exactness to the problems of machine tool efficiency in the manufacture of their product. I believe there is a lack of knowledge of the possibilities of the most common type of machine tools in every shop; in fact, there is not one shop in ten in which the possibilities of even the engine lathe are thoroughly understood.

There is no doubt but that development along this line has been retarded by the system of arranging tools upon the basis of production. Department superintendents and foremen have had to cover too wide a field; their thoughts and energies have been distracted by the multiplicity of things needing attention every minute of the day. Some of you, who have been shop foremen in the past, must concede that there are a few things that need constant attention regardless of the system you may have devised to relieve you of the clerical and detail work. Furthermore, I believe it to be a physical impossibility for a foreman to produce a well-balanced and maximum product with machine tools grouped on the basis of production. A few words from an editorial in the *Motor Age* of March 30 will illustrate this point with respect to the operator.

"The arrangement of machinery was not symmetrical, drills were placed side by side with planers, and planers with lathes, and lathes with grinders. It was discovered that this mixing of operators brought about an unconscious confusion in the mind of the workman. The workman at the lathe might be a master of his job, but his energies were not concentrated on it. One minute he was watching a grinder at his right, the next a drill at his left, with the result that his efficiency was impaired and it was impaired because of distracting environments."

Now, if the operator's mind becomes distracted under such conditions when he has nothing to think of but his machine and the subject he is machining, what must be the state of mind of the foreman of this department?

A foreman as well as an operator has his "hobby," and if he did not ride it he would not be human. He may be fascinated with the lathe, but despise the sight of a grinder. The operations on the lathe will receive his best attention whether the work done on the other types of machines needs super-

*Abstract of paper presented before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 19, 1911.

† Superintendent, Pierce Arrow Motor Car Co., Buffalo, N. Y.

vision or not, in spite of the fact that he may be the so-called "all-around" mechanic. He is more or less a jack-of-all-trades, flitting from one job to another without learning the real possibilities of any of the machines under his charge. These conditions preclude thinking of labor and machine efficiency as applied to his department.

For general supervision, the plan of grouping the machines upon the basis of production is disastrous in most factories because of the impossibility of effecting a working balance between the various operating departments and of making the production equal in all departments. The grouping of machine tools upon the basis of equipment is the only solution for better and increased production. This is true because no man becomes an expert in all lines of mechanics. He increases production because he intensifies or specializes along narrow lines. The foreman who concentrates his energies upon one class of machine tools, and is alive to the possibilities of his equipment, has the opportunity of his life for increasing to the highest degree the labor and machine efficiency of his department.

The problem of securing proper departmental supervision becomes less serious under the system of grouping machines according to equipment rather than according to production. I have seen foremen in charge of departments equipped with lathes, drills, grinders, etc., who were unable to get satisfactory results, but when these same men were placed in charge of one special class of work with machines with which they were entirely familiar, they became so interested and enthusiastic with the result, that their earning power and efficiency were greatly enhanced.

Nor is it only where the human element is concerned that the plan of grouping machines with regard to equipment is superior to the plan of grouping with regard to the product; it has been demonstrated that less permanent investment is needed because less floor space is required. Consequently it admits of a better lighting system and requires fewer lights and less heating apparatus. The saving in pulleys, hangers, shafting, belting, etc., is considerable. Power, labor and supplies for the up-keep of the extra equipment are also saved.

In fact, on several occasions the rearrangement of machinery to the plan based upon equipment has saved the necessity of erecting new buildings to increase production. In one change, I recall that 110 hangers, and other power transmission equipment in proportion, were eliminated. When machines of the same type are grouped together it is possible to discern their productive capacity and set an efficiency standard with greater accuracy. It also assists the foremen in selecting the better types of machine tools and in eliminating the poorer ones.

Organized upon the basis of product, there is a tendency of department foremen to carry a stock of their own jigs, chucks of various sizes, milling machine and lathe arbors, drills, taps, dies and cutters of all sorts which are frequently duplicated in other departments. The diversity of opinions among foremen about high-speed steels, emery wheels, etc., is accountable for the great variety found in so many manufacturing plants organized on this plan.

This duplication and confusion incident to the handling of small tools and apparent lack of exact knowledge may be obviated by the installation of a central tool storage, equipped with first-class grinding facilities and supervised by a tool specialist. By this method, worn tools may be properly ground and kept in perfect condition, ready for use when needed. This arrangement makes possible the standardization of emery wheels, sizes of tool steel and all kinds of shop supplies.

At the Pierce-Arrow Motor Car Co. the arrangement of machine tools on the basis of equipment is carried out to a much greater degree of refinement than at most shops operating under this system. All lathes are not only grouped to form a department, but they are subdivided into smaller groups according to size, class of work, etc. For instance, one section known as the "turret department" is divided into groups of automatic chucking machines, automatic screw machines, flat and hexagon, turret lathes and hand screw machines. The larger turret lathes of the Gisholt type and vertical boring tools are not included in this department, but form separate groups. The hand and spur gear-cutters form separate groups. The milling machines are classified as vertical, horizontal, Lincoln type and hand groups. The drilling machines are divided into radial, heavy-duty, medium and sensitive groups. The grinders are grouped as internal, plain and surface. Supervision is effected by placing an assistant foreman in charge of a subdivision of machines. He is responsible to the foreman who has direct charge of the departmental group. The foreman is under the direct supervision of a general foreman or assistant superintendent, of which there are several. They, in turn, receive their instructions from the general superintendent.

In our production engineering department, which has been instituted for the purpose of effecting a more closely related shop organization, we now have a working force of three mechanics and three clerks; the former have been in the employ of the company for a number of years and understand our product thoroughly. The head of the department has served as draftsman, tool designer, head of specification, pattern and material order departments, and is intimately acquainted with the materials used in our product. The second is a patternmaker, designer of special machinery and tools, and is also a machinist. The other is an expert toolmaker, former tool-room foreman, and has had considerable experience in the manufacture of special machinery.

A "suggestion blank" pad is to be found on every shop foreman's desk. These blanks are used by the foremen and his men for the purpose of bringing to the attention of their department such changes in manufacturing operations and handling of our product as occur to them from time to time. The suggestions are carefully analyzed by this department, and if no objections to their adoption are found by them or by the department superintendent, by whom the suggested changes are finally approved, the changes are made. On the other hand, if the suggested changes are rejected, the reasons therefor are reported to the men who make them.

When new parts for our production are determined upon, this department, with the assistance of the shop foreman interested, carefully analyzes the operations necessary for each part, so as to assist our chief tool draftsmen in determining correct working points in making quick-acting and economical tools.

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The Woolworth building, which will be erected on Broadway between Park Place and Barclay St., will be the world's greatest sky-scraper and highest structure, barring the Eiffel Tower in France. It will be 750 feet high or 50 feet higher than the tower of the Metropolitan Life Insurance Co.'s building, and 138 feet higher than the Singer Tower, and will have a frontage on Broadway of 152 feet, 197 feet on Park Place, and 192 feet 6 inches on Barclay St. The tower part of the building is 86 by 84 feet. The main structure will be twenty-nine stories high, and with two stories in the gables, thirty-one stories at the highest point of the main structure. The total number of stories is fifty-five, and thirty-four elevators will be provided to serve them. The cubic contents of the building exceed 13,200,000 cubic feet. The foundation work is the greatest piece of caisson work yet done in New York City, and will cost about $1,000,000. The caissons extend down to solid rock at a distance of 110 to 130 feet below the street. The plot of land cost about $4,500,000, and the cost of the building and foundation is placed at another $4,500,000, making the total cost about $9,000,000. The building will be completed in the fall of 1912.

* * *

The Union Steel Casting Co. of Pittsburg, Pa., has experimented considerably with vanadium steel castings. It has been found that steel castings containing about 0.2 per cent of vanadium show a great increase in tensile strength and elastic limit. Castings have been made by this company having a tensile strength of 90,000 pounds per square inch; the average tensile strength, however, is about 80,000 pounds, and the elastic limit about 45,000 pounds.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The nineteenth semi-annual convention of the National Machine Tool Builders' Association was held in Atlantic City, May 18-19 at the Marlborough-Blenheim Hotel; the presiding officers were: President, F. A. Geier; and secretary, Charles L. Hildreth. The meeting was fully up to the mark set by previous Spring meetings, both in the character of technical papers presented and in the number of the membership present. A spirit of optimism pervaded notwithstanding the depression affecting the trade for the past year or two, and expressions of confidence in the resumption of normal business in the near future were heard.

On opening the meeting, Mr. Geier referred to the trials and tribulations of the machine tool business during the time of dull trade, and expressed the thought that the recent Supreme Court decision in the Standard Oil Co. case would clear away the uncertainty that had unsettled the business conditions of the country. The time was opportune for carefully examining present methods and making plans for securing greater efficiency generally.

The secretary, whose able work has so strengthened the association, spoke strongly of the need of eliminating all sectional feelings and prejudices. These are harmful in business, and one of the chief functions of the association is the forming of pleasant business relationships and cementing friendships between men, irrespective of the locations of the concerns represented. The secretary is revising a segregated list of machines built by the members, and his intention is to inject a personal element into the membership list by including the names of men prominent in the respective companies.

The condition of the association is prosperous. With an ample balance of funds on hand and an increasing membership, its prospects are bright. Twelve concerns were added to the association at this meeting, as follows:

Brown & Sharpe Mfg. Co., Providence, R. I.
The Burke Machinery Co., Conneaut, Ohio.
The Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio.
Cochrane-Bly Co., Rochester, N. Y.
Iligley Machine Co., Croton Falls, N. Y.
The Massilon Foundry & Machine Co., Massilon, Ohio.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
The Miami Valley Machine Tool Co., Dayton, Ohio.
Steinle Turret Machine Co., Madison, Wis.
The Standard Mfg. Co., Bridgeport, Conn.
The Stoever Foundry & Mfg. Co., Myerstown, Pa.
The United States Electrical Tool Co., Cincinnati, Ohio.

The name of the Grant & Wood Mfg. Co., Chelsea, Mich., having been changed to Flanders Mfg. Co., the membership was transferred to the new name. The business of George W. Fifield, Lowell, Mass., lathe builder, is being wound up on account of the death of the president, Mr. George W. Fifield, and the resignation of the concern was accepted.

Mr. C. L. Taylor of the Taylor-Fenn Co., Hartford, Conn., chairman of the patent committee, reported the failure of Congress to provide for the establishment of the special court for patent appeals that is so urgently needed to handle patent causes efficiently and relieve the congestion of patent litigation. The committee was continued.

Mr. C. H. Norton of the Norton Grinding Co., Worcester, Mass., read the brief report of the committee appointed to prepare a list of machine tool users for the common use of the members for circularizing purposes. It has been found impracticable to carry out the plan because of the reluctance of members to turn in their valuable private lists, when many of the members have no lists of importance to contribute.

Mr. George J. Burns, of the Chandler Planer Co., Ayer, Mass., gave a strong talk on the great need of an American merchant marine. He denounced the great shipping trust that throttles competition and dictates terms to shippers, railways and other factors of international trade. Mr. Burns believes the only way to restore the American flag to the seas is to support our shipping by a liberal subsidy, wisely safeguarded.

Mr. Fred L. Eberhardt of Gould & Eberhardt, Newark, N. J., read a short but interesting report on the definition of "machine tools." The difficulty of precisely defining the term in general terms commonly understood is great, if not almost insuperable, but the need of a definition that will be generally accepted by the trade and the governments of the world is conceded by all. On the motion of Mr. Murray Shipley of the Lodge & Shipley Machine Tool Co., the committee was instructed to confer with a committee appointed by the American Society of Mechanical Engineers to define common mechanical terms.

Mr. C. Wood Walter of the Cincinnati Milling Machine Co., Cincinnati, Ohio, chairman of the committee on cancellation of orders reported gratifying progress in securing the cooperation of members and other associations. Eighty-four of the members are now using the standard clause: "All proposals, quotations and acceptances of orders are made with the mutual understanding that orders are not subject to cancellation, provided shipment is made within the time promised," in their contracts, printed matter, etc.

The committee on incorporating the association, of which Mr. Rufus King of the King Machine Tool Co., Cincinnati, Ohio, was chairman, reported against the proposal to incorporate.

The following excellent papers and addresses were presented to an appreciative audience:

"Department Plan of Machine Tool Arrangement on the Basis of Equipment," by F. C. Kent, superintendent of Pierce-Arrow Motor Car Co., Buffalo, N. Y.

"Department Plan of Machine Tool Arrangement on the Basis of Product," by C. B. Auel, assistant works manager, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

"The Principles of Scientific Management," by Fred W. Taylor, past president of the American Society of Mechanical Engineers and general manager of the Tabor Mfg. Co., Philadelphia, Pa.

"The Proper Distribution of Expense Burden," by A. Hamilton Church, certified accountant, Boston, Mass.

"Employer's Liability and Worker's Compensation," by F. C. Schwedtman, chairman, Citizens' Industrial Association of St. Louis, St. Louis, Mo., and James A. Emery, counsel National Association of Manufacturers, Washington, D. C.

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NATIONAL ASSOCIATION OF MANUFACTURERS CONVENTION

The sixteenth annual convention of the National Association of Manufacturers at the Waldorf Astoria, New York City, May 15, 16 and 17, 1911, proved a decided success both in point of view of attendance and quality of matter presented before the association in the form of reports of committees and original papers.

The reports of Messrs. F. C. Schwedtman and James A. Emery were the main feature of the convention, for in these two papers was given the pith of the investigations conducted by these gentlemen during the past year on the European continent as commissioners from this association, analyzing European systems of industrial indemnity insurances. Mr. Schwedtman dealt with the practical side of the question, touching the advisability of the systems investigated, while Mr. Emery, as a lawyer, dealt with the legal phases of the subject and the legality of introducing such a system on the basis of general taxation.

Before outlining the systems operative throughout Europe, more particularly the ones in Germany, the speakers pointed out how the United States is behind other large countries in the matter of considering such a scheme. That public sentiment has been awakened is evidenced by the fact that upward of two hundred workmen's compensation bills have been before different legislatures in this country during the past six months, many of them having been adopted.

In Germany the mutual organization prevails, and every employer is compelled to belong. Power is invested in them to enforce the rules and they are subject to heavy fines should they fail in so doing. The businesslike manner in which the organizations are handled was forcibly brought out when it was mentioned that the average cost of administering these funds in Germany is only 12.8 per cent, while in the United States the injured party only receives on the average from 20 to 30 per cent of that which is due him, the balance being principally eaten up in litigation. As a means of keeping the workmen interested in the system the principle of

workmen's compensation was deemed the better, for by taking the employe into a co-partnership, an increased feeling of responsibility is created in the latter.

A number of committees, appointed by the association in the convention last year, made their various reports on the subjects which they had been commissioned to investigate. These reports—many of them lengthy—contained much information of vital importance to the country in general and to manufacturers in particular. Representative men presented the various addresses on important subjects, among which might be mentioned the paper on "Industrial Education," by Prof. Arthur A. Hammerschlag, director of the Carnegie Technical School.

At the elections on the last afternoon, John Kirby, Jr., was re-elected president of the association.

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BALL-BURNISHING

A smooth surface may be produced on metals in two ways, *viz.*: by reducing the high spots by abrasion, or rubbing them down with a hard substance under pressure. The first-mentioned is the ordinary polishing method, while the second is the burnishing process.

The steel ball burnishing process consists in tumbling the articles together with a comparatively large number of steel balls in a tumbling barrel provided with a proper lubricating solution. For satisfactory results an especially designed barrel and hardened steel balls are required.

The barrel made by the Globe Machine & Stamping Co., Cleveland, Ohio, is made with proper regard for expeditious work. This company's barrel is of large diameter and short length which is advantageous in concentrating a much greater weight of balls on a given surface than would be possible in a long shallow barrel of the same holding capacity. The lubricating material is a mild soap solution and bright clean surfaces are produced, which are satisfactory for plating purposes. Curved and intricate surfaces are easily treated by simply varying the sizes of the balls.

For small articles such as saddlery, cabinet and trunk hardware, pipe fittings, stove parts and stampings, or similar pieces which are used by manufacturers in large quantities, the burnishing process is very successful in producing a hard, smooth and highly polished surface. In addition, this finish is obtained without the removal of any material or without the necessity of the separate handling of each piece that would be required in the polishing process. One man can handle several burnishing barrels, treating hundreds of pieces per day.

* * *

DRILLING INDEX PLATES

At the Owen Machine Tool Co., Springfield, Ohio, a rapid and convenient method is used for drilling the holes in the index plates for milling machine index heads. The holes are drilled in a Brown & Sharpe gear cutter. The index plate is mounted in a vertical position on the gear cutter head spindle, and a special device is placed on the cutter slide for holding and driving the drill. This device consists simply of a pulley for a round belt, placed on a shaft connected by bevel gearing to the drill spindle, which, of course, is horizontal. As all the movements for automatically drilling and indexing the index plate are provided on the gear cutting machine used, it is only necessary to start the machine, which will automatically stop when one series of holes has been drilled. Then the operator simply raises the head for the next circle of holes, provides the gears for proper indexing, and sets the machine going, and so on.

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PERSONALS

A. N. MacFarland has taken charge of the advertising department of the Crocker-Wheeler Co., Ampere, N. J. Mr. MacFarland assumed his duties May 1.

F. G. Brown has resigned the position of tool-room foreman of the Packard Motor Car Co., to become manager with E. J. Kruce & Co., Detroit, Mich., contracting toolmakers and machinists.

Edward F. Croker, ex-chief New York fire department, has taken the chairmanship of the section of the American Museum of Safety, New York, on fires, fire prevention and apparatus.

E. Lichtenberg, draftsman and designer for the Whitman & Barnes Mfg. Co., Chicago, Ill., has resigned to become chief draftsman and mechanical engineer of the Koehring Machine Co., Milwaukee, Wis.

J. W. Bryce, draftsman with the Blickensderfer Mfg. Co., Stamford, Conn., has resigned to take a similar position with the B. L. Co., of Norwich, Conn., manufacturer of ball bearings; he assumed his new duties May 22.

Frederick Hughes, for the past six years chief engineer for the Driggs-Seabury Ordnance Corp., of Sharon, Pa., has joined the engineering staff of the New Departure Mfg. Co., of Bristol, Conn., manufacturer of ball bearings.

Charles W. Cade recently resigned as foundry manager of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., which position he had held for the last eight years. Mr. Cade is at present engaged in consulting work.

O. E. Clark has been promoted from the position of tool designer and draftsman to that of superintendent of the Denver Rock Drill & Machine Co., Denver Col. Mr. Clark succeeds Mr. A. C. Brown, formerly of the Remington Arms Co., Ilion, N. Y.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, Mass., has recently added to his staff, John S. Nicholl, late of the New York Edison Co., and formerly acting manager for F. W. Horne, importer of American machinery, Yokohama, Japan.

Charles L. Gulley has taken the position of manager of the power apparatus and fire alarm installation department in the Toronto office of the Northern Electric & Mfg. Co., Montreal, Can., leaving his position as senior demonstrator in electricity at the University of Toronto for that purpose.

Hardy S. Ferguson, for several years chief engineer of the Great Northern Paper Co., is now established as an independent consulting engineer at 200 Fifth Ave., New York. He will devote himself particularly to engineering work in connection with paper, pulp and fiber mills, including buildings and complete mechanical equipment, etc.

E. G. Eldridge, formerly with the E. L. Essley Machinery Co., Chicago, Ill., has opened a store at 566 Washington Blvd., Chicago, Ill., for the sale of new and second-hand machine tools. Mr. Essley was with the McDowell & Stocker Machine Co. prior to his connection with the E. L. Essley Machinery Co. which dates from the inception of the latter.

Wolcott Remington, well known as a designer and manufacturer of oil engines, has associated himself with the Blanchard Machine Co., Cambridge, Mass. He is now engaged in getting out for them a line of stationary and marine oil engines ranging from 10 to 100 H. P., which will be manufactured under the name of the "Blanchard oil engine."

Gordon C. Keith, for several years managing editor of *Canadian Machinery*, the *Power House* and *Canadian Foundryman*, resigned from the MacLean Publishing Co., May 1, to take a similar position with the *Canadian Manufacturer* as editor of that paper. Mr. Keith's wide experience in responsible positions should prove very valuable to this representative Canadian paper.

Henry R. Cobleigh, for the past seven years mechanical editor of the *Iron Age*, has resigned to take the position of publicity manager for the International Steam Pump Co., 115 Broadway, New York. Mr. Cobleigh was a publicity man prior to his connection with the *Iron Age*, and the experience acquired in the conduct of a first-class mechanical journal has well fitted him for his present responsible place.

W. J. Kaup, who since 1898 has been in charge of the department of machine construction of the Pratt Institute, Brooklyn, N. Y., has resigned to become production engineer with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Kaup is a man of remarkable resource and versatility. He started work, after taking a high school course, as a telegraph messenger, and has been an operator, railroad man, machinist, toolmaker, draftsman, inspector, organizer, lecturer, instructor and consulting engineer. He is a "live wire" and an inspiration to his classes, having the faculty of making men ambitious to succeed. He spent three months last summer making a report on the production methods of the company by which he is now employed.

Frederick A. Halsey, editor-in-chief of the *American Machinist*, resigned the position May 1 on account of ill-health, and was succeeded by Mr. L. P. Alford, who has been the engineering editor for several years. Mr. Halsey is the originator of the premium system of rewarding labor, in use in American and foreign manufacturing plants under that and various other names, the basic principle being a piece-work plan under which the workman is guaranteed his regular day's pay and additional payment for production in

excess of certain specified amounts. He is an ardent opponent of the metric system, and was prominent in the organized opposition to it a few years ago, when a bill was introduced in Congress to substitute that system on government work for the present English system of weights and measures. An outcome of the agitation was the book "The Metric System Fallacy," by Halsey and Dale. Mr. Halsey is also the author of "Worm and Spiral Gearing" and "Locomotive Link Motion."

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OBITUARIES

Alexander E. Brown, president of The Brown Hoisting Machinery Co., Cleveland, Ohio, died April 26.

Ferd. Herold, builder of the first steel hull boat on the Mississippi river, died at his home in St. Louis Mo., May 1, aged eighty-two years.

Edwin S. Stacy head of the Stacy Machine Co., Springfield, Mass., died at his home in that city April 30, aged seventy-two years. Mr. Stacy established the business bearing his name forty-five years ago.

J. W. Kissick, the foundry superintendent of the Columbus Iron Works Co., died at his home in Columbus, May 11, aged sixty-four years. Mr. Kissick had been connected with the Columbus Iron Works Co., as foundry superintendent for twenty-six years, and was well known to foundrymen throughout the country.

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COMING EVENTS

May 30-June 2.—Spring meeting of the American Society of Mechanical Engineers at Pittsburg, Pa., headquarters, Hotel Schenley. Local committee, E. M. Herr, chairman; Elmer K. Niles, secretary; office of local committee, 2511 Oliver Bldg., Pittsburg. The professional sessions will be held in the lecture hall of the Carnegie Institute, near the headquarters, Wednesday morning and evening, and Thursday and Friday mornings. A number of inspection trips to various industrial plants in the vicinity have been planned. Calvin W. Rice, secretary, 29 West 39th St., New York.

June, 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics' and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 15-17—Annual summer meeting of the Society of Automobile Engineers at Dayton, Ohio, headquarters, the Algonquin Hotel. A number of valuable papers will be presented. Coker F. Clarkson, general manager, 1451 Broadway, New York City.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 20-23.—National Gas and Gasoline Engine Trades Association convention, Hotel Pontchartrain, Detroit, Mich. Albert Stritmatter, secretary, Cincinnati, Ohio.

October 9-13.—Annual convention of the American Electric Railway Association at Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Columbus Trade School, Columbus, O., has issued a pamphlet entitled, "Cooperative Industrial Education," which embodies a plan for trade school work in that town.

David Ranken, Jr., School of Mechanical Trades, St. Louis, Mo., has just issued its first annual catalogue describing the general aim, scope of work and other information relative to tuition, etc. The courses are described in detail, and appear to be very thorough in their range.

University of Wisconsin, Madison, Wis. The eleventh annual session of the summer school of engineering, under the direction of the College of Engineering of the University of Wisconsin, opens June 26, continuing for six weeks. Regular and advanced courses are offered in direct and alternating currents, hydraulics, machine design, descriptive geometry, applied mechanics, shop work, steam and gas engineering and surveying. Elementary courses adapted to the requirements of those not having preparation for the advanced work are offered in mechanical drawing, machine design and shop work, in addition to which opportunity is offered for laboratory work in the electrical, steam and gas laboratories for those who have had power plant experience or correspondence instruction. The teaching staff is taken from the regular instructional force, and all laboratory equipment of the engineering college is available for students. For bulletin or further information, address F. E. Turneaure, dean, College of Engineering, Madison, Wis.

NEW BOOKS AND PAMPHLETS

A General Formula for the Shearing Deflection of Beams. By S. E. Slocum. 25 pages, 6 by 9 inches, paper. Illustrated. Published by the J. B. Lippincott Co., Philadelphia, Pa.

This pamphlet, developing a formula for the shearing deflection of beams of arbitrary cross-section, either variable or constant, written by Prof. Slocum of the University of Cincinnati, is a reprint of the original article which appeared in the April issue of the *Journal* of the Franklin Institute. It is a highly mathematical treatment of the subject, and some very interesting deductions are drawn, a general formula being finally deduced. A numerical application of the formula to a planer cross-rail is included.

Monoplanes and Biplanes. By G. C. Loening. 323 pages, 6 by 8 inches. Illustrated. Published by Munn & Co., Inc., 361 Broadway, New York. Price, $2.50.

Aviation, though still in its infancy, seems to have afforded a particularly fine field for writers, judging by the number of books on the subject that have made their appearance. This is doubtless due to the predominant place aviation occupies in the mind of the public. The writer of this book undertook the task with the conviction that a treatise, neither too technical nor too general, is required, and most of the books already published have not met this requirement. This book would appear to be well adapted to meet the wide demand for a practical work, for only such theory is embodied as comes in direct relation to actual aeroplane design. Much of the work involved in the writing of the book was performed for a thesis at Columbia University. The chapters are as follows: Historical Introduction; The Resistance of the Air and the Pressure on Normal Planes; Flat Inclined Planes; The Pressure on Curved Planes; The Frictional Resistance of Air; the Center of Pressure on Flat and Curved Planes; The Effect of Depth of Curvature and Aspect Ratio upon the Lift and Drift of Curved Planes; Numerical Example of the Design of an Aeroplane; Definitions; Important Types of Monoplanes; Prominent Types of Biplanes; Comparison of the Prominent Types; Controlling Apparatus; Accidents; and The Variable Surface Aeroplane. The book is profusely illustrated.

Power. By Charles E. Lucke. 304 pages, 5½ by 7½ inches. Published by The Columbia University Press, Lencke and Buechner, agents, 30-32 W. 27th St., New York. Price, $2.00.

This book by Prof. Lucke, the well-known power-plant engineer, consisting of the Hewitt lectures arranged in book form, is unique. It is not intended to be a text-book explanatory of the operation of the different types of power, but rather, has in view the pointing out of the enormous effect the substitution of mechanical power for hand and animal labor has had on the organization of society and the conditions of living. This is accomplished by the presentation of the development of power machinery to show what sort of ideas have produced this result. Thus, the bulk of the subject matter is concerned with the apparatus and machinery for converting natural energy in any of its available forms into useful work. The theoretical machine of any group is first given, followed by numerous illustrations of large installations of various sources. It is an interesting book, intelligible and instructive to engineer and layman alike. The chapters are as follows: The Relation of Mechanical Power and Machinery to Social Conditions; Means Employed for the Substitution of Power for the Labor of Men; Essential Elements of Steam-Power Systems; Principles of Efficiency in Steam-Power Systems; Processes and Mechanism of the Gas-power System; Adaptation of Fuels for the Use of Internal Combustion Engines; Water-power Systems and Basal Hydraulic Processes; and Social and Economic Consequences of the Substitution of Power for Hand Labor.

The Production of Malleable Castings. By Richard Moldenke. 125 pages, 6 by 9 inches. 35 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $3.00.

It is only at rare intervals that information of unusual value is made the common property of the engineering public through the medium of a text book on the subject; this book happens to be one of those rare instances. It enjoys the unique position of being the first and only book ever issued on the subject, and in it are made known many of the secrets of malleable iron practice. Nothing need be said with regard to the authorship, for Mr. Moldenke is so well known in foundry circles through his untiring zeal for the American Foundrymen's Association that his authority cannot be questioned. That such a book has not appeared before is all the more remarkable when it is considered that the production of malleable iron castings has been more or less known to the trade for many years, though such knowledge of the process did not extend beyond the use of certain brands or grades of pig iron, which, when annealed, would produce serviceable malleable castings. This book represents Mr. Moldenke's life work, and is devoted to clearing up the mysteries of the practice. It was with the hope that the work would serve to stimulate interest in this important industry that such a task was undertaken. The range of the book is best shown by citing the chapters: History, Early Development and Present Importance of the Malleable Iron Industry; Characteristics of Malleable Cast Iron; The Testing of Malleable Cast Iron; The Pattern Shop; Molding Methods in the Malleable Foundry; Melting Process; The Construction and Operation of the Air Furnace; Construction and Operation of the Open-Hearth Furnace; The Use of Gas Producers in Malleable Foundries; Mixing the Charges for Malleable Iron; Casting Malleable Iron; Annealing Malleable Castings; Characteristics of Malleable Fractures; Use of Pyrometer in Annealing Room; and Cost of Malleable Castings.

CATALOGUES AND CIRCULARS

Schuchardt & Schutte, Cedar and West Sts., New York. Leaflet describing indestructible "Elastic-grip" paper file-handles.

C. W. Hunt Co., West New Brighton, N. Y. Catalogue No. 114 describes the line of grab buckets, coal tubs and coal handling machinery, manufactured by this company.

Hess-Bright Mfg. Co., 2020 Fairmount Ave., Philadelphia, Pa. Folders announcing a new grease which this company has put on the market for use in anti-friction bearings.

Bristol Co., Waterbury, Conn. Bulletin 146A, Bristol Long-distance Recording Tachometer; and 147A Bristol Durand Radii Averaging Instrument for Circular Chart Records.

Thos. H. Dallett Co., Philadelphia, Pa. Bulletin No. 203 describes this company's duplex and compound belt-driven air compressors; bulletin No. 204 describes those that are steam-driven.

General Electric Co., Schenectady, N. Y. Bulletin No. 4821, Type F, K-12, Oil Break Switch; No. 4822, GE-98, Railway Motors; and No. 4823, Type F, Form K-10 and K-15, Oil Break Switches.

Joseph Dixon Crucible Co., Jersey City, N. J. Folder illustrating street railway properties painted with Dixon's silica-graphite paint. The folder explains the special adaptability of this paint for street railway uses.

Manville Bros. Co., Waterbury, Conn. Catalogue of foot presses used by manufacturers of brass, steel and tin goods, celluloid work, for covering cloth buttons, securing trimmings to suspender webbing, eyeleting fabrics, etc.

Cushman Chuck Co., Hartford, Conn. The condensed 1911 catalogue and price list of Cushman chucks and faceplate jaws, containing the complete line manufactured by this firm in concise form. The variety shown is quite extensive.

Mesta Machine Co., Pittsburg, Pa. The Mesta horizontal double-acting four-cycle gas engine is the subject of an artistic booklet from this company, which describes the engine in a general way, and illustrates several typical installations.

Mumford Molding Machine Co., Plainfield, N. J., has just issued a loose-leaf catalogue illustrating its line of molding machines for foundry work, including jolt ramming machines, split pattern machines, power squeezers, and pneumatic vibrators.

Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill. Catalogue No. 76 on the "Eclipse" pumper, a vertical gasoline engine with jack suitable for pumping, running machinery, and other work on the farm requiring cheap and easily controlled power.

B. L. Co., Norwich, Conn., has recently issued a catalogue tabulating all the different sizes of B. L. radial bearings as applied to automobiles, this being the automobile edition. It is attractively gotten up and all information is contained in concise form for reference purposes.

KEUFFEL & ESSER Co., Hoboken, N. J. Circular of the Champion continuous blueprinting machine which will blueprint tracings up to 54 inches wide, and of any length. The price of the machine complete with two mercury-vapor lamps is $850.

Q. M. S. Co., Plainfield, N. J., has issued attractive loose-leaf catalogues illustrating its line of metal sawing machines, hand-power traveling cranes, jib cranes, I-beam trolleys, pneumatic hoists, power hack-saws, car-wheel grinding machines, pneumatic pit jacks, etc.

VALLEY CITY MACHINE WORKS, Grand Rapids, Mich. Catalogue of emery grinding and polishing machinery, covering quite a wide range of sizes for different classes of work. But little descriptive matter is included, the main information given being the principal dimensions and other similar data.

THEO. ALTENEDER & SONS, Philadelphia, Pa. The latest catalogue of this company is a 100-page book describing the varied drawing instruments which it manufactures. Practically all instruments and appliances required by draftsmen are here listed and described in comprehensive manner.

CINCINNATI IRON & STEEL Co., Cincinnati, O. Ready reference book of classifications and lists of extra weights of "Cisco" iron and steel products. A wide range of iron and steel products is included in this book, which is one that should prove of especial value to every purchasing department.

BUFFALO FORGE Co., Buffalo, N. Y. Booklet No. 114 describes in detail a new type of strainer which this company is placing on the market for the removal of foreign matter from feed water, water supply, and similar systems. It differs from the usual types on the market, and is very simple in its construction.

DAVIS-BOURNONVILLE Co., 97 West St., New York. The second number of *Autogenous Welding* continues the interesting descriptions commenced in the first issue, showing several applications of autogenous welding to pipe lines as well as other places. Examples of welding heavy castings by this process form a feature of this issue.

FIRTH-STERLING STEEL Co., E. S. JACKMAN & Co., agents, 710-714 Lake St., Chicago, Ill., has recently published a little book on Blue Chip high-speed steel, setting forth the main features, and listing all the sizes, prices, etc., in a very convenient manner. The book is side indexed, being divided into ten divisions. The side-index feature makes it very useful.

EDGAR ALLEN AMERICAN MANGANESE STEEL Co., McCormick Bldg., Chicago, Ill. Pamphlet enumerating the uses of manganese steel castings manufactured by this company at Chicago Heights, Ill., and New Castle, Del. Examples of manganese steel parts used in the construction of many kinds of machinery, including mining, agricultural, dredging, railway, conveying, hoisting, brick machinery, etc., are given.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa. Circular No. 1517 entitled "Railroad Electrification" describes several recent changes from steam to electrification on trunk roads, bearing more especially on the installations made by the company on the Pennsylvania and New York, New Haven & Hartford Railroads. Several foreign installations are also described and illustrated. The book is well gotten up.

EDGAR ALLEN AMERICAN MANGANESE STEEL Co., McCormick Bldg., Chicago, Ill. Pamphlet on manganese steel and its application to the ceramic industries, being a reprint of an address by Mr. G. W. Kneisly of the company before the twenty-fifth annual convention of the National Brick Manufacturers' Association at Louisville, Ky. The uses of manganese steel in brick making, rock crushing, cement machinery, etc., are briefly outlined.

LANDIS TOOL Co., Waynesboro, Pa., has issued an interesting and artistic booklet entitled, "A Trip Through the Plant of the Landis Tool Co.," in which the plant is illustrated and described from beginning to end. A few of the typical machines made by the company are shown in operation. The company has also issued a new booklet on the making and repairing of locomotives, in which the Landis grinder is shown in operation on different parts of the locomotive.

GEUDER, PAESCHKE & FREY Co., Milwaukee, Wis. Circular illustrating and describing a practical guard for punching, stamping, cutting, embossing and drawing presses and similar machines, consisting of a folding gate attached to the ram of the press in front, which protects the workman's hands during the down stroke. The device must be extended clear down to the bed of the press in front before the clutch can be engaged. No alteration of the press is required for this attachment.

AUTOMATIC TRANSPORTATION Co., 2933 Main St., Buffalo, N. Y. Catalogue of electric trucks, designed and constructed for handling package freight at railway and steamship terminals, freight houses, manufacturing plants, wholesale establishments, warehouses, storage plants, etc. The operation of the truck is simple; one charge of electricity will operate it for an entire day or night, at a small cost for power. The truck weighs 1800 pounds and will carry from 2000 to 4000 pounds of freight. The price for standard trucks is $1250; with double frame, $1300.

FRANK MOSSBERG Co., Attleboro, Mass., in its catalogue No. 101 describes the metal shears and spools which it manufactures. A wide variety is shown and described in this book. Other productions are also illustrated and described. There is also a circular of Mossberg double-end wrenches, hardened and tempered and furnished in three finishes, *viz*: semi-finished, finished, and polished nickel. An additional catalogue describes Mossberg socket wrenches as put up in sets in wooden or leather cases and separately to suit individual needs. A special catalogue is devoted to wrenches especially adapted for the use of automobile owners.

WESTMACOTT GAS FURNACE Co., 9 Codding St., Providence, R. I. Catalogue D of appliances using gas as fuel for the heat treatment of metals, comprising forges for treating high-speed and carbon steel for general shop use and special uses. These appliances are made in a variety of forms and sizes, including muffle furnaces for lead and cyanide hardening, chloride of potassium, brass melting, assaying and enamelling, brazing and soldering, etc., all of which are illustrated and described. Valuable data on heat treatment of high-speed steels, of various degrees of heat, etc., make the catalogue of unusual value to practical men.

PRATT & WHITNEY Co., Hartford, Conn., has just issued an extremely fine catalogue descriptive of its grinding machines. It is quite a large book, well printed and arranged in an attractive manner, representing a fine piece of typographical art. The first part of the book describes the different grinding machines made by the company, illustrating them fully with many of their more important attachments. The latter half of the book gives illustrations of the work which these machines will handle, and the pieces shown are remarkably varied in character, indicating the wide possibilities of the grinding machine. It is really a short descriptive treatise on the grinding machine.

TRADE NOTES

HILL-STANDARD MFG. Co., Anderson, Ind., has disposed of its tool department to the Union Caliper Co., Orange, Mass.

SMITH & WESSON, Springfield, Mass., will build a brick mill construction addition to their factory, 47 by 108 feet, which will cost $30,000.

OXY-ACETYLENE APPLIANCE Co., Singer Bldg., 149 Broadway, New York, is in the market for machinery and tools required for the manufacture of its apparatus. Catalogues are requested.

YALE & TOWNE MFG. Co., Stamford, Conn., is erecting a seven-story brass foundry. The plans and specifications are being prepared by Charles T. Main, mill engineer and architect of Boston, Mass.

NILES-BEMENT-POND Co., 111 Broadway, New York, has moved its warehouse from 30-31 West St., to Hudson and Van Dam Sts., New York. The removal affects particularly the large stock of Pratt & Whitney's small tools of all kinds which are sold at retail.

NEW HAVEN MACHINE SCREW Co., New Haven, Conn., manufacturer of screw machine products, which has been in existence four years as a partnership, was incorporated May 2. The officers are J. J. Reidy, president; Pierrepont B. Foster, treasurer; D. F. Reidy, secretary.

FOX TYPEWRITER Co., Grand Rapids, Mich., has for a number of years used a maltese cross with a fox head in the center for a trademark and same was recently registered. The company also uses a peculiar form in writing the word "Fox" and this also has been registered.

SPRAGUE ELECTRIC Co., announces the removal of its Boston office from the Weld Bldg. to 201 Devonshire St. More commodious quarters have been obtained in order that the increased demand for Sprague equipment may be more expeditiously handled throughout the New England territory.

UNIVERSAL VANADIUM Co., Frick Bldg., Pittsburg, Pa., is a corporation recently formed under the laws of the state of Delaware to act as selling agent for the American Vanadium Co. in conjunction with the Vanadium Sales Co. of America. The officers are Edward M. McIlvain, president; Colonel Millard Hunsiker, vice-president; and James C. Gray, secretary and treasurer.

CUMMINGS MACHINE Co., announces its removal to the Bush Terminal Bldg., Brooklyn, N. Y., where it now has enlarged space and increased equipment. The specialty of this company is the development and building of automatic machinery, but, in addition, it does experimental work, precision or model work, toolmaking, hardening, grinding, or anything in the machine shop line.

V. & O. PRESS Co., Glendale, N. Y., announces the establishment of a new Chicago agency where its product will be represented exclusively throughout that territory by Hill, Clarke & Co. Hill, Clarke & Co. will carry a full line of presses in stock and, in addition, will have a fully equipped demonstration shop where V. & O. presses, as well as other machinery, may be seen in operation.

L. S. STARRETT Co., Athol, Mass., is having plans and specifications prepared by Charles T. Main, mill engineer and architect of Boston, Mass., for a new office and graduating building. The construction will consist of outer walls of brick with reinforced concrete columns and steel framing protected by concrete. The main portion of the building will be 122 feet 10 inches long by 89 feet wide.

CRANE VALVE Co., Bridgeport, Conn., has let a contract to W. H. Boardman Co., New York City, for a heavy machine shop with traveling cranes, 50 feet by 353 feet. The Hooper-Faulkenau Engineering Co., 165 Broadway, New York City, acted as consulting engineers. The specifications were drawn and bids submitted and accepted in just two weeks from the day on which the engineers first took the work in hand.

NEW YORK LEATHER BELTING Co., 51 Beekman St., New York, announces that its new plant at Easton, Pa., for the manufacturing of Victor-Balata belting in America was opened for active operations May 1 under the name Victor-Balata & Textile Belting Co. The new company is composed of German and American interests that have been connected in a business way in the Balata belting line for a number of years.

NATIONAL TUBE Co., Pittsburg, Pa., recently took the members of the Pittsburg Railway Club and their friends on a trip which included a tour of the Ellwood City plant where the seamless tubing is made. Some four hundred participated in the excursion, and in the party were many prominent railway officials from various parts of the country. Incidentally, it might be mentioned that this plant is the largest seamless tube mill in the world.

NATIONAL-ACME MFG. Co., Cleveland, Ohio, announces the following changes in its sales department: A. W. Hopkins, purchasing agent and office manager, has been appointed sales manager of the product department; E. C. Woolgar, formerly western sales manager, has been appointed sales manager of the machinery department, with headquarters in Cleveland; and R. J. Preston succeeds E. C. Woolgar as manager of the western office and warehouse in Chicago.

DODGE MFG. Co., Mishawaka, Ind., recently furnished some heavy work for the Pittsburg Glass Co., Ford City, Pa., comprising a rope sheave in four sections, weighing 66,750 pounds, 8 feet diameter, and 16 feet 10 inches width of face. The sheave was mounted on a hollow shaft 24 inches in diameter with a 14-inch hole through its entire length of 28 feet 6 inches. The sheave carries 72 wraps of 2-inch rope, and is designed to transmit 4000 horsepower at 187 revolutions per minute.

FAY & SCOTT, Dexter, Me., manufacturers of engine lathes and patternmaker's lathes are building an addition to their plant which will increase the floor space 11,000 square feet. The building comprises an addition to the planing and milling departments, consisting of a single-story concrete structure, 40 by 50 feet; also a two-story building, concrete construction, 40 by 90 feet, to be used largely for storeroom and stock-room. The plans and contracts have been made and the work is in progress. No new machine equipment will be required.

NATIONAL-ACME MFG. Co., Cleveland, Ohio, announces that the suit brought by it against the Universal Machine Screw Co., Hartford, Conn., has been settled out of court on the payment of royalties for past infringement and the expenses of the action, by the defendant. A non-exclusive license has been issued by the Universal Machine Screw Co., under which it may continue to build, use and sell multiple-spindle screw machines embodying the subject matter of the letters patent which have been infringed, in consideration of payment to the National-Acme Mfg. Co. of a royalty on all machines so built.

NEW BRITAIN MACHINE Co., New Britain, Conn., manufacturer of a line of wood-working machinery, grinding machinery and shop furniture, has bought the business of George G. Prentice & Co., New Haven, Conn., manufacturers of multiple-spindle automatic turret machines. Mr. Prentice, who for the past ten years has devoted himself to the manufacture and development of the lathe, retires from business on account of ill health. The New Britain Machine Co. will move the Prentice plant to New Britain, and will immediately erect an addition, 56 by 150 feet, making a main machine shop and floor served by a traveling crane 400 feet long.

NATIONAL BRAKE & CLUTCH Co., 16 State St., Boston, Mass., has changed its firm name to the Cork Insert Co. The company which was originally interested in the manufacture and use in automobiles and street cars of cork insert clutches and brakes, has so broadened the scope of its business among almost every class of power user, by the introduction of cork inserts in many types of pulleys, clutches, brakes, frictions, tensions, etc., that it has been deemed expedient to change the name of the corporation to one more indicative of the business as at present conducted.

SECTION MODULUS AND MOMENT OF INERTIA FOR ROUND SHAFTS—I

Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$	Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$	Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$
1.00	0.09817	0.04909	1.50	0.33130	0.24850	2.00	0.78540	0.78540
1.01	0.10115	0.05108	1.51	0.33801	0.25520	2.01	0.79724	0.80122
1.02	0.10418	0.05313	1.52	0.34477	0.26202	2.02	0.80920	0.81729
1.03	0.10728	0.05525	1.53	0.35162	0.26899	2.03	0.82127	0.83359
1.04	0.11043	0.05742	1.54	0.35856	0.27609	2.04	0.83347	0.85014
1.05	0.11365	0.05967	1.55	0.36559	0.28333	2.05	0.84579	0.86693
1.06	0.11693	0.06197	1.56	0.37271	0.29071	2.06	0.85232	0.88397
1.07	0.12027	0.06434	1.57	0.37993	0.29824	2.07	0.87079	0.90126
1.08	0.12367	0.06679	1.58	0.38723	0.30591	2.08	0.88316	0.91880
1.09	0.12714	0.06929	1.59	0.39463	0.31373	2.09	0.89627	0.93660
1.10	0.13070	0.07187	1.60	0.40210	0.32170	2.10	0.90920	0.95470
1.11	0.13423	0.07452	1.61	0.40971	0.32982	2.11	0.92224	0.97298
1.12	0.13793	0.07724	1.62	0.41739	0.33809	2.12	0.93542	0.99155
1.13	0.14166	0.08004	1.63	0.42517	0.34654	2.13	0.95091	1.01039
1.14	0.14545	0.08291	1.64	0.43305	0.35509	2.14	0.96215	1.02950
1.15	0.14931	0.08605	1.65	0.44101	0.36383	2.15	0.97570	1.04887
1.16	0.15324	0.08888	1.66	0.44908	0.37274	2.16	0.98940	1.06852
1.17	0.15724	0.09198	1.67	0.45724	0.38180	2.17	1.00318	1.08840
1.18	0.16130	0.09517	1.68	0.46551	0.39103	2.18	1.01711	1.10860
1.19	0.16541	0.09844	1.69	0.47387	0.40042	2.19	1.03117	1.12910
1.20	0.16960	0.10180	1.70	0.48230	0.41000	2.20	1.04500	1.14990
1.21	0.17392	0.10522	1.71	0.49089	0.41972	2.21	1.05968	1.17090
1.22	0.17827	0.10874	1.72	0.49956	0.42962	2.22	1.07414	1.19230
1.23	0.18269	0.11235	1.73	0.50832	0.43970	2.23	1.08870	1.21390
1.24	0.18718	0.11605	1.74	0.51719	0.44995	2.24	1.10340	1.23580
1.25	0.19175	0.11984	1.75	0.52616	0.46039	2.25	1.11830	1.25800
1.26	0.19638	0.12372	1.76	0.53522	0.47100	2.26	1.13320	1.28060
1.27	0.20110	0.12770	1.77	0.54140	0.48180	2.27	1.14830	1.30340
1.28	0.20589	0.13177	1.78	0.55368	0.49278	2.28	1.16360	1.32650
1.29	0.21075	0.13593	1.79	0.56306	0.50394	2.29	1.17900	1.34990
1.30	0.21570	0.14020	1.80	0.57260	0.51530	2.30	1.19400	1.37370
1.31	0.22070	0.14456	1.81	0.58215	0.52685	2.31	1.21010	1.39770
1.32	0.22580	0.14902	1.82	0.59185	0.53859	2.32	1.22590	1.42340
1.33	0.23097	0.15359	1.83	0.60166	0.55052	2.33	1.24180	1.44680
1.34	0.23622	0.15826	1.84	0.61158	0.56265	2.34	1.25790	1.47180
1.35	0.24155	0.16301	1.85	0.62161	0.57498	2.35	1.27410	1.49710
1.36	0.24695	0.16793	1.86	0.63177	0.58752	2.36	1.29040	1.52270
1.37	0.25244	0.17292	1.87	0.64198	0.60026	2.37	1.30720	1.54870
1.38	0.25801	0.17803	1.88	0.65249	0.61320	2.38	1.32350	1.57500
1.39	0.26366	0.18324	1.89	0.66280	0.62635	2.39	1.34030	1.60160
1.40	0.26940	0.18860	1.90	0.67340	0.63970	2.40	1.35700	1.62860
1.41	0.27520	0.19402	1.91	0.68407	0.65329	2.41	1.37420	1.65590
1.42	0.28110	0.19958	1.92	0.69487	0.66707	2.42	1.39140	1.68360
1.43	0.28708	0.20526	1.93	0.70578	0.68108	2.43	1.40870	1.71160
1.44	0.29315	0.21107	1.94	0.71681	0.69530	2.44	1.42620	1.73990
1.45	0.29930	0.21700	1.95	0.72795	0.70975	2.45	1.44380	1.76860
1.46	0.30553	0.22301	1.96	0.73920	0.72443	2.46	1.46150	1.79770
1.47	0.31185	0.22921	1.97	0.75058	0.73933	2.47	1.47940	1.82710
1.48	0.31826	0.23552	1.98	0.76207	0.75445	2.48	1.49750	1.85260
1.49	0.32475	0.24194	1.99	0.77367	0.76981	2.49	1.51560	1.88700

Contributed by W. H. Herschel

SECTION MODULUS AND MOMENT OF INERTIA FOR ROUND SHAFTS—II

Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$	Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$	Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$	Diameter d	Section Modulus $\frac{I}{c}=\frac{\pi d^3}{32}$	Moment of Inertia $I=\frac{\pi d^4}{64}$
2.50	1.5340	1.9175	3.00	2.6510	3.9761	3.50	4.2090	7.3662	4.00	6.2830	12.566
2.51	1.5489	1.9483	3.01	2.6773	4.0293	3.51	4.2455	7.4507	4.01	6.3304	12.692
2.52	1.5711	1.9796	3.02	2.7041	4.0831	3.52	4.2818	7.5360	4.02	6.3779	12.820
2.53	1.5899	2.0112	3.03	2.7310	4.1375	3.53	4.3184	7.6220	4.03	6.4256	12.948
2.54	1.6088	2.0431	3.04	2.7581	4.1924	3.54	4.3552	7.7087	4.04	6.4736	13.077
2.55	1.6279	2.0755	3.05	2.7855	4.2478	3.55	4.3922	7.7962	4.05	6.5217	13.207
2.56	1.6471	2.1083	3.06	2.8130	4.3038	3.56	4.4294	7.8845	4.06	6.5701	13.337
2.57	1.6665	2.1414	3.07	2.8406	4.3604	3.57	4.4669	7.9734	4.07	6.6188	13.469
2.58	1.6860	2.1749	3.08	2.8685	4.4175	3.58	4.5045	8.0631	4.08	6.6677	13.602
2.59	1.7057	2.2088	3.09	2.8965	4.4751	3.59	4.5423	8.1536	4.09	6.7169	13.736
2.60	1.7260	2.2432	3.10	2.9250	4.5333	3.60	4.5800	8.2448	4.10	6.7660	13.871
2.61	1.7455	2.2779	3.11	2.9531	4.5921	3.61	4.6187	8.3367	4.11	6.8159	14.007
2.62	1.7656	2.3130	3.12	2.9817	4.6514	3.62	4.6572	8.4296	4.12	6.8657	14.143
2.63	1.7859	2.3485	3.13	3.0104	4.7113	3.63	4.6959	8.5231	4.13	6.9164	14.281
2.64	1.8064	2.3844	3.14	3.0394	4.7718	3.64	4.7347	8.6174	4.14	6.9663	14.420
2.65	1.8270	2.4208	3.15	3.0685	4.8330	3.65	4.7739	8.7125	4.15	7.0169	14.560
2.66	1.8478	2.4575	3.16	3.0978	4.8946	3.66	4.8133	8.8084	4.16	7.0677	14.701
2.67	1.8686	2.4917	3.17	3.1274	4.9568	3.67	4.8529	8.9050	4.17	7.1188	14.843
2.68	1.8897	2.5322	3.18	3.1570	5.0197	3.68	4.8926	9.0025	4.18	7.1702	14.985
2.69	1.9110	2.5702	3.19	3.1869	5.0832	3.69	4.9325	9.1007	4.19	7.2217	15.129
2.70	1.9320	2.6087	3.20	3.2170	5.1472	3.70	4.9730	9.1998	4.20	7.2740	15.274
2.71	1.9539	2.6476	3.21	3.2472	5.2119	3.71	5.0133	9.2996	4.21	7.3256	15.420
2.72	1.9756	2.6868	3.22	3.2777	5.2771	3.72	5.0540	9.4003	4.22	7.3779	15.568
2.73	1.9975	2.7266	3.23	3.3083	5.3430	3.73	5.0948	9.5018	4.23	7.4305	15.715
2.74	2.0195	2.7668	3.24	3.3391	5.4094	3.74	5.1359	9.6041	4.24	7.4833	15.865
2.75	2.0417	2.8074	3.25	3.3701	5.4765	3.75	5.1771	9.7072	4.25	7.5364	16.015
2.76	2.0641	2.8484	3.26	3.4014	5.5442	3.76	5.2187	9.8112	4.26	7.5898	16.166
2.77	2.0866	2.8899	3.27	3.4328	5.6126	3.77	5.2605	9.9160	4.27	7.6433	16.319
2.78	2.1093	2.9319	3.28	3.4644	5.6815	3.78	5.3024	10.0216	4.28	7.6972	16.472
2.79	2.1321	2.9743	3.29	3.4961	5.7511	3.79	5.3407	10.1281	4.29	7.7513	16.626
2.80	2.1550	3.0172	3.30	3.5280	5.8214	3.80	5.3870	10.2350	4.30	7.8060	16.782
2.81	2.1783	3.0605	3.31	3.5603	5.8923	3.81	5.4297	10.3436	4.31	7.8602	16.938
2.82	2.2016	3.1043	3.32	3.5926	5.9638	3.82	5.4726	10.4526	4.32	7.9149	17.096
2.83	2.2251	3.1486	3.33	3.6252	6.0359	3.83	5.5156	10.5624	4.33	7.9701	17.255
2.84	2.2488	3.1933	3.34	3.6580	6.1088	3.84	5.5590	10.6186	4.34	8.0294	17.415
2.85	2.2727	3.2385	3.35	3.6909	6.1823	3.85	5.6025	10.7848	4.35	8.0810	17.576
2.86	2.2966	3.2842	3.36	3.7241	6.2564	3.86	5.6462	10.8970	4.36	8.1369	17.738
2.87	2.3208	3.3304	3.37	3.7575	6.3312	3.87	5.6903	11.0110	4.37	8.1920	17.902
2.88	2.3452	3.3771	3.38	3.7909	6.4067	3.88	5.7345	11.1250	4.38	8.2491	18.066
2.89	2.3697	3.4242	3.39	3.8246	6.4829	3.89	5.7789	11.2400	4.39	8.3060	18.231
2.90	2.3940	3.4719	3.40	3.8590	6.5597	3.90	5.8240	11.3560	4.40	8.3630	18.398
2.91	2.4192	3.5200	3.41	3.8928	6.6372	3.91	5.8685	11.4730	4.41	8.4200	18.566
2.92	2.4442	3.5686	3.42	3.9272	6.7154	3.92	5.9137	11.5910	4.42	8.4775	18.735
2.93	2.4695	3.6178	3.43	3.9617	6.7943	3.93	5.9590	11.7100	4.43	8.5351	18.905
2.94	2.4949	3.6674	3.44	3.9965	6.8739	3.94	6.0046	11.8290	4.44	8.5930	19.077
2.95	2.5204	3.7175	3.45	4.0314	6.9542	3.95	6.0505	11.9500	4.45	8.6513	19.249
2.96	2.5461	3.7682	3.46	4.0666	7.0352	3.96	6.0966	12.0690	4.46	8.7097	19.423
2.97	2.5720	3.8191	3.47	4.1019	7.1168	3.97	6.1429	12.1930	4.47	8.7685	19.598
2.98	2.5981	3.8711	3.48	4.1375	7.1976	3.98	6.1894	12.3170	4.48	8.8274	19.773
2.99	2.6243	3.9233	3.49	4.1732	7.2824	3.99	6.2361	12.4410	4.49	8.8867	19.950

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SECTION MODULUS AND MOMENT OF INERTIA FOR ROUND SHAFTS—III

Diameter	Section Modulus	Moment of Inertia	Diameter	Section Modulus	Moment of Inertia	Diameter	Section Modulus	Moment of Inertia
d	$\frac{I}{c}=\frac{\pi d^3}{32}$	$I=\frac{\pi d^4}{64}$	d	$\frac{I}{c}=\frac{\pi d^3}{32}$	$I=\frac{\pi d^4}{64}$	d	$\frac{I}{c}=\frac{\pi d^3}{32}$	$I=\frac{\pi d^4}{64}$
4.50	8.9460	20.129	5.00	12.272	30.680	5.50	16.334	44.918
4.51	9.0060	20.308	5.01	12.345	30.926	5.55	16.783	46.574
4.52	9.0660	20.489	5.02	12.420	31.173	5.60	17.241	48.275
4.53	9.1263	20.671	5.03	12.493	31.423	5.65	17.707	50.022
4.54	9.1869	20.854	5.04	12.568	31.673	5.70	18.181	51.817
4.55	9.2477	20.990	5.05	12.644	31.925	5.75	18.664	53.659
4.56	9.3088	21.224	5.06	12.718	32.179	5.80	19.155	55.550
4.57	9.3702	21.411	5.07	12.791	32.434	5.85	19.654	57.490
4.58	9.4318	21.599	5.08	12.870	32.691	5.90	20.163	59.481
4.59	9.4937	21.788	5.09	12.916	32.949	5.95	20.680	61.523
4.60	9.5560	21.979	5.10	13.023	33.209	6.00	21.206	63.617
4.61	9.6184	22.170	5.11	13.099	33.470	6.10	22.284	67.965
4.62	9.6811	22.363	5.12	13.177	33.733	6.20	23.398	72.533
4.63	9.7441	22.557	5.13	13.254	33.997	6.30	24.548	77.327
4.64	9.8074	22.753	5.14	13.332	34.263	6.40	25.736	82.355
4.65	9.8709	22.950	5.15	13.410	34.530	6.50	26.961	87.624
4.66	9.9318	23.148	5.16	13.488	34.799	6.60	28.225	93.142
4.67	9.9989	23.347	5.17	13.567	35.070	6.70	29.527	98.917
4.68	10.0632	23.548	5.18	13.645	35.342	6.80	30.869	104.956
4.69	10.1279	23.750	5.19	13.725	35.615	6.90	32.251	111.266
4.70	10.1930	23.953	5.20	13.804	35.891	7.00	33.674	117.859
4.71	10.2580	24.157	5.21	13.884	36.168	7.10	35.138	124.739
4.72	10.3235	24.363	5.22	13.964	36.446	7.20	36.644	131.917
4.73	10.3892	24.570	5.23	14.015	36.726	7.30	38.192	139.399
4.74	10.4552	24.779	5.24	14.125	37.008	7.40	39.783	147.196
4.75	10.5216	24.989	5.25	14.206	37.291	7.50	41.417	155.316
4.76	10.5881	25.200	5.26	14.287	37.576	7.60	43.096	163.766
4.77	10.6549	25.412	5.27	14.369	37.863	7.70	44.820	172.557
4.78	10.7226	25.626	5.28	14.451	38.151	7.80	46.589	181.697
4.79	10.7894	25.841	5.29	14.534	38.440	7.90	48.404	191.197
4.80	10.8570	26.058	5.30	14.616	38.732	8.00	50.265	201.062
4.81	10.9250	26.275	5.31	14.699	39.025	8.10	52.174	211.305
4.82	10.9940	26.495	5.32	14.782	39.320	8.20	54.130	221.935
4.83	11.0620	26.715	5.33	14.866	39.617	8.30	56.135	232.960
4.84	11.1310	26.937	5.34	14.949	39.915	8.40	58.189	241.392
4.85	11.1990	27.160	5.35	15.034	40.215	8.50	60.292	256.239
4.86	11.2690	27.385	5.36	15.118	40.516	8.60	62.445	268.512
4.87	11.3390	27.611	5.37	15.202	40.819	8.70	64.618	281.220
4.88	11.4090	27.839	5.38	15.288	41.124	8.80	66.903	294.375
4.89	11.4790	28.067	5.39	15.373	41.526	8.90	69.210	307.985
4.90	11.5500	28.298	5.40	15.459	41.739	9.00	71.569	322.062
4.91	11.6210	28.530	5.41	15.545	42.019	9.10	73.982	336.616
4.92	11.6920	28.763	5.42	15.633	42.361	9.20	76.448	351.659
4.93	11.7630	28.997	5.43	15.718	42.674	9.30	78.968	367.190
4.94	11.8350	29.233	5.44	15.805	42.990	9.40	81.542	383.249
4.95	11.9070	29.471	5.45	15.893	43.307	9.50	84.173	399.820
4.96	11.9790	29.710	5.46	15.980	43.626	9.60	86.859	416.922
4.97	12.0520	29.950	5.47	16.068	43.946	9.70	89.601	431.567
4.98	12.1240	30.192	5.48	16.157	44.268	9.80	92.401	452.766
4.99	12.1980	30.435	5.49	16.245	44.572	9.90	95.259	471.531

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TABLE FOR CALCULATING CENTRIFUGAL FORCE

The common formula for centrifugal force is $F = 0.000341\,W R n^2$, in which F = centrifugal force, in pounds; W = weight of revolving mass in pounds; R = mean radius of revolving mass in feet; and n = revolutions per minute. By making C = centrifugal force of one pound one inch from axis, we get $C = 0.000028416\,n^2$, which constant has been calculated and tabulated below. Then $F = W r C$; r is in inches in this formula, and C is found in the table.

n	C	n	C	n	C	n	C	n	C
50.0	0.07104	75	0.15984	125	0.44400	175	0.87024	255.0	1.8478
50.5	0.07247	76	0.16413	126	0.45113	176	0.88021	257.5	1.8841
51.0	0.07391	77	0.16848	127	0.45832	177	0.89024	260.0	1.9209
51.5	0.07537	78	0.17288	128	0.46557	178	0.90033	262.5	1.9580
52.0	0.07684	79	0.17734	129	0.47287	179	0.91047	265.0	1.9955
52.5	0.07832	80	0.18186	130	0.48023	180	0.92067	267.5	2.0333
53.0	0.07982	81	0.18644	131	0.48765	181	0.93093	270.0	2.0715
53.5	0.08133	82	0.19107	132	0.49512	182	0.94124	272.5	2.1101
54.0	0.08286	83	0.19576	133	0.50265	183	0.95162	275.0	2.1490
54.5	0.08440	84	0.20050	134	0.51023	184	0.96204	277.5	2.1882
55.0	0.08596	85	0.20530	135	0.51788	185	0.97253	280.0	2.2278
55.5	0.08753	86	0.21016	136	0.52558	186	0.98307	282.5	2.2678
56.0	0.08911	87	0.21508	137	0.53334	187	0.99367	285.0	2.3081
56.5	0.09071	88	0.22005	138	0.54115	188	1.00433	287.5	2.3488
57.0	0.09232	89	0.22508	139	0.54902	189	1.01504	290.0	2.3898
57.5	0.09395	90	0.23017	140	0.55695	190	1.02590	292.5	2.4312
58.0	0.09559	91	0.23531	141	0.56493	191	1.03664	295.0	2.4729
58.5	0.09725	92	0.24051	142	0.57298	192	1.04752	297.5	2.5150
59.0	0.09892	93	0.24577	143	0.58108	193	1.05846	300.0	2.5574
59.5	0.10060	94	0.25108	144	0.58923	194	1.06946	305.0	2.6434
60.0	0.10230	95	0.25645	145	0.59744	195	1.0805	310.0	2.7308
60.5	0.10401	96	0.26188	146	0.60571	196	1.0916	315.0	2.8196
61.0	0.10573	97	0.26737	147	0.61404	197	1.1028	320.0	2.9098
61.5	0.10748	98	0.27291	148	0.62242	198	1.1140	325.0	3.0014
62.0	0.10923	99	0.27851	149	0.63086	199	1.1253	330.0	3.0945
62.5	0.11100	100	0.28416	150	0.63936	200	1.1367	335.0	3.1890
63.0	0.11278	101	0.28987	151	0.64791	202	1.1595	340.0	3.2849
63.5	0.11458	102	0.29564	152	0.65652	204	1.1826	345.0	3.3822
64.0	0.11639	103	0.30147	153	0.66519	206	1.2059	350.0	3.4809
64.5	0.11822	104	0.30735	154	0.67391	208	1.2294	355.0	3.5811
65.0	0.12006	105	0.31328	155	0.68269	210	1.2531	360.0	3.6823
65.5	0.12192	106	0.31928	156	0.69169	212	1.2771	365.0	3.7857
66.0	0.12378	107	0.32533	157	0.70042	214	1.3013	370.0	3.8901
66.5	0.12566	108	0.33144	158	0.70928	216	1.3258	375.0	3.9960
67.0	0.12756	109	0.33761	159	0.71838	218	1.3505	380.0	4.1032
67.5	0.12947	110	0.34383	160	0.72745	220	1.3753	390.0	4.3220
68.0	0.13140	111	0.35011	161	0.73657	222	1.4005	400.0	4.5466
68.5	0.13334	112	0.35645	162	0.74575	224	1.4258	410.0	4.7767
69.0	0.13529	113	0.36284	163	0.75498	226	1.4514	420.0	5.0126
69.5	0.13726	114	0.36929	164	0.76427	228	1.4772	430.0	5.2541
70.0	0.13924	115	0.37580	165	0.77362	230.0	1.5032	440.0	5.5013
70.5	0.14124	116	0.38236	166	0.78306	232.5	1.5361	450.0	5.7542
71.0	0.14325	117	0.38899	167	0.79249	235.0	1.5693	460.0	6.0128
71.5	0.14527	118	0.39566	168	0.80201	237.5	1.6029	470.0	6.2770
72.0	0.14731	119	0.40240	169	0.81159	240.0	1.6358	480.0	6.5470
72.5	0.14936	120	0.40921	170	0.82122	242.5	1.6710	490.0	6.8227
73.0	0.15143	121	0.41604	171	0.83091	245.0	1.7057	.....	......
73.5	0.15351	122	0.42294	172	0.84065	247.5	1.7407	.....	......
74.0	0.15561	123	0.42991	173	0.85046	250.0	1.7760	.....	......
74.5	0.15772	124	0.43692	174	0.86032	252.5	1.8117	.....	......

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MACHINERY

July, 1911

DROP-FORGE DIE-SINKING*—1

By CHESTER L. LUCAS† and J. WILLIAM JOHNSON‡

THE art of drop forging has worked a great change in the product of the blacksmith shop, both in regard to the quality and the quantity of the work produced. It has created a new branch of the business, and has enabled forgings to be employed in thousands of cases where this had formerly been impossible on account of the expense. Drop forgings are made today for nearly every brauch of metal manufacturing, although the automobile industry has given rise to a much greater demand for drop forgings than has any one other industry. Drop forgings are made that weigh but a fraction of an ounce, and others that weigh a hundred pounds or over. They are made from iron, steel, copper and bronze. It is needless to speak of the advantages of the operation of drop forging; economy of manufacture, strength, interchangeability, and the general appearance of the product, are all important factors.

The object of this article is not, however, to deal with the drop forging operation itself, but to treat of the dies for this interesting work, and to consider some of the methods

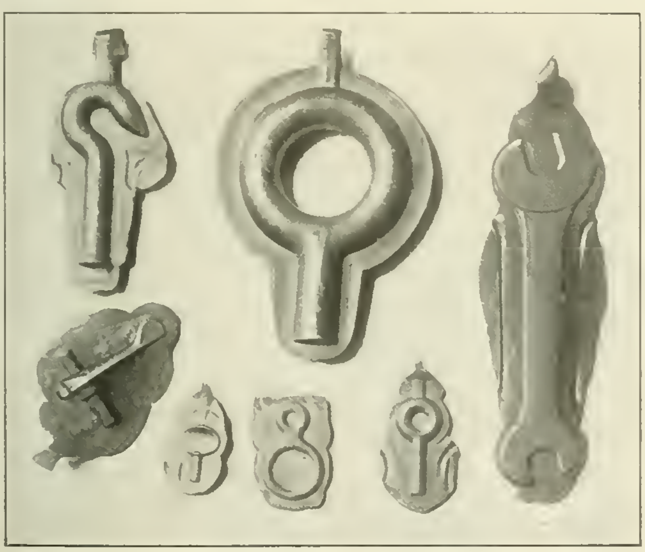

Fig. 1. A Group of Untrimmed Forgings

and tools used in the die-sinking. The good die-sinker must be somewhat of a composite mechanic: he must have the knowledge of machine work of the machinist; the skill of the ornamental die-sinker, for sinking the irregular impressions; and a knowledge of steel working so as to know just how the hot steel will flow under the dies. The majority of the drop-forge die-sinkers of today have emanated from the ranks of the machinists and tool-makers, but the die-sinkers of tomorrow will be specialists whose thorough training has been acquired entirely in this one important class of work.

Classes of Drop-forging Dies

Drop-forging dies, like dies for the punch-press, are of several different types. Perhaps the most simple form of drop-forging die would be a pair of dies for producing a simple round forging, as, for instance, a gear blank. These dies would require a central impression turned in each of the dies of the pair. Before using the dies, a square plate of steel is worked under the hammer, drawing out a short shank at the side, and "knocking down" the corners. This roughly shaped block of steel is held by the shank and placed between the dies and thus brought to shape.

The most common form of drop-forging die, however, is

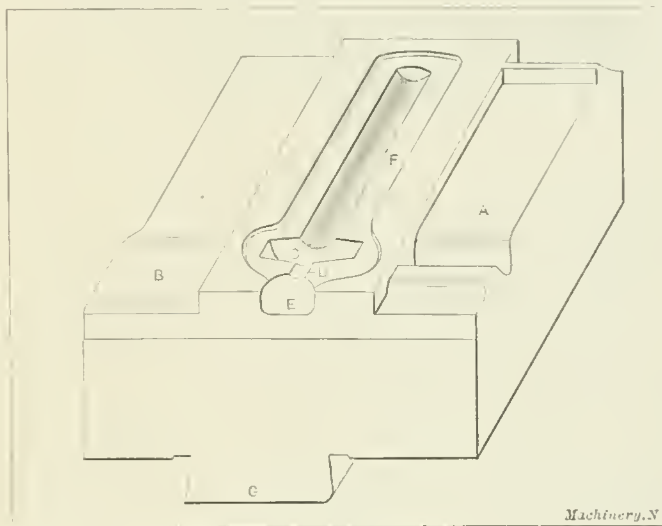

Fig. 2. The Lower Die of a Pair of Drop-forging Dies

the one in which there is a central impression to shape the forging, and a side impression, called the "edger," "break-down" or "side-cut," that helps to properly distribute the hot steel. To make the use of these two sets of impressions clear, a drop-forging die of this description may be likened to a

Fig. 3. A Number of Small Finished Drop Forgings

drawing of the finished forging, in which the outline of the central impression would resemble the plan view of the forging, and the two halves of the edger would correspond to the side elevation of the forging. Of course this illustration is not literally correct, but it expresses the general idea. The edger is always on the right-hand side of the die, and the steel bar is struck first in the break-down, edgewise, and then turned and struck flat in the impression, alternating in this manner until the forging is "full."

There are also dies that in addition to the central impres-

* The following articles, dealing with this and kindred subjects, have previously been published in MACHINERY: September, 1908, "Drop Forge Work in an Automobile Shop"; May, 1908, "Drop and Stamped Forgings"; April, 1907, engineering edition, "The Drop Forge and Hardening Plant"; January, 1905, "Making Drop Forging Dies." See also MACHINERY'S Reference Series No. 45, "Drop Forging."

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J. William Johnson was born in Lawrence, Mass., 1876. He served an apprenticeship with Davis & Furber Machine Co., Andover, Mass., and has worked for S. B. Bailey, Lawrence Machine Co., United Shoe Machinery Co., Revere Drop Forging Co., and the General Electric Co. He has held the positions of assistant foreman and foreman. His specialty is die-sinking.

sion and the edger are made with an anvil or "fuller," as it is sometimes termed. The anvil is formed in the dies at the left-hand side, and is used to draw out the stock previous to striking it in the edger or in the impression itself. Dies with anvils are necessary in making forgings in which there is a considerable displacement of the stock. As an example may be mentioned a double-ended wrench, which is thin in some places and very much thicker and wider in other places. The anvil consists of two flat-faced parts of the die, whose faces, called "fullers," come just near enough together to flatten the stock to such dimensions that when finished in the central impression very little stock will be left to be squeezed out as the fin. After the stock has been thus drawn out to roughly fit the impression, the forging is shaped in the usual way by means of the edger and the die impressions. A considerable number of large drop-forging dies require anvils. In making the dies for difficult forgings, there are often other special features incorporated in the dies, which will be more fully described later.

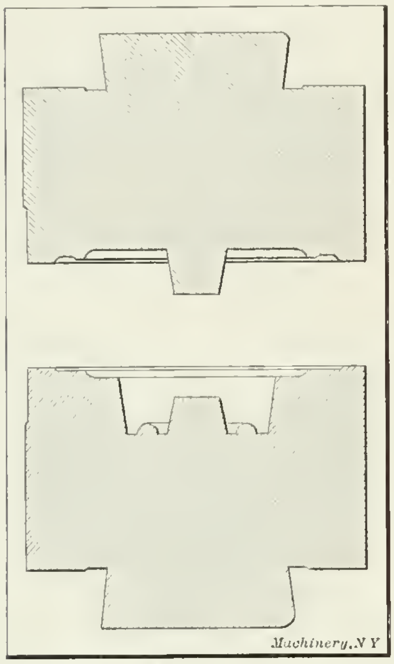

Fig. 4. Drop-forging Dies of a Type that should be made of a High-carbon Steel and not hardened

Fig. 2 shows the lower half of a set of dies with a breakdown *A*, an anvil *B*, and the die impression *C*. The sprue is shown at *D*, the gate at *E*, the flash at *F*, and the shank at *G*. In Fig. 1 are shown several completed forgings before being trimmed. The center of the eye-bolt is the only part that has been trimmed. The excess metal around the forging is called the "fin" and is removed in a separate operation, which may be done either hot or cold. If the forgings are to be cold-trimmed, as is the case with most small forgings, the dies are made with a cut-off to sever the forging from the bar when finished. If the forgings are to be hot-trimmed, they are severed in the trimming press, and the forging dies

Fig. 5. Laying out the Dies: Transferring a Line from One Die to the Other of a Pair

will need no cut-off. Fig. 3 shows a group of small finished forgings.

Thus far we have considered only dies with one impression, but in dies for first-class forgings, especially when there is a large number to be made, two impressions are provided, the forming and the finishing. The forging is nearly completed by the edger and the forming impression (and anvil if needed), and finally struck several blows in the finishing impression to bring it up to size and finish it. Thus the finishing impression is saved the severe duty of completely forming the forging, and hence the dies last longer. On small and medium-sized forgings these two impressions are placed side by side in the same die, but if the forging is large, the finishing impression is made in a separate set of die-blocks and set up in a hammer beside the dies that form the forging. The forger uses both hammers to get out the work in such cases. It is seldom that more than two impressions are cut in the same set of dies, but if the piece is small and the number of pieces to be forged great, it is often advisable to make the set of dies with two or more finishing impressions in addition to the forming impression. If this is done, the die has a longer life, for after one of the finishing impressions gives out by spreading or "checking," there is still a good finishing impression left.

In addition to these different styles of drop-forging dies, the dies for trimming the fin from the forging must be taken into consideration. As already indicated, trimming dies are of two classes: those for trimming the forging while it is hot, and those for trimming the forging after it is cold. The making of drop-forging dies for forgings of other metals than steel or iron involves the use of special methods. This phase of the subject will be treated later in this series of articles.

Information Required by the Die-sinker

Before the die-sinker begins making the die, he should be given certain information about the job he is to do, in order to make a set of dies that will give satisfactory results. As a general rule, he is furnished with either a drawing or a model of the finished part, or, what is most satisfactory of

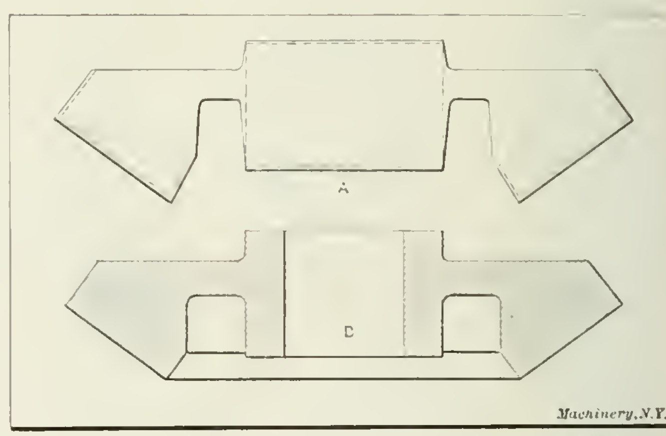

Fig 6. Templet with Shrinkage, Draft and Finish Allowances added, used in turning out the Impression in a Die for a Bevel Gear Blank. B shows the Finished Gear Forging after being machined

all, with a sample forging. He must know what finishing operations the forging is to pass through, so as to allow enough stock for machining, and he must know of what metal the piece is to be made, so as to cut the dies large enough to allow for the shrinkage of the metal.

With this information supplied, he must decide upon some other points that are largely a matter of judgment on his part—points that have to do with the successful working of the dies. He must decide, first, whether to make the set of dies with a forming impression in addition to the finishing impression; second, the way in which to "face" the impression on the die-block, so as to be able to use the best form of edger; third, whether to include an anvil in the dies; and fourth, the type of hammer or hammers the dies will be used in, so that the dies are made in blocks of the proper size. In making the trimming dies, he must also decide whether to trim the forging hot or cold. With these points decided, he is prepared to start the making of the dies.

Steel for Drop-forging Dies

Open-hearth crucible steel is the material from which nine-tenths of all drop-forging dies are made; a 60-point carbon steel is used for most of the dies. In some cases, however, steel as low as 40-point carbon and as high as 85-point carbon is used, but few shops use anything but 60-point carbon steel for the general run of work. If a low-carbon steel is used, a special hardening treatment is required, which outweighs

any saving in the price of the steel. Of course, the high-carbon steels make good dies, but except in special cases, there is no necessity for using so high-priced a steel. The average 60-point carbon steel die, if properly hardened, should last for from 15,000 to 40,000 forgings, and sometimes as many as 70,000 forgings are made from one set of dies.

In making dies for large forgings, it is often considered advisable to use 80-point carbon steel for the dies, and not to harden them. This obviates the danger from "checking" or cracking in hardening, and the steel, unhardened, is hard enough to resist the tendency to stretch. In Fig. 4 is shown, in cross-section, a pair of drop-forging dies for forging automobile hubs. Dies of this design should be made of high-carbon steel and left soft, on account of the projecting ring in the bottom of the impression which would be very apt to break off if the die were hardened. A steel fairly high in carbon should always be employed for dies that are to be used for making forgings from tool steel or other hard steel. When making forgings for very thin parts that cool quickly while being forged, it is usually preferable to use tool steel for the dies, in order that they may be hardened to a depth sufficient to withstand the tendency of the dies to "dish." A drop-forging die or any die used in the drop hammer, is said to be "dished" when the force of the blows it receives causes the central part of the face to sink beneath the level of the remainder of the face. This condition results in forgings or stampings that are too thick in their central parts. Dishing is usually traceable to a low grade of steel or to improper hardening.

Preparation of the Stock

The best method of preparing the die-blocks is to plane the stock in lengths of from six to eight feet, after which it may be cut to any lengths required by the sizes and shapes of the forgings for which the dies are being made. Occasionally a pair of die-blocks must be planed for a special job, but it is quicker and cheaper to plane them in lengths when the work warrants it, although many shops do not take advantage of this. The steel may be obtained from the mills in ordinary sections suitable for dies six or eight inches in height, which are the sizes mostly used. At the time of planing, the dies are "shanked" with the proper bevel and height of shank, to agree with the system in vogue in the shop where the dies are to be used.

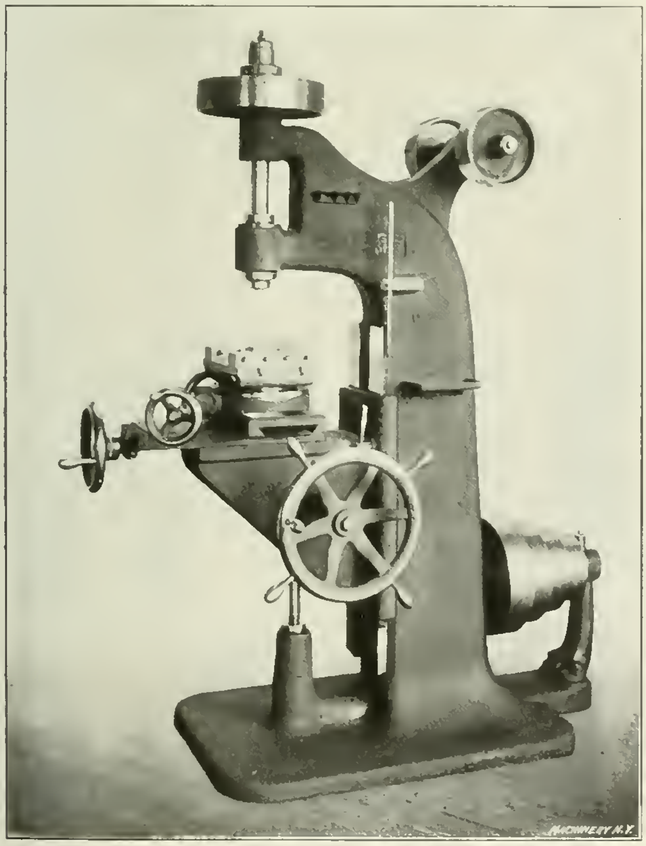

Fig. 7. The Pratt & Whitney No. 2 Die-sinking Machine

The die-blocks are planed on the front and left-hand sides for a distance of two inches or a little less from the face. These two cuts are merely "skin chips," and are perfectly square with each other and with the shank of the die; their purpose is to furnish faces from which the impressions may be laid out. The use of these "matching-sides" is plainly indicated in Fig. 5. The reason for using the left side is because the edger is always to the right, and in cutting away for this part of the die, the lay-out face would be destroyed. This would make it impossible to work from that side afterwards, in case it should be necessary to make changes in the impression. On the left side the anvil is formed, but this interferes but little with the working face that has been planed, because the anvil occupies but little space, at least as regards depth. In planing these working faces, care must be exercised to have the faces perfectly parallel with the shanks of the dies; otherwise the two halves of the forging will appear to be twisted with relation to each other, and to correct the error it will be necessary to "shim" the dies—a practice that should be permitted only as a last resort.

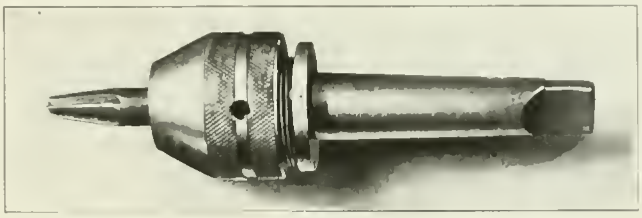

Fig. 8. Special Cutter Chuck for the Die-sinking Machine

There are various precautions taken to prevent blunders in the setting up of the dies. The forger usually lines up the dies by matching the sides of the die-blocks. On dies whose matching faces have been cut away, the die-sinker usually cuts a deep "nick" from one die to the other, while they are in alignment. The shank of the upper die-block is milled with a "half-hole" to fit the familiar "dutchman" in the hammer of the drop-press.

Laying Out the Dies

We are now ready to take up the work of laying out and cutting the impressions in the dies. The laying-out of drop-forging dies is totally different from the laying-out of blanking dies, this being due principally to the different allowances that must be made for shrinkage, draft and finish. The allowance for shrinkage is an important one. In order to properly understand the considerations to be taken into account, it is necessary to understand the trimming methods employed for removing the fin. Small forgings are invariably completed, and the fin trimmed off after they are cold; such forgings are said to be cold-trimmed. Larger forgings are trimmed hot and then struck once or twice to finish and straighten them, as it is probable that the trimming has somewhat distorted them. At the time of the last blow, the forging has cooled to a low red heat. In making dies for small cold-trimmed steel forgings, the proper allowance for shrinkage is 3/16 inch to the foot or 0.015 inch to the inch. Such forgings are completed at a bright red heat, and the rate of shrinkage is great.

In making dies for hot-trimmed steel forgings, which are of medium and large size, the proper allowance for shrinkage is 1/8 inch to the foot or 0.010 inch to the inch. Hot-trimmed forgings, receiving the finishing blow while relatively cold, shrink a smaller amount than forgings that are cold-trimmed. These proportions hold true for all dimensions of the die impression, whether they be depth, width or length. In making dies for forging bronze or copper, the same principles apply, and the rate of shrinkage for cold-trimmed forgings is 3/16 inch to the foot, and for hot-trimmed forgings 1/8 inch to the foot, or practically the same as for steel.

The Draft Allowance

It would be very convenient if we could sink forging dies with sides perfectly straight, the same as a die-casting mold, but in die-sinking this is impossible, as the forging would stick in the die. To overcome this tendency, we employ "draft," just as the patternmaker does. The amount of draft

given a drop-forging die varies from 3 degrees to 10 degrees. If the die is for a thin regular forging, like an oval treadle plate, 3 degrees is ample, but if the forging die is deep, with narrow ribs which are apt to stick, at least 7 degrees is necessary. Should the die be for forging a piece that is ring-shaped or has a ring in its make-up, the central plug that forms the interior of the ring will require a draft of 10 degrees, because, as the forging cools while being worked, it

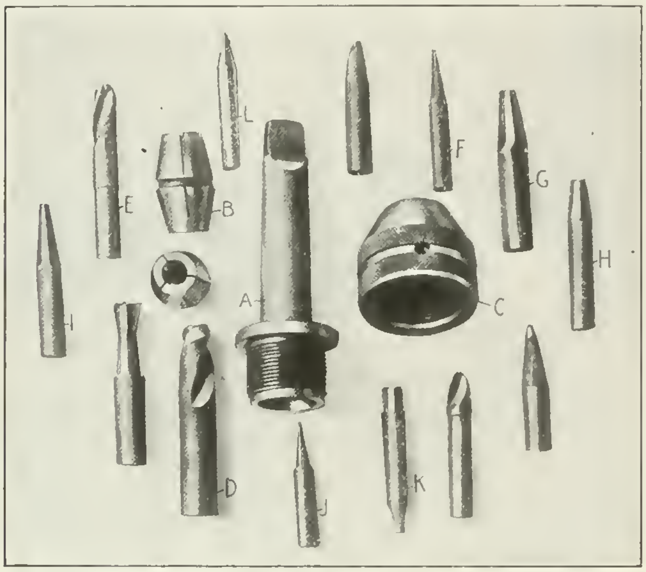

Fig. 9. Chuck Parts and Cutters for the Die-sinking Machine

tends to shrink together around the plug, and if the draft is insufficient, it will stick in the die. With the above exceptions, however, the majority of drop-forging dies are cut with a 7-degree draft. For convenience in laying out, it is well to remember that a 7-degree taper equals practically a 1/8-inch taper to the inch, and a 10-degree taper, 3/16-inch to the inch.

The Allowance for Finish

By "the allowance for finish" is meant the additional metal that is "put on" the forging at those places that are to be machined. Very often it happens that there is no finish required on the forging, in which case, of course, there will be no allowance. Usually, however, there are bosses to be faced off or other places that require machining, and in such cases the forging is left 1/32 inch oversize at these points.

Scribing the Outline

In laying out the dies, the first step is to copper the faces of both the upper and lower die, after which center lines should be scribed from the two matching-sides of the die-blocks. If the forging is irregular in outline, it is advisable to make a templet. Not only will the templet be useful in laying out the two impressions, but if the forging is to be hot-trimmed, the templet can be used in laying out the trimming die and punch. The use of a templet insures that the two dies will match perfectly, for after laying out the lower die, the templet is simply reversed and used for the upper die. The templet should be made of thin sheet metal, and if brass or zinc is used, it may be sawed out with a band or scroll saw and then filed to the line in the usual way. Fig. 6 shows at *A* a templet for a bevel gear forging, with the various allowances made, ready to be used in laying out the impression; *B* is the finished gear blank. First the outline of the finished forging is laid out, then the draft allowance is added, and at those points that must be machined, allowance is made on the templet for this purpose. In laying out the set of lines for the shrinkage allowance, a shrink-rule is used, either a 1/8 inch to the foot or a 3/16 inch to the foot, as the case may require.

Frequently it happens that the outline of the forging at the parting line is simple and regular, as, for instance, in the case of an eye-bolt forging. In the case of such a simple shape, there is no necessity for a face templet, as the outline may be laid out from the two matching-sides of the dies by means of a square and dividers. In order that the outlines of the impressions on the two blocks may come in perfect alignment, two and sometimes three combination squares are used in locating the templet on the blanks, in case a templet is used. The templet is placed in its proper position on the face of one of the die-blocks, and a combination square is set from each of the matching-sides to the edge of the templet. With the templet against the ends of the square blades, the outline is scribed; then, without changing the blades of the squares, they are placed in corresponding positions on the other die-block, thus locating the templet (now reversed), and the outline is scribed on this die. The combination square also affords a good way for transferring lines from one die to the other. Fig. 5 shows the die-sinker transferring a measurement from one die to the other die upon which he has started work. After the outlines of the two impressions are scribed on the faces of the die-blocks, they should be either lightly prick-punched at intervals along the lines, or they should be traced with a small, sharp chisel, using the chisel after the manner of a punch, and moving it after each tap of the hammer so as to obtain a clear, deep, continuous line.

Fig. 10. Hub, Forming and Miscellaneous Cutters for the Die-sinking Machine

In planning the lay-out of a drop-forging die, there are several points that must not be overlooked. The heaviest end of the forging should always be at the front of the die-block, as illustrated in Fig. 2. This makes the forging easier to handle while being forged and still on the bar, and it also permits the use of a liberal-sized sprue. In selecting a die-block and laying out the impression, there should be at least 1½ inch left all around the impression from the outside edge of the block or from any part of the die, such as the edger, anvil or forming impression. If the forging has a hub or other projection that extends some distance from the body of the forging on one side, as in the illustration at the center of Fig. 3, the upper or top die should contain this deeper im-

pression. This is an important point, for every die-sinker and drop-forger knows that it is easier to "shoot" the metal up than down; just why it is so, however, is difficult to understand.

Sinking the Impression—The Machine Work

The work of sinking the impressions in the dies may be roughly divided into two parts: the machine work, and the hand work. In the machine work, the lathe and the vertical milling or die-sinking machine are the two principal machine tools used. Generally speaking, if there are parts of the impression that can be cut out on the lathe, it is good policy to do this work first, although there are exceptions to this rule which will be mentioned later. The advantage of doing the lathe work first lies in the fact that a large amount of the stock is removed quickly and uniformly, so that the die-sinker has a better chance to start the milling cutters.

The best method of holding the dies for the lathe work is by means of a special bolster, bolted to the faceplate. The

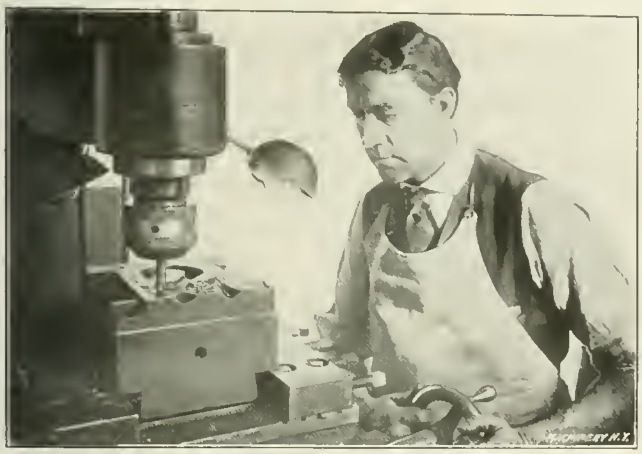

Fig. 11. Using the Circular Attachment

bolster is planed to take the shank of the die-block, which is held in place by a key. This method has certain advantages over the practice of holding the die-block with set-screws, in that the block may be more easily made to run true, and there is less danger of the die-block working loose. Much time may be saved in the turning if the lathe is equipped with a compound rest, for the draft may then be bored out by swinging the rest over the required number of degrees. If the lathe work is other than very plain, it is necessary to make use of templets. In turning out the impression for a bevel gear blank, for instance, the templet for the turning would appear as shown at A in Fig. 6. A study of this templet will give a good idea of the allowances for draft, shrinkage and finish. The lines of the finished gear show a straight hub, that is, there is no bevel on its sides. In cutting the impression, however, these lines must be given a draft of 7 degrees to prevent the forging from sticking in the dies. The top and bottom of this hub, as well as the face where the teeth are to be cut, will of course be machined; therefore 1/32 inch is added to the templet at these places. The shrinkage allowance is taken care of by laying out the dimensions of the templet with the 1/8 inch to the foot shrink-rule, as the forging will be trimmed hot.

The Die-sinking Machine

The die-sinking machine is by far the most important asset of the die-sinker's equipment. At the present time, most die-sinking shops are equipped with machines of the Pratt & Whitney make—the No. 2 machine for the small and medium work and the No. 3 for the heavy work. These two machines will take care of any dies to be made, and in small shops where but one die-sinking machine is installed, the No. 2 size will be found sufficient, if the work is not very large. The illustration Fig. 7 shows the latest model of the No. 2 machine. The dies are held in the vise of the machine, the shank of the die-block furnishing a good gripping surface. The cutters are held in a spring chuck, that, by substituting different collets, will accommodate cutters made of stock from 1/4 inch to 1 inch diameter. This chuck, shown in Fig. 8, and its parts in Fig. 9, is made in three pieces—the shank A, which is recessed to take the split collet B, and the sleeve C, which has an internal taper bearing surface. As the sleeve is screwed onto the shank, the split collet is compressed, drawing together upon the cutter without throwing it out of center. The sleeve is tightened by the aid of a spanner wrench, and no trouble is experienced from the cutter slipping in this style of chuck.

Cutters for Die-sinking

The subject of cutters for die-sinking is a very important one, for neither good nor fast work can be done with poor cutters. The very best of roughing cutters can be made from "stub ends" of Novo drills, and nearly every die-sinker takes advantage of this fact. These short drills are ground ball-pointed on the cutting end, given clearance, and the center ground out as shown at D and E in the illustration Fig. 9. This kind of cutter is so easily and quickly made, and stands up so well in "hogging out" the stock, that it does not pay to use any other kind.

For finishing, the cutters are made with three or more flutes, so as to get smooth surfaces. Finishing cutters must be provided in a large variety of shapes, to take care of the various forms in the dies being cut. At F, G, H and I in Fig. 9 are shown good examples of finishing cutters, most of which are made for finishing dies with a draft of 7 degrees; at J and K are shown special cutters, the former for cutting very narrow grooves, and the latter for shallow dies with a draft of 2 degrees.

The die-sinker is guided in the milling by the lines laid out on the face of the die-block and by the index on the pilot wheel of the die-sinking machine, the scribed lines giving the outline, and the index of the pilot wheel taking care of the depths of the various parts of the impression. Except when using special cutters like hub and forming cutters, no oil is used on the tools. The speeds at which the cutters should work vary with the size and style used. If the cutter is a small one, like that shown at J, Fig. 9, the speed may be much higher than would be used with a stout cutter like that shown at G. Of course, special forming cutters that are sometimes as large as 3 inches in diameter must run very much slower, and the use of lard oil is advisable. Fig. 10

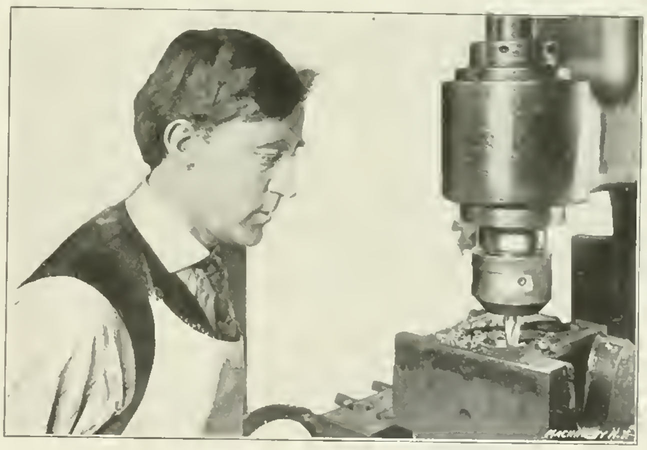

Fig. 12 Roughing out the Impression

illustrates some of these hub and forming cutters, and also shows a large variety of finishing cutters of various shapes and degrees of draft.

All circular parts of the impression are not bored out in the lathe, and indeed it is rarely advisable to bore out any parts under 3 inches in diameter, especially if they are deep. These small circular depressions are best taken care of by special forming cutters or by the circular attachment on the die-sinking machine.

A great many forgings for machine parts have bosses in which must afterwards be drilled a central hole. It is not practical to forge the part with the hole, but it is a great help to "spot" the forging, and thus obviate the necessity for using a jig for the following operation of drilling the forgings. To produce the projection in the die for this "spot," a hub cutter is used. (See A and B in Fig. 10.) On account of being milled out at the center, and relieved, the cutter will leave a cone-shaped projection in the bottom of the impression

that will produce a deep countersink in the boss of the forging.

It is very essential that a large cutter should be correctly located in relation to the outline of the impression before being fed into the die. In order to check its location, it is well to scribe, from the same center, a circle one or two inches larger than the one that is used for obtaining the outline. On this outer circle, four points, equidistantly spaced, should be prick-punched. After lightly entering the cutter, the outline should be tested with dividers from these four points.

The Circular Attachment

The circular attachment on the die-sinking machine is a valuable feature in milling the impressions. By its use, much circular work may be done that would be awkward to bore out in the lathe, and short arcs may be cut far better and quicker than in any other way. In using, a straight pointed rod is held in the chuck in place of a cutter. The machine table is adjusted with the two feed handles until the indicating marks, placed on the sides for this purpose, are in line. The table is lowered and the die-block located in the vise so that the center point of the arc to be milled is directly under the indicator in the chuck. Thus located, the table may be moved off center far enough to bring the cutter to the part of the impression that is to be milled, and the line followed by using the feed provided. In Fig. 11, the die-sinker is cutting the impression for forming the eye of a chain hook, using the circular attachment in doing so. The old-style method of cutting these curves, used when the die-sinking machines were not equipped with circular attachments, was to loosen the check-nuts of the swivel vise, and after moving the die to the proper distance from the center, clamping a long steel bar to the vise, and rotating the vise by hand. This method is here mentioned for the benefit of those whose die-sinking equipment is not of modern design.

Throughout all the machine work on the impressions, it must be remembered that as little stock should be left to be taken out by hand as is possible, for not only is hand work slower, but its quality can never equal machine work that is properly done. To this end, the finishing cutters should be run over the last cut two or three times, so as to get the smoothest possible surfaces. The heavy milling should be done with the roughing cutter, held in the chuck close to the cutting point, after the manner illustrated in Fig. 12. If, after the finish milling, the surfaces are smooth and the line is "split," there will be little left to be done by hand save the corners and possibly a few irregular shapes that cannot be milled. In the final milling cut for finishing to correct depth, exact dimensions may be obtained by setting the cutter so that it just touches the surface of the die, and then moving the index on the pilot wheel to zero and raising the table to the required dimension, as indicated by the reading of the index.

* * *

SOLDERING ALUMINUM

A new method of treating aluminum for soldering has been patented by L. Maitre of Predame, Switzerland. The aluminum is prepared for soldering by first depositing a thin layer of iron on the surface. It is then immediately immersed in boiling water and then in cold water. Next it is reheated until the deposit has acquired a blue color, when it is again immersed in cold water in the same manner as that employed in hardening steel. This treatment causes the iron deposit to adhere more strongly to the aluminum base. The film of blue oxide is now removed from the surface of the iron deposit by means of fine emery cloth, when the parts are ready for soldering. The soldering is accomplished by the ordinary method employed in soldering sheet steel or similar work.—*The Brass World.*

* * *

Trouble has sometimes been experienced in hardening high-speed steel tools in the chloride of barium bath, by the formation of drops of an exceedingly hard substance that cling to the steel. This substance is so hard that it can be ground off only with great difficulty, with emery or carborundum wheels. The trouble can be avoided by skimming off all scum or dross floating on top of the melted barium.

HALF A DAY IN AN OIL-COUNTRY SHOP

By V. J. M.

It was one of those first warm days in the springtime when a person feels lazy and the hum of machinery has a sleep-producing effect; these symptoms used to be known as "spring fever" before the advent of the more modern and up-to-date disease called "hookworm." (Speaking of hooks brings to mind that the fishing down at the canal is fine. Tor, our helper, was down after quitting time and caught some very nice suckers; one of them weighed—well, no matter how many pounds; it was good and big to hear him tell it!) We had just started in on a fairly long cut with an unusually fine feed, intending to slide into the tool-room and have a look at the Pittsburg papers which the cub gets, to see what Jeff and Mutt were up to, when along comes Billy, the boss. We knew by the way he handled his six-foot jointed rule that there was something doing.

"Say, Jim, I've got to go up to the brewery; Chris says the ammonia pump is 'busted' and you know what that means. Clem and Dick are both out on the Smith farm where the power house burned so you kind of keep an eye on things until I get back. Tell Brownie to be sure and lace the belts on the blower at the foundry, for Sam has a big heat to pour off to-night, and, by the way, we will have to make a set of rings for the brickyard engine to-morrow. Tell John to take the 12-inch pattern and nail a piece of rubber belting around it. I guess that will make it so it will clean up. Sandy says the new key we put in the gas engine at the woodshop is working out again, so send Mike down to have him drive it in. And Big Ben, the blacksmith, wants a new bolster bored to make those 2-inch pipe flanges for the boiler shop. McGee wants a half dozen nozzles faced and some 3½- and 4-inch flanges.

"And say, if Teddy comes in from the refinery tell him we will send a couple of our boilermakers up there the first thing in the morning; and as soon as Milt gets the cylinder he is working on bored out, have him cut that temper screw-box. Oh, yes, and keep Harry right on those connected valves for we have twenty five to ship out to the Territory. If Clem and Dick come back, send one of them over to the laundry, for they want a new piece put on the lineshaft; and don't forget to have those pulleys bored for the flour mill—which reminds me that the boss from the rolling mill wants those rail trucks right away, so you'd better get Dad to take the castings to the planer, so that if he comes he'll see that we've made a start.

"Have Ted put up the countershaft he took down on the screw machine for we need some sucker-rod joints very soon, and have Tom put up some cup packers for the 5⅝-inch hole—Syd wants them in the stove. Send Jim, the pipe-fitter, over to the Park Hotel; something has gone wrong with their dishwasher. Ike says he never wants to go back to the tannery, so if they send in, let Joe get a scent; and, by the way, when the team get back from the Valley Station, have them return the load of coke that we borrowed from the upper foundry and tell the joint turner that Jones Bros. want that set of all-steel bits ready to go when their team comes after the casing. Incidentally, the new man on the old lathe can help rough out working barrels if he runs shy of work.

"Well, I must catch that 1:40 car. Guess you'll get along all right. Oh, say, if my wife stops here on her way over to town, tell her—tell her—well, don't bother, she won't believe it anyhow."

At last he is off for the brewery and between you and me and the tailstock, those breakdowns are sometimes imaginary. Well, what did we do after listening to all that spiel? We have heard him before—when he was dry—so we just sat down on an empty nail-keg and tried to think out what to do first with a week's work laid out ahead and less than half a day in which to do it. Such a condition ought at least to make a person sympathize with the boss that carries a load like that around most of the time.

* * *

Foolish Question No. 1: When does a steady rest?

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—3

By S. N. BACON

The assembling operation described in the previous installment of this article was so successful that when the part shown at *A* in Fig. 8 came along it was decided to make this also in the No. 2 Brown & Sharpe automatic screw machine. Although this part was assembled in an entirely different manner, it was found to be more interesting than the preceding one. It is made up of a stud *a*, on which turns the roller *b*, held in place by the washer *c*, the latter being pressed on the stud. Referring to the part which is shown disassembled at *B* in Fig. 8, it will be seen that there are two unusual operations to be performed. The first is to ream a

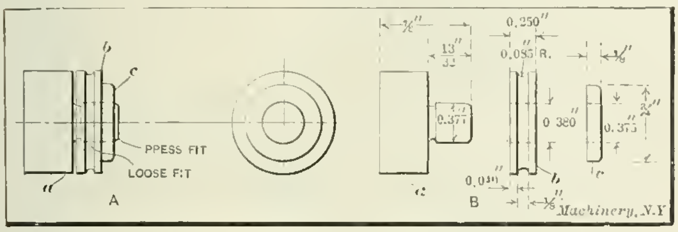

Fig. 8. The Assembled Part and its Details

large hole behind a small one, and the second is to cut off, three times, this requiring the stock to be fed out three times for the completion of each assembled part.

In operation, the stock is first fed out to the length shown at *A* in Fig. 9, where the hole is centered, drilled, and the

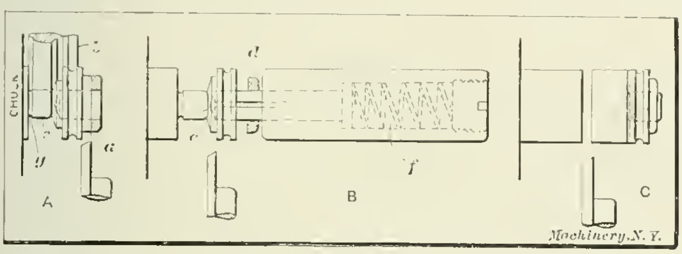

Fig 9. Positions of Stock for the Various Operations

washer shown in section at *a* is reamed to 0.375 inch diameter. The remainder of the hole, which is in that part of the stock that will form the roller, is bored with a recessing tool to 0.380 inch. Meanwhile the circular form tool *b* has turned the hub *c* to 0.377 inch diameter, and also formed the groove in the roller. The form tool leaves sufficient stock around the bottom of the hole to hold the parts together.

Before cutting off the washer, the special tool shown at *B* in Fig. 9 comes forward and enters 1/8 inch into the hole. The pilot of this tool is slotted and spring tempered, so that it will take hold of the washer when it is cut off. When the washer is separated from the bar, the cut-off tool drops back and the stock is fed forward sufficiently to allow the roller to be cut off. The pilot tool has now entered the hole of the roller as seen at *B*, which also shows the relative position of the washer. This pilot tool is also used as the stop, the stock being fed against the face *d*.

The pilot, holding both the roller and the washer, now moves forward until the end comes in contact with the stud at *e*, when the turret still advances sufficiently to push the roller on the stud, and also to press the washer on the end, thus holding the roller in place. In the meantime the pilot has been held against the end of the stud by the coil spring *f*. The work is now fed forward to the over-all length, and cut off as shown at *C*. Provision is made for the slight burr which is left around the edge of the hole when the roller is cut off, by cutting a groove *g* in the stud, as shown at *A*. The outside diameter of the washer is turned with a box-tool, which obviates the necessity of using an extremely wide forming tool. The order of operations is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	27	2
Revolve the turret	34	2½
Turn and center with box-tool 0.145 inch rise at 0.0054 inch feed	27	2
Form 0.350 inch rise at 0.001 inch feed	(350)	(25)
Revolve the turret	41	3
Drill 0.561 inch rise at 0.0045 inch feed	125	9
Revolve the turret	42	3
Ream 0.145 inch rise at 0.0052 inch feed	28	2
Revolve the turret	41	3
Recess front cross-slide cam 0.011 inch rise at 0.001 inch feed	14	1
Recess lead cam 0.260 inch rise at 0.0074 inch feed	35	2½
Revolve the turret	42	3
Cut off the washer 0.360 inch rise at 0.002 inch feed	180	13
Take hold of washer with pilot	—	—
Clearance	14	1
Feed stock against pilot holder	27	2
Cut off roller 0.554 inch rise at 0.002 inch feed	277	20
Clearance	28	2
Push on roller and washer 0.375 inch rise	42	3
Revolve the turret	42	3
Feed stock to stop	28	2
Cut off finished piece 0.554 inch rise at 0.002 inch feed	277	20
Clearance	14	1
Total	1385	100

With a spindle speed of 277 revolutions per minute it requires 300 seconds to complete one assembled part, which gives a gross output of 120 pieces in 10 hours. The writer is not in favor of using the combination box-tool and center tool, but in this case it was necessary as the turret was filled with tools.

Referring to the lay-out of the cams shown in Fig. 10, it will be seen that there are a number of short lobes on the lead cam. These lobes, when made accurately, will work just as well as the longer ones, because the cam is turning very slowly. The front-slide cam from 26¼ to 27½ feeds the recessing tool in at right angles to the spindle, and from 27½ to 30 is a dwell, while the recessing tool is fed forward by the lead cam. The front slide drops back a little ahead of 30, so as to release the recessing tool before it is withdrawn

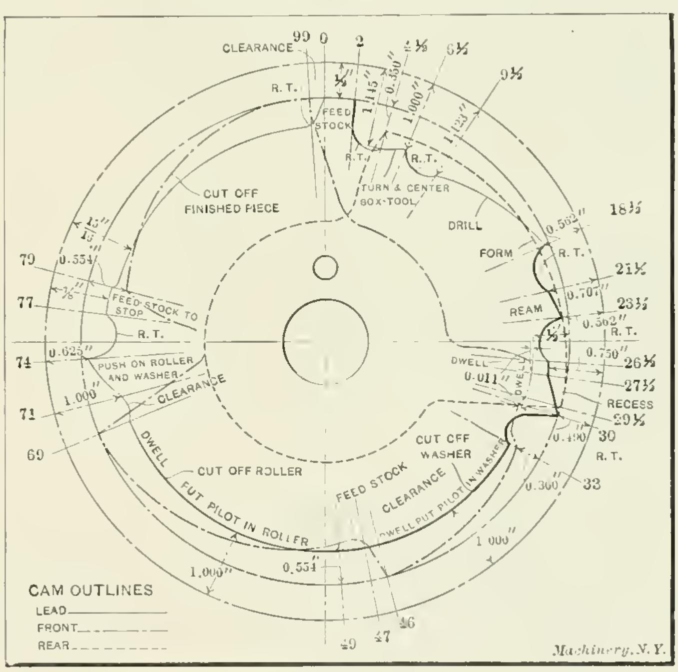

Fig. 10. Lay-out of the Cams for Making and Assembling the Various Pieces

by the turret. From 33 to 46 the front cam actuates the cut-off tool, separating the washer from the bar, and after dropping back enough at 46 to allow the roller to be fed out, it again advances and cuts off the roller. After feeding the stock again, the finished part is cut off by the lobe from 79 to 99.

The dwell on the lead cam which follows the recessing lobe keeps the spring pilot in the hole of the washer while it is being cut off. From 47 to 49 the stock is fed forward preparatory to cutting off the roller. The rise from 71 to 74 which pushes the roller and washer onto the stud was not made when the job was first set up, as it was a case of cut-

and-try, to get the proper advance. The shape of the curve shown in the illustration was finally arrived at and was successful. When the stock is fed at 77 to 79 it reaches the length shown at C in Fig. 9, and when it is again fed 0 to 2 it reaches the length shown at A. The weight of the piece causes it to drop before the cut-off tool has reached 99, so that no interference occurs when revolving from one stop to the other.

It might be well here to give the reason why one stop could not be used for these last two feedings of the stock, thus allowing space in the turret for a centering tool instead of using the combination box-tool and center. The reason this could not be done is that the difference in the length between the two feeds is so great that the cam at 77 to 79 would have to be cut very much lower than it is from 0 to 2, and in rising from the low to the higher point of the cam, the stop in the turret would strike the work before it was cut off; of course, cam space could be allowed to prevent this, but it would mean lost time.

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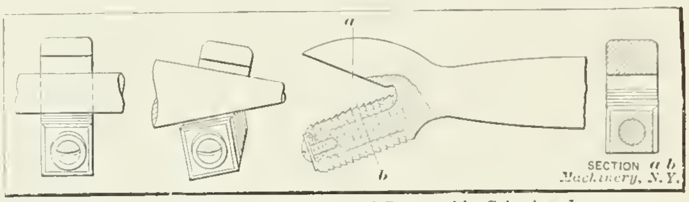
ALLIGATOR WRENCH WITH ADJUSTABLE AND RENEWABLE JAW

An interesting improvement of the common alligator wrench is the substance of U. S. patent No. 990,050 (April 18, 1911), issued to F. O. Jaques, Jr., Cranston, R. I. The device consists, as shown in the illustration, of the usual handle end and plain jaw, and in place of an unadjustable toothed jaw, a circular projection is provided on which a square section



Alligator Wrench with Four-sided Renewable Gripping Jaw

of the form indicated, with teeth on all four sides, is placed. This arrangement has several advantages, for not only does it prolong the life of the wrench by having the wearing faces renewable, but it also adapts it for use on tapered work, inasmuch as the gripping jaw, being free to turn on its spindle, will conform to the taper and give a good grip, adjusting itself automatically.

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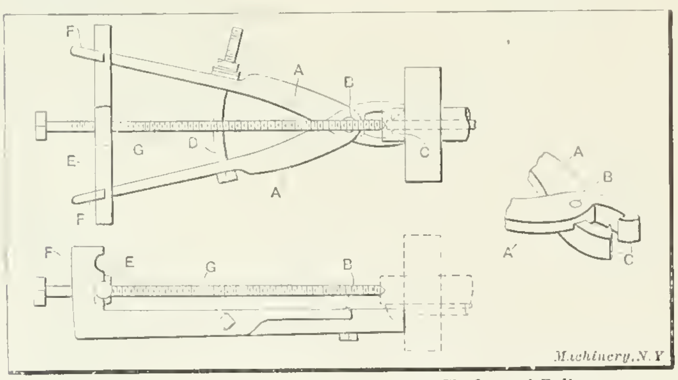
DEVICE FOR REMOVING KEYS FROM SHAFTS AND PULLEYS

Jacob Butsch, Lynnville, Ind., has patented a device (U. S. patent No. 986,113, March 7, 1911), for removing keys from shafting and pulleys. The body of the device is in the form of a vise or key-gripping member with two arms A pivotally connected at B and having their shorter ends formed into key-fitting jaws C, as shown in the illustration. These jaws are



Patented Device for Removing Keys from Shafts and Pulleys

formed in a manner calculated not only to prevent slipping, but also to prevent a swinging or pivotal action of the device about the gripping points. The arms A may be clamped together with a bolt D, set at a sufficient distance back from the pivot point B to give a good clamping action. A crosshead E fits into recesses in the bent-up projections F on the ends of the arms A. A bolt G through this crosshead is set in such a manner as to press against the shaft from which the key is to be removed. The illustration shows the manner in which the device is set up for use.

KNURLS AND KNURLING OPERATIONS

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

While on a recent visit to the works of the Brown & Sharpe Mfg. Co., Providence, R. I., the writer obtained information on the subject of knurls and knurling operations which will in a measure supplement the articles previously published on this subject in the June and July, 1909, numbers of MACHINERY (engineering edition). The articles referred to dealt particularly with cross-slide knurling operations, while the present

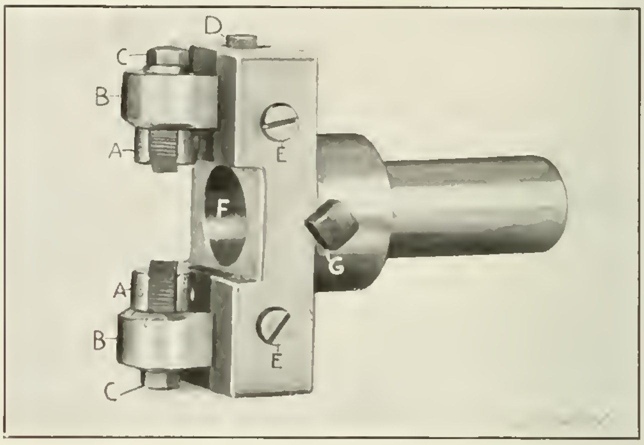


Fig. 1. Brown & Sharpe Adjustable Turret Knurl-holder

article takes up knurling from the turret, and special knurling operations.

Adjustable Turret Knurl-holder

An adjustable knurl-holder for turret knurling is shown in Fig. 1. This holder can be used for either spiral or straight knurling, as the knurl-holders A can be swiveled to any angle. The illustration shows the holders set with the zero mark

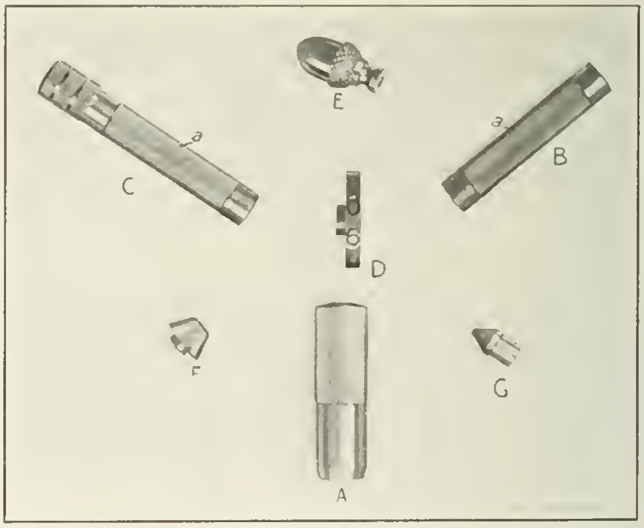


Fig. 2. Samples of Knurled Work

opposite 30 degrees, in which position the knurls would produce a diamond knurl, as shown on the piece A in Fig. 2. The knurl-holders A are held in the lugs B by collar nuts C which are screwed onto the threaded shank of the holders. Lugs B are graduated at 5-degree intervals, so that the knurls can be easily set to the desired angle. These lugs project into the body of the holder and fit in beveled slots cut to receive them. The lugs are adjusted in and out by means of collar-head screws D, only one of which is shown in the illustration. These collar-head screws are locked by means of small brass shoes, operated on by the headless screws E.

This knurl-holder can also be provided with bushings which fit in the hole F for holding centering tools or other internal cutting tools, so that other operations can be performed at the same time as the knurling operation. The cutting tools are held in position in the bushing by means of the set-screw G. The chief advantage of this knurl-holder is that straight

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knurls can be used for spiral as well as for straight knurling. This is an important feature, as straight knurls are more easily and quickly cut than spiral knurls, and also produce better results.

Opening Knurl-holder

The range of the knurl-holder shown in Fig. 1 is somewhat limited, in that it is impossible to knurl a piece of work back from the end, when the diameter to be knurled is smaller than or of the same size as the part preceding it. For this

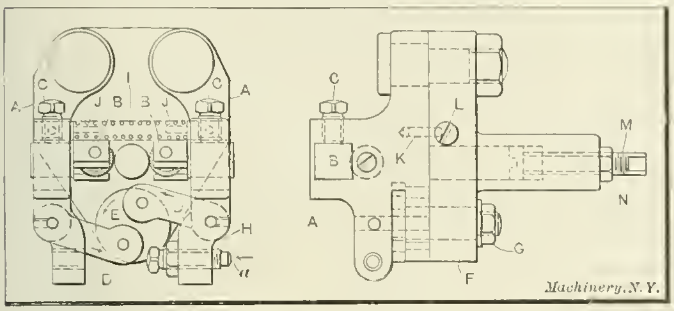


Fig. 3. Brown & Sharpe Opening Knurl-holder

class of work it is necessary to bring the knurl-holder onto the work, and then force the knurls in to the depth required, so that the work can be knurled in any desired position without passing over the whole surface. A knurl-holder which can be used for this class of work is shown in Fig. 3. This type is used especially for work similar to that shown at *B* and *C* in Fig. 2, where, as can be seen, the knurled portions *a* are practically in the center of the work.

The knurl-holder shown in Fig. 3 is made on the "swing" principle, and consists mainly of two swinging members *A*, in which the knurl-holders *B* are held by set-screws *C*. Rectangular holes are provided in the swinging members *A*, into which these knurl-holders *B* fit. As these two swinging members have to work together, it is necessary to connect them. This is accomplished, as shown in the illustration, by two connecting links *D*, attached to a stud *E* held in the main body

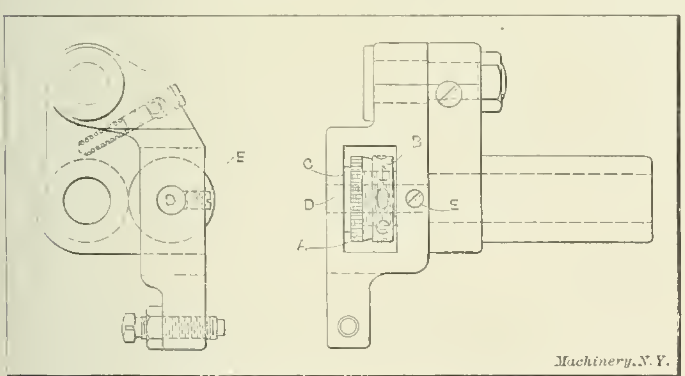


Fig. 4. Numbering Tool of the Swing Type

of the holder *F* by the nut *G* which is screwed onto the shank of the stud.

In operation, the rising block, held on the cross-slide, presses against the point *a* of the screw *H*, and forces the right swinging member *A* in the direction of the arrow. This revolves the stud *E* in the direction of the arrow, which action, in turn, draws in the left swinging arm. These members are held apart by coil spring *I* pressing against two spring plungers *J*, which, in turn, press against two pins *K* held in the swinging members. These pins *K* project into the main body of the holder, and are stopped by means of two headless screws *L*, which are tapped into the main body of the holder. The swinging members *A* are attached to the main body of the holder in the same manner as the ordinary swing tool. The knurl-holders in this case, however, cannot be set to any desired angle, but are held rigidly, so to speak, in the swinging members. The forward ends of these holders are offset so that a straight knurl is held at an angle of 30 degrees with the axis of the holder for producing diamond knurling. However, the knurl-holder proper can be used for straight knurling or other knurling from the turret, by supplying it with knurl-holders *B* of the desired shape to suit conditions.

This knurl-holder is provided with a stop *M*, similar in shape to an ordinary fillister-head screw, which is tapped into the shank of the holder. The screw is flattened on the end projecting from the holder, so that a wrench can be used for adjusting it, the nut *N*, of course, being used for locking when the stop is set in the desired position. The advantage of this stop is that when all the holes in the turret are full and it is necessary to feed the stock out again, the holder will act as a stop when the stock is fed out into it. The rise on the lead cam is, of course, used to govern the position of the knurls on the work.

Numbering Tool

In Fig. 4 is shown a swinging knurl-holder which was used for rolling figures in a wheel for a cash register. While this is not strictly a knurling operation, nevertheless knurling is performed. The method of rolling the figures on the wheels is interesting. The knurl *A* and the numbering wheel *B* are

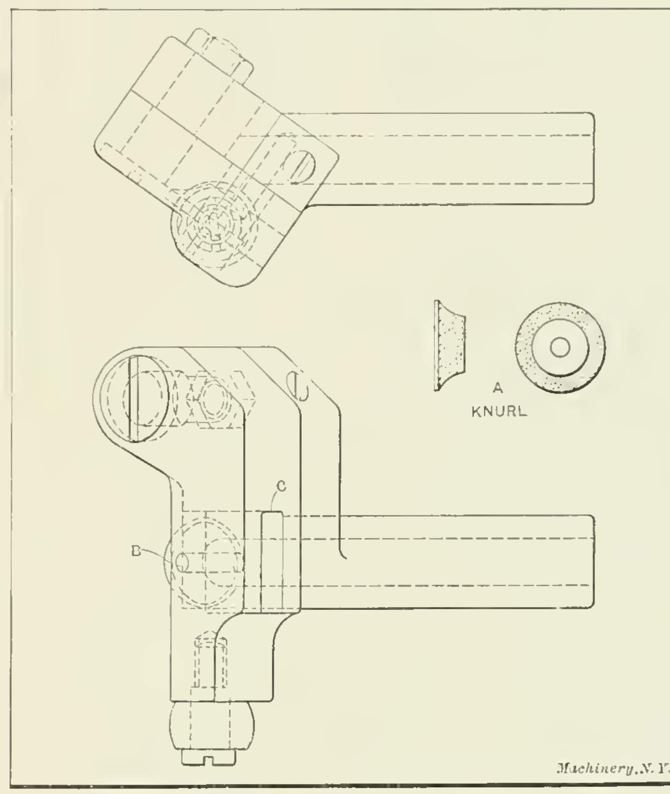


Fig. 5. Knurl-holder for Concave and Convex Knurling

made separately, and are screwed onto a sleeve *C* which, in turn, is held on a pin *D*. This pin is driven into the swinging member of the holder, and is held by a headless screw *E*.

The diameter of the knurl *A* is slightly larger than the diameter, over the figures, of the numbering wheel, so that the knurl comes in contact with the work first. The object of this is to provide a drive for the numbering wheel, so that it will not slip and "chew up" the letters, which are being rolled in the work. The knurled portion is removed after the letters have been rolled by a circular form tool operated from the cross-slide, which operation leaves the work in the con-

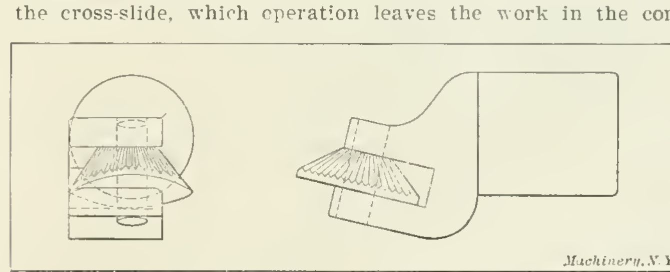


Fig. 6. Bevel Knurl-holder used in the Turret

dition shown at *D* in Fig. 2. This idea of using a knurl to drive the numbering tool is worth noting, as the same principle could be used in a number of cases for performing work of this or similar character.

Knurl-holder for Concave and Convex Knurling

At *E* in Fig 2 is shown an acorn nut, a portion of which is knurled as indicated. This operation would be difficult to

perform with a cross-slide knurl-holder, owing to the fact that the knurl could not be brought in straight—that is, having its axis parallel to the axis of the spindle—as the knurl would have a tendency to glide off. This, however, was accomplished by knurling from the turret with a knurl-holder operated by a rising block held on the cross-slide.

The knurl-holder for performing this operation, and the knurl used, are shown in Fig. 5. This knurl-holder is of the swing type, and is offset as shown. The manner of holding the swinging member is that commonly used and needs no description. The angle to which the knurl-holder is offset is such that the knurl can be held with its axis parallel to the face of the work to be knurled. The face of the work in this case, however, is convex, so that the axis of the knurl is held parallel to an imaginary line, joining the smallest and largest diameters of the knurled portion. Forcing this knurl-holder in at an angle, makes it necessary to provide a roller on the swinging member, so that the pressure can be directed in a straight line and still deflect the swinging member to the required angle without cramping. The knurl *A* is held on a pin *B* driven into the swinging member of the holder, and a rectangular hole *C* is cut in the swinging member into which the knurl fits.

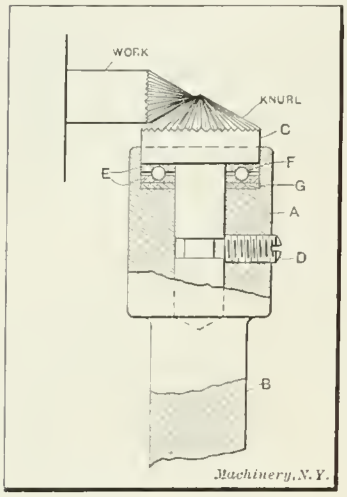


Fig. 7. Bevel Knurl-holder used on the Cross-slide

Holders for Bevel Knurling

At *F* in Fig. 2 is shown a piece which is beveled and knurled, and in Fig. 6 is shown the knurl and holder which were used to perform the knurling operation. The holder is of simple design and will not need further explanation. The knurl is held, as shown, at the desired angle with the work, on a pin driven into the knurl-holder. This simple knurl-holder performed the operation successfully.

At *G* in Fig. 2 is shown a piece somewhat similar to that at *F*, but it is smaller in diameter, and the included angle of the tapered portion is less. This piece was not knurled from the turret, but was operated on by a cross-slide knurl-holder of the type shown in Fig. 7. The body *A* of this holder is cylindrical in shape, while the shank *B* is of rectangular section, and is held in the cross-slide holder used for holding straight forming tools. This holder can be furnished for the Brown & Sharpe automatic screw machine when so desired. The knurl *C* is made with a shank, which passes into the body of the holder *A* and is held in the holder by a pointed set-screw *D* fitting in an annular groove cut in the shank of the knurl. As the thrust exerted on the knurl when in operation is considerable, it is necessary to provide this knurl-holder with roller bearings to reduce the friction. Two steel washers *E* act as retainers for the ball bearings *F*, and an additional bronze washer *G* is provided to separate the body of the holder from the tool-steel retainers. These retainers *E* are hardened, as is also the knurl *C*.

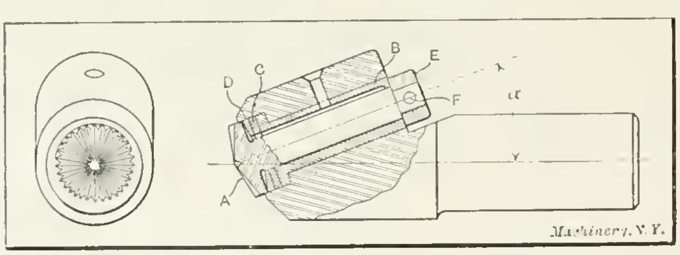


Fig. 8. Turret Knurl-holder for End Knurling

Turret Knurl-holder for End Knurling

It is sometimes necessary, when using special turret tools, especially those of the generating type, to knurl the end of the work so that the tool in the turret can be kept in step with the work. The knurl-holder and knurl for performing this class of work are shown in Fig. 8. The knurl *A* is held in the holder at an angle with the horizontal center line. The angle *a* at which the knurl is held should be from 15 to 30 degrees; about 20 degrees, however, is ordinarily used. The shank of the knurl *A* passes into the body of the holder and fits in a bronze sleeve *B*, the sleeve being driven into the holder. An oil groove is cut in this sleeve to supply oil to the shank of the knurl. A hardened steel washer *C* and a bronze washer *D* are also provided to reduce the friction. The knurl is held up against these washers *C* and *D* by a collar *E*, which is fastened to the shank of the knurl with a pin *F*.

This type of knurl-holder is also used for assembling operations. The piece to be assembled on the work in the chuck is put in place, and the knurl-holder is brought in, upsetting the end so that the part assembled cannot be taken off. A hole is usually drilled in the end of the knurl, as shown, to facilitate the cutting of the teeth.

Laying Out Cams for Turret Knurling Operations

Knurling from the turret differs from knurling from the cross-slide, in that the turret knurl-holder cannot be taken off the work on the quick-drop of the cam. If this were done, the knurls would "chew up" the knurling which has been made on the forward travel of the knurls. The method of laying out the rise on the lead cam for knurling from the turret is shown in Fig. 9. This is the lay-out of a set of cams for making a Brown & Sharpe micrometer sleeve, shown at *A* in Fig 2. The other machining operations on this sleeve, however, are not within the scope of this article, so we will turn our attention to the lobe which performs the knurling operation. This lobe is shown at *A* on the lead cam. It will be noted that the part of the lobe for the forward travel of the knurls covers a greater number of hundredths of the cam surface than does the part of the lobe used for backing the knurls off the work. As a rule, the part of the lobe used in backing the knurl off the work should contain about half the number of hundredths used for feeding the knurl on the work, or, in other words, the feed used for backing-off should be about twice that used for feeding on.

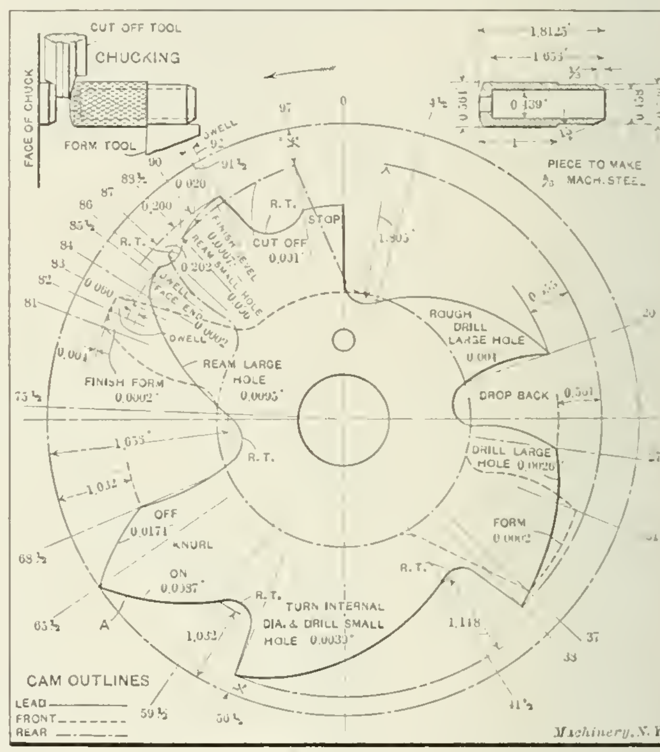


Fig. 9. Cams for Making Brown & Sharpe Micrometer Sleeve, showing method of Laying out Lobe for Turret Knurling

Designing and Cutting Bevel and End Knurls

The making of bevel knurls differs from the making of bevel gears only in that the pitch circle of the knurl is not taken into consideration, as the teeth are shallow and do not require to run in any previously formed teeth, but make

teeth by a rolling action. This rolling action displaces a certain amount of the material to form the teeth, and in so doing increases the diameter of the work, thus changing the original pitch circle. Knurling is similar to thread rolling in this respect.

In Fig. 10 is shown the ordinary method of designing a bevel knurl. Angle α, of course, is made to conform to the face angle on the work. The face angle β on the knurl can be found by the following formula: First find tan η, which is equal to $\frac{d}{A}$ (d = depth of tooth, and A = length of face cone radius of knurl.) The diameter of the knurl, D, is made to suit the requirements.

Then

$$\beta = \alpha + \eta$$

The included angles of the teeth for the knurls used in knurling different materials were given in the June, 1909,

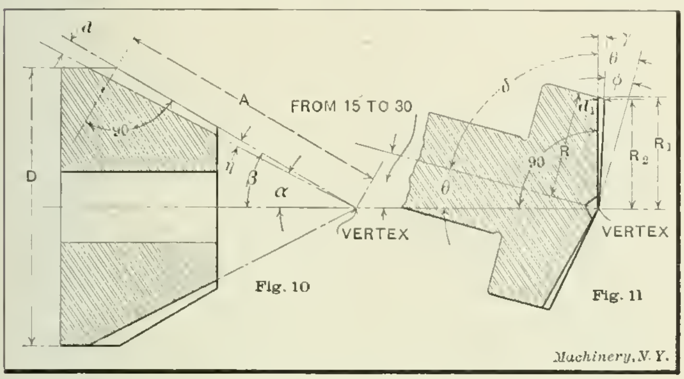


Fig. 10. Method of Finding the Cutting Angle of Bevel Knurls.
Fig. 11. Method of Finding the Face Angle of End Knurls

number of MACHINERY (engineering edition), as was also a table giving the depth of teeth for various included angles. Reference should be made to the above in connection with this article.

In Fig. 11 is shown a method of designing an end knurl. The bottom of the tooth in the knurl should be at right angles to the center line of the spindle when the knurl is held in the position shown, so that the face of the teeth on the knurl project past the perpendicular, thus forming the teeth in the work deeper at the outer circumference than at the center. In cutting the knurl, when the angle θ at which the knurl is held in the holder is known, the setting of the knurl in the milling machine is, of course, a simple problem. The face angle of the knurl has to be found, however, before the knurl can be made. This angle can be found by the aid of the following formulas, in which

θ = angle of inclination of axis of knurl,
δ = angle of bottom of tooth with axis of knurl,
γ = tooth angle,
ϕ = face angle of knurl,
R = radius of knurl, made to suit requirements,
R_1 = distance from vertex to circumference at bottom of tooth,
R_2 = distance from vertex to circumference at face of tooth,
d_1 = depth of tooth.

$$\delta = 90 \text{ degrees} - \theta$$

$$R_1 = \frac{R}{\cos\theta}$$

$$R_2 = R_1 - (d_1 \times \tan\theta)$$

$$\tan\gamma = \frac{d_1}{R_2}$$

Hence

$$\phi = \theta - \gamma$$

For example, assume that it is required to design an end knurl with the following data:

Angle θ = 20 degrees,
Depth of tooth, d_1 = 0.027 inch,
Radius of knurl, R = 0.375 inch.
Then

$$R_1 = \frac{0.375}{\cos 20 \text{ deg.}} = \frac{0.375}{0.9397} = 0.399 \text{ inch.}$$

$$R_2 = 0.399 - (0.027 \times \tan 20 \text{ deg.}) = 0.399 - 0.0098 = 0.389 \text{ in.}$$

$$\delta = 90 \text{ deg.} - 20 \text{ deg.} = 70 \text{ deg.}$$

$$\tan\gamma = \frac{0.027}{0.389} = 0.0694, \text{ the tan of 3 deg. 58 min.}$$

Hence

$$\phi = 20 \text{ deg.} - 3 \text{ deg. 58 min.} = 16 \text{ deg. 2 min.}$$

For some classes of work it may be necessary to have the diameter of the knurl tapering, so that the circumference is at an angle of 90 degrees or less to the face of the knurl. This, however, decreases the strength of the teeth at the circumference, and promotes chipping of the teeth.

Rise on Lead and Cross-slide Cams for Turret Knurling

Knurling from the turret can be divided into five distinct groups as follows:

1. Spiral or diamond knurling when the knurl-holder is operated on entirely by the lead cam;
2. Spiral or diamond knurling when the knurl is operated on by both the lead and cross-slide cams;
3. Bevel knurling when the knurl is operated entirely from the turret;
4. Bevel knurling when the knurl is operated on by both the lead and cross-slide cams;
5. End knurling when the knurl is operated on entirely from the turret.

The rise on the cam for knurling from the turret, subject to the conditions above stated, can be found by referring to Fig. 12. At A is shown the diagram for spiral or straight knurling when the knurl is operated on entirely from the turret. The rise on the lead cam for this operation would be $b + a$. The value a takes into consideration the bevel on the knurl, which is necessary to prevent the corners from chipping.

For spiral or straight knurling when the knurl is operated on by both the turret and cross-slide cams, the diagrams shown at B and C are used. Here the lead cam brings the knurls onto the work into the position shown, by the quick-rise of the cam. A dwell is then made on the lead cam, and the cross-slide cam forces the knurls in to the proper depth. The lead cam then advances, while a dwell is made on the cross-slide cam. The

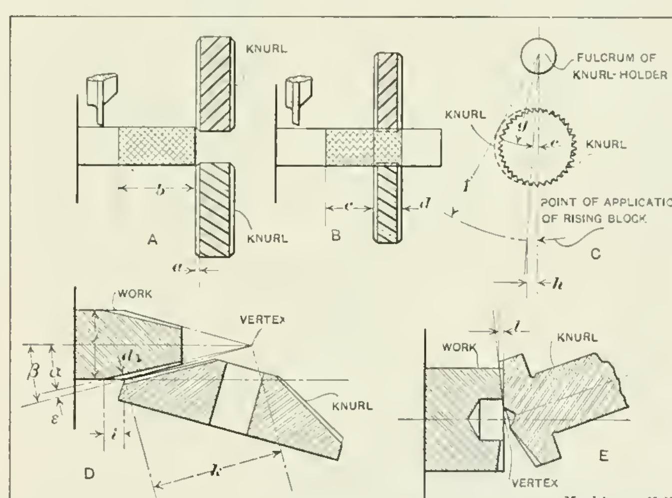


Fig. 12. Diagrams for Finding Rise on Lead and Cross-slide Cams for Turret Knurling

rise on the lead cam is equal to c, or the length of the knurled portion, minus the thickness d of the knurl. The rise h on the cross-slide cam is found by the following formula:

$$h = \frac{e \times f}{g}$$

The value e is equal to the depth of the tooth. This value is slightly greater than the rise on the cam required for knurling, as the material is displaced. However, the depth of the tooth, e, is near enough for all practical purposes.

The method of obtaining the rise on the cam for bevel knurling when the knurl is operated on entirely by the lead cam, is shown at D, where i equals the rise required on the cam. The rise i is obtained by means of the following formulas, where

k = face cone radius of work,
j = diameter of work,

i = rise required on cam,
α = angle of bottom of tooth with axis of work,
β = angle of face with axis of work,
ϵ = tooth angle,
d_1 = depth of tooth.

$$k = \frac{j}{2 \sin \beta}$$

$$\sin \epsilon = \frac{d_1}{k}$$

$$\alpha = \beta - \epsilon$$

Then

$$i = \frac{d_1}{\sin \alpha} + 0.010 \text{ to } 0.015 \text{ inch.}$$

The method used for obtaining the rise on the cross-slide cam for bevel knurling when the knurl is operated on by both the lead and cross-slide cams, is the same as that shown at

FEEDS FOR TURRET KNURLING

Pitch of Knurl	Brass Rod, Feed per Revolution	Gun Screw Iron, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
16	0 0100	0.0080	0.0060	0.0040
18	0.0105	0.0084	0.0063	0.0042
20	0.0110	0.0088	0.0065	0.0044
22	0.0115	0.0092	0.0068	0.0046
24	0.0118	0.0096	0.0070	0.0018
26	0.0123	0.0100	0.0072	0.0050
28	0.0128	0.0103	0.0074	0.0051
30	0.0135	0.0106	0.0076	0.0052
32	0.0140	0.0110	0.0078	0.0053
34	0.0145	0.0115	0.0080	0.0054
36	0.0150	0.0120	0.0082	0.0056
38	0.0153	0.0125	0.0084	0 0057
40	0.0158	0.0128	0.0086	0.0058
42	0.0161	0.0132	0.0088	0.0059
44	0.0168	0.0136	0.0090	0.0061
46	0.0173	0.0140	0.0092	0.0062
48	0.0178	0.0143	0.0094	0.0063
50	0.0182	0.0145	0.0098	0.0064
52	0.0185	0.0148	0.0103	0.0065
54	0.0189	0.0150	0.0108	0.0066
56	0.0193	0.0153	0.0111	0 0067
58	0 0195	0.0156	0.0115	0.0068
60	0 0198	0.0158	0 0118	0.0069
62	0.0200	0 0160	0.0120	0.0070

C in Fig. 12. The holder in which the knurl is held is offset, so that the face of the knurl is held parallel with the face of the work when being fed in. The depth of the tooth, therefore, is used for obtaining the rise on the cross-slide cam, by the aid of the diagram shown at *C*. No rise is required on the lead cam, as the knurl is brought to the correct position on the work by the quick-rise of the cam, and then allowed to dwell until the knurling is completed.

The method of obtaining the rise on the lead cam for end knurling is shown at *E*, where it can be seen that the rise l equals the depth of the tooth.

Speeds and Feeds for Knurling

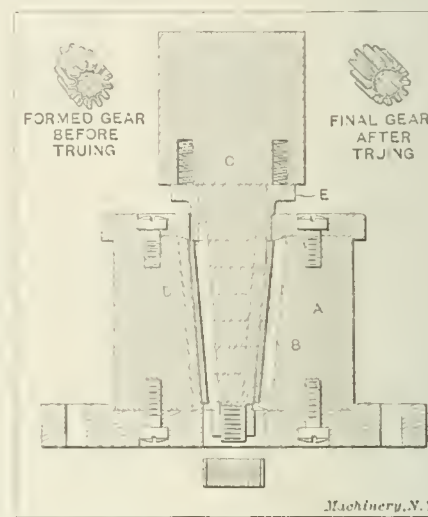
Knurls, as a rule, can be operated at about the same speed as circular forming tools, if the proper feed is given and the knurl is provided with a copious supply of good lard oil. However, it may be advisable in some cases, especially when knurling tool steel or drill rod, to decrease the speed somewhat.

Definite information cannot be given for feeds for turret knurling, as it is impossible to take into consideration all the various conditions under which a knurl will be operated. When two knurls are employed for diamond or spiral knurling, the knurls can be operated at a higher rate of feed for producing a spiral than they can for producing a diamond knurl. The reason for this is that in the first case the two knurls would be working in the same groove, whereas in the latter case the two knurls are working independently of each other, so that each has to do its own share of the work. Another condition encountered is end knurling where the knurl only has to be fed in to the depth of the tooth. Here the feed varies, of course, from that used for spiral or diamond knurling; so it is obvious that no definite rule can be laid down which will cover all conditions. The diameter of the work is also a determining factor, making the problem still more difficult. Feeds for turret knurling are given in the accompanying table for knurling different materials. The feeds here given are applicable particularly to spiral and diamond knurling, but can also be used, with judgment, for bevel or end knurling. The diameter of the work is not taken into consideration, and allowance should be made for this when using the feeds given. The feeds to be used for backing the knurls off the work should be as follows: For brass, screw stock and machine steel, twice the feeds given in the table; and for tool steel, three times the feeds given in the table.

* * *

MAKING GEARING OF SHEET METAL

U. S. patent No. 985,905 (March 7, 1911), issued to Allen Johnston, Ottumwa, Iowa, describes an interesting method of forming gears from sheet metal. Referring to the illustration, *A* is a die body which contains in a central tapered hole a series of hardened steel ribs *B*, extending lengthwise of this hole and held top and bottom by the beveled members shown. The punch body *C* is similarly arranged with a series of lengthwise ribs *D*, also held in place by beveled connections, as indicated. The ribs of the punch alternate with the ribs of the die, both sets being equidistantly spaced around the circumference. A sheet-metal ring, preferably a short length of metal tube such as die-drawn steel, of the requisite diameter, is placed under the punch, and when the latter is at the top of the stroke the blank will be caught by the lower edge of ring *E*, which encircles punch *C*, and forced down between the converging ribs of the punch and die. Succeeding blanks force the blank to continue its passage through the die hole, corrugating the blank to the desired depth, when it is forced out at the bottom. After this, the teeth, which are properly spaced by this process, are closed to form the teeth of the gear, seaming up the space left by the ribs of the punch member. To obtain this result, the sides of the outer bends of the corrugations are subjected to lateral pressure, whereby they are brought into approximate contact with each other to form rough gear teeth. After the bends of the crimps are closed, the gear is subjected to a truing action which brings the teeth into regularity of form, and at the same time forges the walls of the crimps into substantially solid teeth, particularly at the crowns. This is done either by cold or hot forging in a specially arranged punching die which consists of a plain blank of the inside diameter of the rough gear blank, which holds the gear centrally. Properly shaped teeth attached to the die by spring members are forced radially inward by the tapered walls of the die, which the outside of these spring-connected teeth strikes, when the punch descends. These gears, before and after the truing operation, are shown in the upper part of the illustration.



First Punch and Die of a Patented Set for Forming Sheet-metal Gears. The Finished Product is shown in the Upper Right-hand Corner

* * *

According to the *Brass World*, coffin hardware is first nickel-plated and afterwards given a very light deposit of silver. This is done because if the light silver deposit were put directly on the soft metal (lead and antimony), it would be absorbed in a comparatively short time, as soft metals in general have the property of absorbing light deposits of silver and copper.

TOOLS AND METHODS USED BY THE OESTERLEIN MACHINE CO.

A number of interesting tools and methods are used in the shops of the Oesterlein Machine Co., Cincinnati, Ohio. The accompanying illustrations show a few of these, and a brief description of their construction, action and advantages will be given in the following article.

Method of Boring Cone Pulleys

In Fig. 1 is shown a method for boring out and turning the inside of cone pulleys for milling machines. The pulleys are first rough-turned on the outside and are then put into a holder or head, this latter being screwed onto the lathe spindle nose. This holder is shown in detail in Fig. 2. It is finished all over on the inside, and is split part way as indicated, so that when the cone pulley has been put into place, it can be securely clamped by means of two bolts, one through each of the lugs on the sides of the head. Two clamps, one on each side, as best shown in Fig. 1, hold the end face of the pulley against a finished face in the holder,

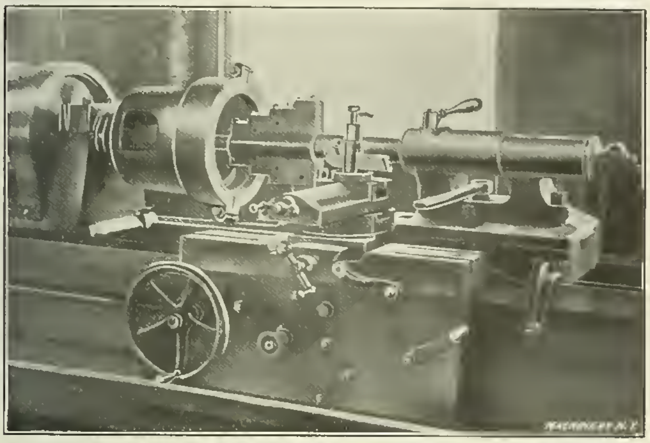


Fig. 1. Method of Boring Cone Pulleys practiced by the Oesterlein Machine Co., Cincinnati, Ohio

so that all the pulleys will be alike after the inside turning is completed.

The work is done in a twenty-four-inch lathe, and the facing and boring are done by tools held in a cutter head, all the tools being fed into the work simultaneously. In all, thirteen tools are fed in, twelve of which are held in the cutter head illustrated in position in Fig. 1, and shown in detail in Fig. 3; one of the tools, for facing the outside end of the pulley, is held in the regular toolpost. The cutter head has provision for holding eight boring tools, for boring out the four steps in the cone pulley, and for four facing tools, one of which is indicated by dotted lines, in Fig. 3, for facing the steps on the inside. A stop *A* is provided for preventing the cutter head from being fed into the pulley more than the required distance.

The arbor on which the cutter head is supported is held in the tailstock of the lathe. The tailstock spindle is removed,

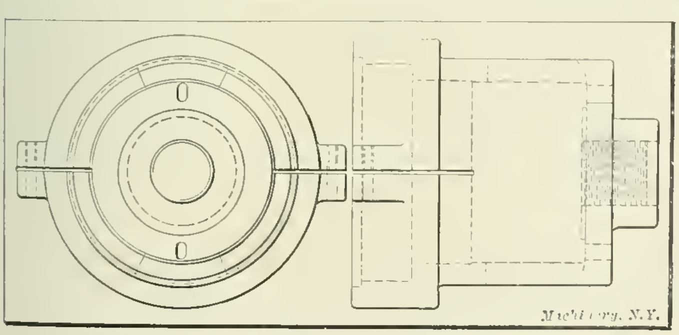


Fig. 2. Device for Holding Cone Pulleys while being bored

and in its place a long, heavy bar, reaching across the carriage, is inserted, this bar acting as the arbor on which the cutter head is mounted. The front end of this arbor is supported, when the tools are in action, by a bronze bushing inserted in the spindle. This prevents any springing action of the arbor or chattering of the tools, and tends to produce true and smooth surfaces in the pulley being bored.

The work can be turned out with considerable rapidity by this device. The total time required for the inside turning and facing of a four-step cone pulley having 4-inch steps, the largest step being 12 and the smallest 6 inches in diameter, is about 30 minutes. This is the average time for a lot of 60 cone pulleys, and includes the time required for setting-up, tool grinding, adjustment, etc.

The cutter head is fed into the work by operating the car-

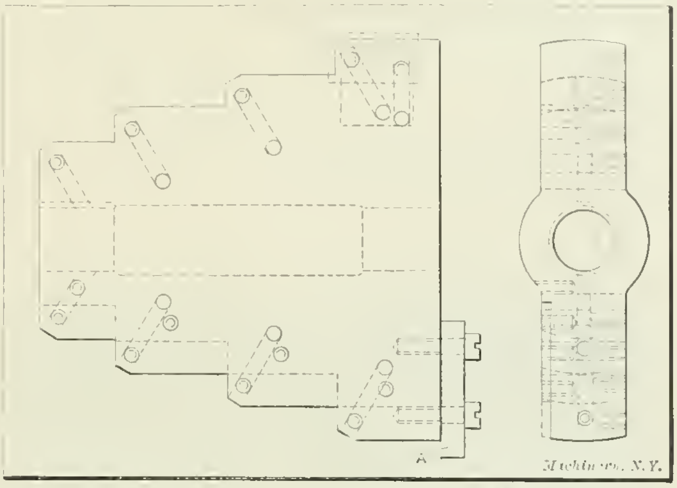


Fig. 3. Boring Head used for Boring and Facing Inside of Cone-pulley Steps

riage feed, the tailstock being attached to the carriage by means of two bolts between the shears.

Fixture for Milling Spanner Wrenches

In Fig. 4 is illustrated a convenient method for milling spanner wrenches. About a dozen wrenches are clamped in a fixture as indicated, a stop being provided at the bottom, in

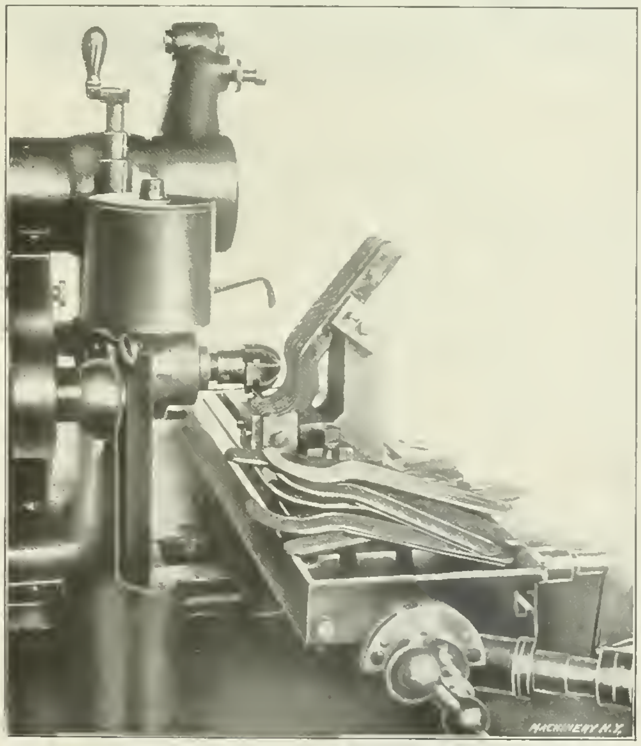


Fig. 4. Method of Milling Spanner Wrenches

the front, and two clamps on the side, one at the top and one at the bottom. A specially shaped cutter is used for milling the end and rounded portion of the spanner wrench to the required form. The advantages gained are the rapidity with which the work can be done and the accuracy and interchangeability obtained in the products.

Handwheel Turning Device

In Fig. 5 is shown an interesting and convenient device for turning the outside rounded surface of handwheels. The device is placed on the cross-slide of a lathe carriage, and can be used for any diameter of wheel within the capacity of the lathe. It can also be used for handwheels with rims of

different radii, by moving the turning tool in or out in its holder. The device consists of a base-plate, fitted to the cross-slide. The upper part of this base-plate is provided with a circular projection, on the cylindrical face D of which teeth are cut as shown. On the base-plate, and pivoted at its center, is mounted a tool-holder C. This tool-holder can be rotated about the center of the base-plate by means of a small pinion placed on the lower end of the upright shaft A shown in the illustration, which is provided with a handwheel B at its upper end. In this way, when the handwheel B is operated, the tool-holder C will move in a half-circle about the rim of the handwheel, and thus the rim will be finished to the required shape.

Jig for Drilling Cutter Grinder Dog

In Fig. 6 are shown three devices, each of which is of considerable interest. The one shown at A is a jig for drilling dogs used on a cutter grinder. The features of this jig are the simplicity of the locating and clamping means and its

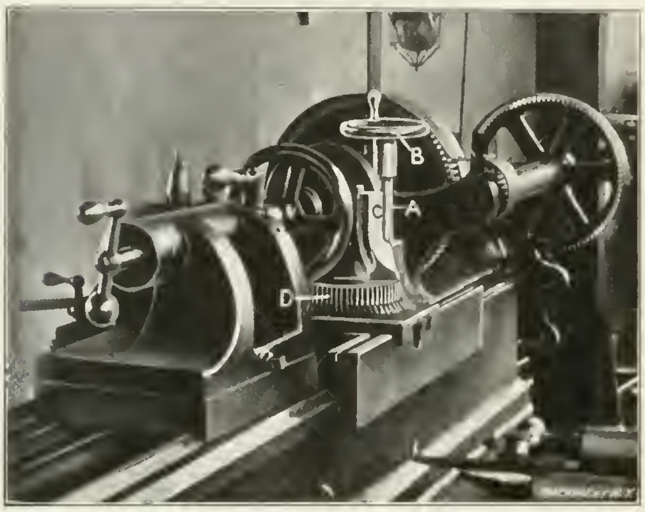


Fig. 5. Turning the Rim of a Handwheel

adaptability to dogs of varying shapes and sizes, as indicated by the collection in the front of the jig. The hole to be drilled is the set-screw hole in the dog, and the latter is located for the drilling by means of a cone center entering the large center hole in the dog. This cone center is made in one piece with clamping-stud B. The dog is further located by a spring plunger C, which enters into the slot D in the dogs. Clamping-stud B slides freely in its hole in the jig body, but a key prevents it from turning. The clamping is effected by screw E passing through the swinging arm F, which swings out of the way when a piece of work is removed or inserted, as clamping-stud B must then move outward. When the arm is again in position one turn of the binding screw will clamp the work. The device is very quickly manipulated, and is

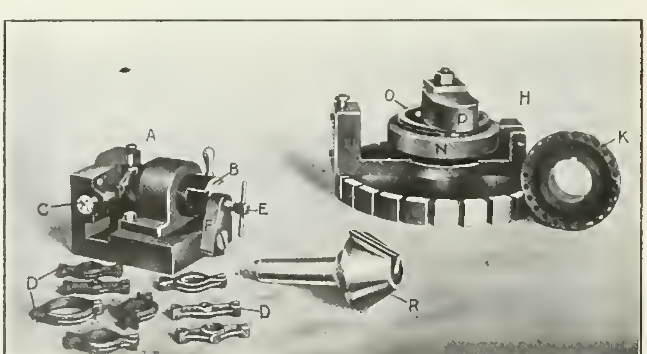


Fig. 6. Two Examples of Drill Jigs and a Combination Centering Tool and Cone Center

very convenient on account of the wide range of sizes it can take care of.

Jig for Drilling Index Worm-wheels

At H in Fig. 6 is shown a jig for drilling the holes for direct indexing in an index-head worm-wheel. The advantages of the jig are the accuracy obtained, the elimination of broken drills, and the convenience of operation. Instead of having a jig with twenty-four guide bushings, one for each hole to be drilled, this jig has but one guide bushing, and it remains always in a fixed position beneath the drill spindle. In the illustration, K is one of the index worm-wheels which has been drilled, and another is shown in the jig at O. The base L of the fixture is an index-plate, which is secured to the drill-press table when the jig is in use. Members M and N are movable, and hold the work to be drilled, these parts

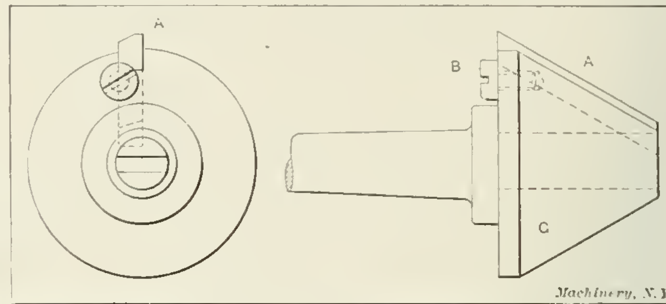


Fig. 7. View showing Principle of Combined Centering Tool and Cone Center

being pivoted at the center of the index-plate. Guide-bushing holder P is secured to the index-plate, and, hence, is stationary. The action of the device is simply that the work is indexed for each hole to be drilled, the jig itself remaining in a fixed position. This insures that the drill is always in line with the guide bushing, after it has once been so adjusted, and the difficulties due to non-alignment of drill and drill bushing are avoided. A 5/16-inch drill, as used in this case, would not be able to pull a heavy fixture into place, if drill and bushing were not in line, and the drill would most likely break. The greater accuracy obtained, and the simplicity and convenience of operation are the main advantages obtained by the use of this fixture.

Combination Centering Tool and Cone Center

At R in Fig. 6 is shown a combination centering tool and cone center which has been found very convenient. A detailed

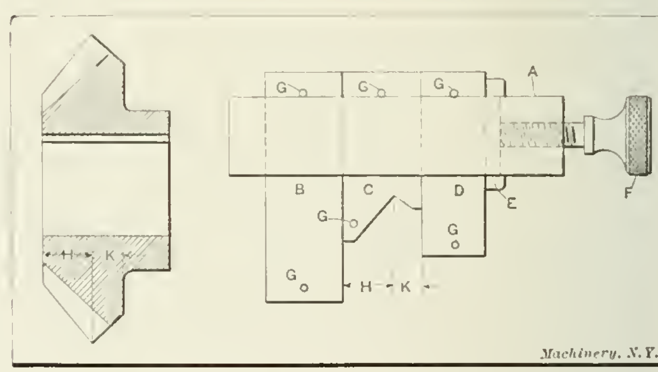


Fig. 8. A Gage for Turning Bevel Gears

view of the construction of this tool is shown in the line-engraving Fig. 7. The tool is used first for centering the front bearing box for a milling machine, before turning, and is afterward used as a revolving cone center, the tool having been removed. The end of the hole in the bearing-box casting is rough, so that it is impossible to use it as a support while turning the outside, unless it is first centered. The purpose of the tool shown is to eliminate a separate centering operation, and to provide a rapid means for centering the box, so as to obtain a true bearing surface for the cone center. This is accomplished as follows: The tool is held in the tailstock of the lathe and the bearing box is chucked as usual. The operator then slips tool A, Fig. 7, into its slot, in which it is held endwise by the head of screw B. He then brings up the tailstock spindle toward the work, and centers it. Then the tool A is removed, and the member C, when brought into position, acts as a cone center. The operator is now ready to proceed with the turning. When centering, the tool A itself acts as a key, locking the cone center and the arbor together, so that the tool will not revolve about the arbor while centering, although the cone center itself is of the revolving type.

Gage for Turning Bevel Gear Blanks

In Fig. 8 is shown a convenient gage used when turning bevel gear blanks; by means of this gage the correct angles and the dimensions of the face and the thickness of the gear are quickly and accurately obtained. The gage consists of a holder *A* made of rectangular cross-section and having a rectangular slot through it, into which the gage pieces *B*, *C*, and *D* are inserted. A binding shoe *E* is provided, against which screw *F* is tightened when it is required to hold the gage pieces in position. The latter pieces have a free sliding fit in the slot in holder *A*, so that they can move easily when not clamped by screw *F*. Pins *G* are provided to act as stops, so as to prevent the gage pieces from sliding out of the holder. On the side of the holder is stamped the number of the machine and the size of the gear for which the gage is used, so as to prevent mistakes in the use of the tool.

When turning the blanks, the face angle is first machined, and the gage is used for obtaining this angle and distance *H* (see section of gear to the left in Fig. 8). When first gaging the angle, parts *B* and *D* can be moved back, out of the way. When the width of the gear is gaged, *B* and *D* are moved back into the position shown in the engraving. The dimensions *H* and *K* of the gear correspond to distances *H* and *K* in the gage. One of the principal advantages of this tool is that it permits the gear to be gaged without taking it off the mandrel. In addition, the mistakes frequently made in measuring angles by regular bevel protractors are guarded against. With this gage there is no possible chance, or, at least, no excuse, for a mistake in angles or dimensions. E. O.

* * *

COOPERATIVE ENGINEERING EDUCATION

The system of engineering education inaugurated by Prof. Schneider of the University of Cincinnati, under which students work one week in the class room and one week in the shop, seems to meet with general favor. In one instance, a large steel and concrete construction company was requested to take two or more students to work in its shop in connection with its outside contracting work. The chief engineer of the company advised against employing the students. He was not in favor of employing college graduates when out of college for the first few years, anyway, because of the difficulty of making them apply themselves conscientiously to the simple duties at first entrusted to them, the average young engineer usually appearing to believe that his education fits him to begin somewhere else than at the bottom of the ladder. The chief engineer in question believed that the case would be somewhat similar with these students from the university. This belief seemed well founded, especially as the work of the company, because of its very nature, is more or less spasmodic, and at certain periods there is comparatively little to do. At such times some very simple work, laborer's work, in fact, might have to be given to the boys, and the chief engineer expected that this would cause dissatisfaction and trouble. However, the boys were taken on, and it is very gratifying to state that they have worked right along, doing, with apparently equal enthusiasm and efficiency, any kind of work given to them. The Schneider system of engineering education seems to eliminate the objectionable features which manufacturers and mature engineers have always been prone to point out in the young college graduate. The Cincinnati method of "catching them young" seems to have a great future ahead.

* * *

The Toledo Machine & Tool Co., Toledo, Ohio, manufacturer of punch presses, drop hammers and other sheet-metal working tools, makes a practice of giving the speed at which its machines should be operated. On the punch presses the speed of the flywheel is stamped on the rim, as is also an arrow indicating the direction in which the flywheel should be rotated. This appears to be information that is worth while, and is useful not only when setting up the machine for the first time, but also when replacing the belt, should it come off, as it is a common occurrence for a punch-press operator to put the belt on so that the press is driven in the wrong direction.

HOLDERS FOR SCREW MACHINE CHUCKS

The accompanying illustrations show two types of holders used when grinding screw machine chucks in the shops of the L. S. Starrett Co., Athol, Mass. The holders are of simple design, and are well adapted to meet the requirements. In Fig. 1 is shown the type of holder used for grinding Nos. 1

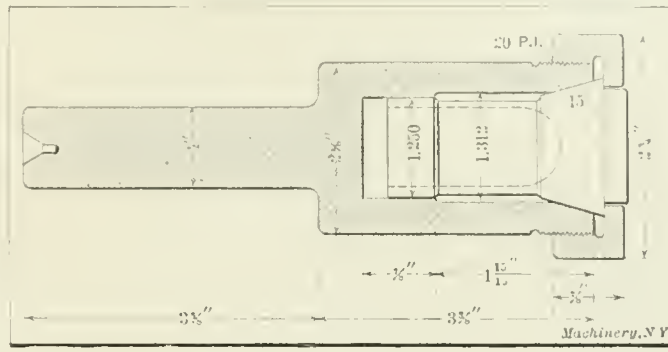


Fig. 1. Holder for Grinding No. 1 Brown & Sharpe Screw Machine Collets

and 2 Brown & Sharpe screw machine chucks. The dimensions given in the illustration are for the holder for the No. 1 machine. This consists of a main body made of machine steel, carbonized and hardened, and a cap made of machine steel, knurled on the outside, and casehardened. The part to

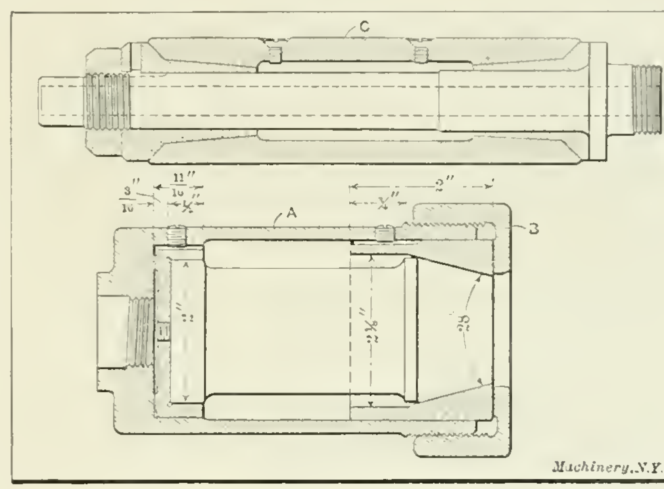


Fig. 2. Holder and Quill for Grinding Hartford and Pratt & Whitney Collets

be threaded is protected from the carbonizing influence during this process, and the thread is cut after hardening.

In Fig. 2 is shown the type of holder used for grinding screw machine chucks for the Pratt & Whitney and Hartford screw machines. The same chuck body *A* and cap *B* are used for a number of sizes of chucks, but adapter bushings are made

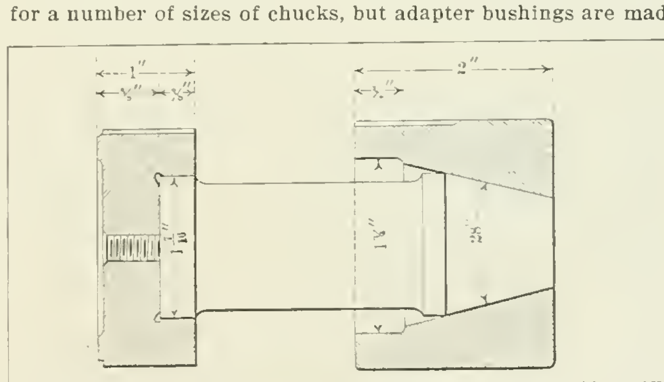


Fig. 3. Adapter Bushings used in Holder shown in Fig. 2

as indicated in Fig. 3, two bushings, of course, being required for each size of chuck. The quill shown at *C*, Fig. 2, is screwed into the end of the chuck body *A*, the end of the spindle being a tight fit in the chuck body both on the threaded part and in the plain, straight hole. The quill and chuck holder are not taken apart after they are once assembled. The chuck-seats and angles in the bushings that fit into holder *A* are ground in place after assembling the quill and chuck body, the bushings, which are made of machine steel, having previously been carbonized and hardened.

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Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Fred. H. Moody,
Associate Editors

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JULY, 1911

PAID CIRCULATION FOR JUNE, 1911, 26,034 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SCIENTIFIC MANAGEMENT AND ECONOMIC PROBLEMS

In December, 1906—nearly five years ago—Mr. Frederick W. Taylor read his famous presidential address "On the Art of Cutting Metals," before the American Society of Mechanical Engineers. Although the discovery of high-speed steel by Taylor and White in 1898 had effected a revolution in the design of machine tools in general, comparatively few at the time recognized the fact that a new era in manufacturing had dawned—not simply because of the discovery of a new cutting steel, but because of the development of a system of managing men which had accomplished results never before attained, and which is destined to have far-reaching effects.

The great interest in Mr. Taylor's address before the National Machine Tool Builders' Association in Atlantic City last May shows that machine tool builders are studying production methods and management as they have never studied them before. Comparatively few of the builders of metal-working machines know what the possibilities of their product are or how to determine them. They heard with astonishment of cases where production has been multiplied eight-fold by studying the operator at work and reducing to a minimum the number of his movements necessary to produce a part. The result of scientific management is reduction of labor costs and increase of wages.

In his address, Mr. Taylor spoke of the limitation of output as being one of the greatest evils of our times. Workmen are generally deluded with the belief that their prosperity as a class depends upon doing as little and getting as much for it as they can. This is a fundamental error, as everyone should know who has made even an elementary study of economics. Workmen are the chief consumers, and if they produce little there is a scarcity of manufactured goods to consume—a condition that is indicated by high prices. But the inefficiency of workmen directly engaged in manufacturing is not the only cause of high-priced output. Inefficient selling organizations, high transportation rates, high tariff, private ownership of land and valuable franchises, are a few of the other conditions which limit output and raise prices. Mr. Taylor's scientific management is a wonderfully efficient means of producing at low cost; but until the cost of marketing is reduced, the consumer will continue to pay too much for his commodities. Along with scientific management we should have scientific business methods and scientific government, in order to cheaply distribute commodities that are cheaply produced. Many of the departments of the national government furnish striking examples of waste and inefficiency.

* * *

SELLING MACHINE TOOLS

The salesman who can market machine tools successfully must be of a different type and training from those who sell commodities. He must possess, besides the selling faculty, a thorough mechanical knowledge of his machine, and the ability to take off his coat and demonstrate it at a moment's notice. The modern purchaser of machinery is keenly alive to the importance of getting the machine best adapted to his work, and of paying no more for it than he must; and a salesman who doesn't thoroughly understand his business will find that the possible buyer knows more about the subject than he does.

The peculiar combination referred to is seldom found in one person, and the most successful machine tool salesmen have been graduated from the shop, worked into a thorough knowledge of their specialty, and educated in the selling end—a process which requires time and doesn't always result as the employer hopes.

Machine tool manufacturers sometimes complain that dealers' salesmen don't give enough time to pushing their particular machines. How can they, when they have a hundred different machines to sell? A salesman's business is primarily expressed in figures, and when he is selling a line of standard tools of various kinds, totals can most readily be increased by selling what a customer wants, or thinks he wants, rather than by educating him to see that he doesn't know what he wants, but should have another machine than the one he had in mind. This condition has resulted of late in a constantly increasing number of specialists, who cover their territory systematically; and if they can't sell a man a machine no one can. Even on standard tools like lathes, planers, etc., the most successful manufacturers employ their own specialists to supplement the work of their agents.

* * *

THE INDIRECT CUSTOMER

Many people connected with the manufacturing end of a business consider that advertising and publicity matter which reaches any one except actual prospective buyers is wasted; and although it does seem wasteful to distribute expensive catalogues to every one who asks, many concerns make it a practice to do so, and feel that it has been profitable. It has been said, with a great deal of truth, that "the opinion of the man who may never buy, often guides the man who buys"; and that is the real reason why it pays to distribute advertising literature to inquirers who may not themselves be buyers but whose opinions and advice may count when those in authority are ready to decide on the buying of new equipment. The opinion of a machine operator working under obscure conditions in the shop, and perhaps never coming into direct contact with the purchasing department of his own firm, has often an influence on the purchase of a machine such as he is operating. His opinion is transmitted to the foreman, through the latter to the superintendent, and then to the manager; and somehow the unanimous opinion of the operators will very likely be the prevailing opinion in the organization when a machine is bought. Therefore it is worth while to convince the operator of the advantages of the machine, and to point out to him through the channels of advertising literature, the best methods of operation and the means of avoiding difficulties in the working of that particular machine.

The same logic also applies to advertising in engineering journals. There is a kind of public opinion in industrial plants as well as elsewhere which is very powerful, and every person who tries to reach customers through advertising, whether by catalogues or through the engineering press, should remember the maxim that "the opinion of the man who may never buy often guides the man who buys."

SUGGESTIONS FROM READERS ALWAYS WELCOME

Many readers of MACHINERY occasionally feel an impulse to write to the editor suggesting some topic for publication, or criticising an article that has been published, but hesitate for fear their suggestions are not desired.

We are always glad to receive criticisms and hints from readers, no matter what their positions are or what their experiences have been. Every reader has a right to expect that MACHINERY will, one time or another, treat practically every phase of machine shop practice; and if any subject has been neglected, the reason is that we have not recognized the need, or have not found a man with the practical experience required to write on it authoritatively.

Although special knowledge is necessary to write an informative article on almost any subject, an observing man will obtain ideas of general interest from a comparatively short mechanical experience. There is hardly a reader of this article who cannot add some bit of personal knowledge of shop practice which is unknown to the majority of mechanics. Machinists working in repair shops connected with mills and factories have peculiar problems to handle, and peculiar methods are developed for doing work unknown to machine shops engaged in manufacturing or general jobbing work. We want to know about such operations even though it may not be feasible to describe them at the time. Write us about them.

Die-casting, permanent mold work, cold drawing, deep-hole drilling, rifling, muffle brazing, aluminum soldering, mechanical assembling, machine tool repairing, alignment of shafting, erecting large engines, boring cylinders, repairing broken gears, handling men and teaching apprentices, shop management, drafting-room methods, making or breaking press fits in different places, treating steel for permanent magnets, refined methods of producing precision work, practical mathematical problems, laying out and erecting cams, eccentrics and cranks, are a few of many topics of general interest.

What articles would you like to see published? What articles published during the past year have been of the most interest to you, and what ones have interested you least?

* * *

ARE TRADE SECRETS WORTH KEEPING?

The difficulty of keeping a manufacturing process secret is well known to all who have had occasion to employ methods of the kind known as "trade secrets." As long as the method requires that hired help be employed, and as long as men wander from employer to employer in search of better compensation or working conditions, so long will it be extremely difficult to employ trade secrets in manufacturing which for any length of time will remain unknown to competitors.

There are numerous instances of competing firms employing the same or similar means for accomplishing the same results, which each firm zealously guards from its competitors; but as the men who move from place to place learn of these methods there are very few trade secrets which an enterprising manufacturer cannot come into possession of through employes who have at one time or another worked for a competitor.

This condition is recognized by discerning manufacturers in many lines. One firm which for several years has kept secret the design of certain machines used in its manufacturing processes, has apparently concluded that sole dependence on this method is unsatisfactory and unsafe, and patents are now being taken out to protect the machines and methods from infringement. This course undoubtedly is much wiser than trying to keep the methods secret. As a rule, it may be said that wherever a large number of men are employed, the mere fact that certain methods are kept secret furnishes an incentive to find out about them; and the employes are certain to give them more attention than if nothing were done to conceal the design of the machine or the method. Each manufacturer of course must follow his own judgment as to the better policy; but it is worth noting that the firms who have no trade secrets, and who show freely all their methods to the interested visitor, are, as a rule, fully as prosperous and successful as those whose shops and methods are, in a way, under lock and key.

CALCULATING CENTRIFUGAL FORCE*

The calculation of the centrifugal force in a flywheel or pulley rim requires considerable time on account of the several factors entering into the generally used formula. The sum of the centrifugal (radial) forces of the whole rim of a flywheel is:

$$F=\frac{W v^2}{g R}=\frac{4 W \pi^2 R n^2}{3600 g}=0.000341\ W R n^2$$

in which

F = centrifugal force in pounds;
W = weight of rim, in pounds;
v = velocity of rim, in feet per second;
g = 32.16 = acceleration due to gravity;
R = mean radius, in feet;
n = revolutions per minute

The formula is not, however, in most cases as convenient in this form as it would be if the radius were given in inches. Let r be the mean radius in inches. Then

$$F = 0.000028416\ W r n^2$$

Now let $C = 0.000028416\ n^2$. This, then, is the centrifugal force of one pound, one inch from the axis. The formula can now be written in the form:

$$F = W r C$$

If C is calculated for various values of the revolutions per minute n, and the calculated values of C tabulated as in the accompanying Data Sheet Supplement, then the arithmetical work of the calculation of centrifugal force may be reduced to a minimum. It is simply required to find the value of C in the table and to multiply it by the product of W and r, the five multiplications in the original formula given thus having been reduced to three. The saving in time is, of course, not as decided as in many other cases where tables may reduce the arithmetical work to but a fraction of that generally required, but the saving is nevertheless well worth while.

* * *

CALCULATION OF BENDING AND TURNING MOMENTS FOR ROUND SHAFTS†

The bending moment for a beam or shaft of any cross-section may be expressed by the well known general formula:

$$M_b = \frac{S I}{c} = S Z$$

in which

M_b = bending moment in inch-pounds,
S = working stress in pounds per square inch,
I = moment of inertia of section about an axis passing through the center of gravity,
Z = section modulus, or moment of resistance,
c = distance from center of gravity to most remote fiber.

For circular cross-sections

$$I=\frac{\pi d^4}{64}, \text{ and } Z=\frac{I}{c}=\frac{\pi d^3}{32}$$

In actual calculations, most of the time is consumed in carrying out the arithmetical work involved in determining the moment of inertia I, and the section modulus Z. In order to eliminate this work in calculations for round shafts of ordinary proportions, the tables in the accompanying Data Sheet Supplement have been prepared. These tables give the values of I and $\frac{I}{c}$ $(=Z)$ for shafts from 1 to 10 inches. The table may also be used for other diameters by multiplying the values given by the cube or fourth power respectively, of the ratio of the diameter for which the values are to be found to the diameter given in the table. For example, if the moment of inertia of a shaft 10 inches in diameter is required, find in the table the moment of inertia for a shaft of 1-inch diameter, and multiply this value by 10,000, which is the fourth power of the ratio of the two diameters. The moment of inertia of the 1-inch shaft is 0.04909. Hence, the moment of inertia of a 10 inch shaft is 490.9.

* With Data Sheet Supplement.
† With Data Sheet Supplement. For section moduli and moments of inertia, advancing by sixteenths, eighths, and fourths, see Data Sheet No. 87.

The twisting moment for a beam or shaft of any cross section may be expressed by the formula:

$$M_t = \frac{S\,J}{c}$$

In which

M_t = twisting moment in inch-pounds,

J = polar moment of inertia of section,

and S and c have the meaning previously given.

For circular cross-section

$$J = \frac{\pi\,d^4}{32}, \text{ and } \frac{J}{c} = \frac{\pi\,d^3}{16}$$

The values of J and $\frac{J}{c}$, hence, can also be found by the aid of the tables in the accompanying Data Sheet Supplement, as it is apparent that J and $\frac{J}{c}$ are exactly double the values of I and $\frac{I}{c}$, respectively, for the same shaft diameters. This relationship is true only for circular cross-sections.

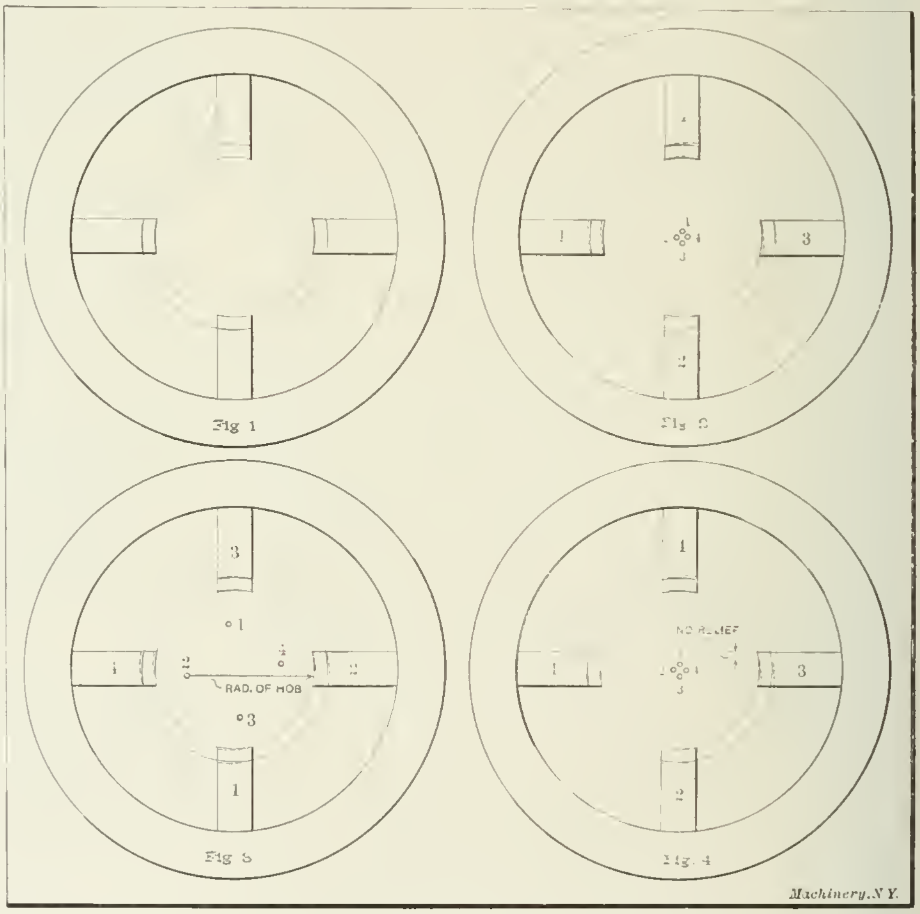
* * *

RELIEVING DIE CHASERS

By CORRESPONDENT

A proper relief on die chasers is very important if good cutting action and standing up qualities are to be expected. There are a number of methods by which die chasers may be relieved, some of which give no satisfaction at all and others of which give a reasonable measure of satisfaction, but the method advocated in the following is more satisfactory than any other known to the writer.

In Fig. 1 is shown a die with four chasers, the chasers having been milled with a hob of the same diameter as the thread to be cut, and with the center of the hob coinciding with the center of the die in which the chasers are inserted. In other words, these chasers have no relief. In Fig. 2 the dotted line indicates the appearance of a relieved thread in the chasers, the relief being obtained by using the same hob for cutting the chasers as was used in the case of Fig. 1, but with the center of the hob moved slightly toward one side with reference to the center line of the chaser, as indicated by the four small circles near the center of the die, each of these representing the center of the hob when cutting the chaser correspondingly marked. Relieving dies by this method gives a keen cutting edge, but there is too much relief back of the edge, and the chaser does not stand up in a satisfactory manner. The piece threaded is also likely to be out of round, unless the relief is very slight.



Figs. 1 to 4. Different Kinds of Relief for Die Chasers

In Fig. 3 is shown a method of relieving the chaser so as to produce a smaller relief immediately back of the cutting edge, but producing at the same time an ample total relief so as to permit the die to cut freely. This method also produces a stronger cutting edge. In this case the relief is cut with a hob of considerably larger diameter than the diameter of the thread to be cut, as indicated by the small circles, each of which represents the center of the hob when cutting one of the chasers, and which are marked with figures corresponding to those on the corresponding chasers. The center of the hob is, of course, moved slightly to one side of the center line of the chaser. This relief is preferable to the relief shown in Fig. 2, and may be considered fairly satisfactory.

In Fig. 4 is shown the method of relieving die chasers which is advocated by the writer. In this case the chaser is cut by a hob of the same diameter as that of the thread to be cut by the die, but the center is set over to such an extent that the relief does not extend clear to the cutting edge, but leaves a section equivalent to about one-quarter of the width of the chaser without relief. This gives the cutting edge additional strength and enables it to stand up for a considerable time without being dulled or losing its size. The relief provided is ample for clearance, and a free cutting chaser is provided.

Of course, the cost of the chaser becomes somewhat greater, as it is necessary to cut it twice, first with the hob center exactly on the center line of the chaser, and then with the hob moved over toward one side. In the other cases, one cut is sufficient, as the relief extends to the point of the cutting edge. So far as the writer knows, there are no chasers manufactured for the market on this basis, and it is necessary for anyone who wants to use chasers of this type to cut them himself.

* * *

ULTIMATE RESISTANCE OF SOILS AND ROCKS FOR FOUNDATIONS

In an article on "The Importance of Scientific Investigation" in the *Journal* of the American Society of Engineering Contractors, a table of the ultimate resistance of soils and rocks is given. While this table pertains more particularly to structural engineering, it may be of some value to machine erectors and others engaged in the setting up of heavy machinery on foundations or other structures. The table giving the ultimate resistance of foundations is as follows:

	Per square foot
Compact bed-rock granite or equivalent......	30 tons
Compact bed-rock limestone, Northern, sound	25 tons
Compact bed rock sand-stone, Northern, red..	20 tons
Dry coarse gravel, well packed..............	6 to 8 tons
Soft friable rock, shales, etc.................	5 to 10 tons
Good solid, natural earth, dry...............	4 to 6 tons
Clays, in thick beds, absolutely dry	4 tons
Clays, in thick beds, moderately dry.........	2 tons
Soft clays	1 ton
Compact dry sand, well cemented............	4 tons
Clean dry sand, natural......................	2 to 4 tons

CINCINNATI BICKFORD TOOL CO.'S PLANT AT OAKLEY, CINCINNATI

The modern tendency to plan a shop so that the work can pass through it from beginning to end, and all the required operations be performed on it without the unnecessary moving of heavy pieces back and forth, is unusually well exemplified in the new plant of the Cincinnati Bickford Tool Co., located at Oakley, forty minutes out, by trolley, from the business center of Cincinnati, Ohio. The location of all the machinery and of the various departments in this shop was carefully planned before the shop was built, so as to insure that all details in the completed plant would meet with the requirements of economical manufacturing methods. It is the object of the following article to briefly describe the arrangement and main features of this plant.

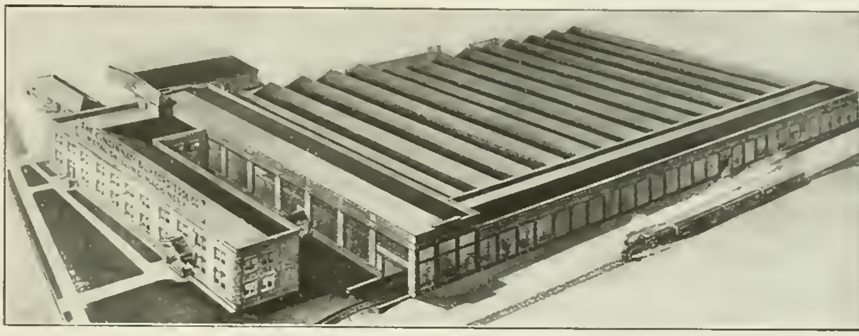


Fig. 1. Bird's-eye View of the Cincinnati Bickford Tool Co.'s Plant

The exterior of this modern manufacturing plant is shown in Fig. 1, while Fig. 2 shows a diagrammatical outline of the plant and the arrangement of the machinery in it. The plant is a one-story building with saw-tooth roof construction; only the office building and the adjoining ell containing the washroom and pattern-shop are two stories high. The general arrangement of the plant will be most easily understood by direct reference to Fig. 2. The shop building proper is 430 feet long by 165 wide. At each end of the shop there is a depressed track leading into it, this track connecting with a railroad track passing by the plant. The reason that one track has been led in at each end, instead of having the track pass straight through the shop along one side, is that floor space is saved by the adopted arrangement. The length that the tracks project inside of the shop at each end is 90 feet, which is ample for permitting two cars to come into the shop at each end at once; this is all that is required at any one time. The track is four feet below the level of the floor in the shop, so that the car floor will be level with the shop floor to facilitate loading and unloading. The track entering at the right-hand side in Fig. 2—the north end—is intended for incoming material, rough castings, bar stock, etc., while the track at the south end is intended for the shipping of finished machines. The whole shop has been laid out with the idea of having the incoming material pass through the various operations, in successive order, from the north to the south end, without unnecessary handling or moving back and forth.

The last bay toward the north end is set apart for a stock-room for rough material and for small parts made in the shop or bought from the outside. This stock-room is 28 feet wide and extends across the shop, as shown. The bay into which the car track enters runs lengthwise of the shop and is 35 feet wide. In this bay are placed the largest and heaviest machines, which take care of such heavy castings as require to pass through this bay only. It is equipped with a lathe for turning heavy drill press columns and sleeves, a boring machine for large castings, two planers and large radial drills. The remainder of the floor space in this bay is employed for assembling and testing the largest sizes of machines. The bay is served by a 15-ton Pawling & Harnischfeger cage-operated crane. The heaviest parts of machines can thus be removed from or placed upon the cars without difficulty, as the cranes go clear over the projecting railroad tracks and cars.

The material for small and medium sized parts is issued directly from the stock-room at the north end, a long counter being provided between the stock-room and the remainder of the shop. The cutting-off machines are placed immediately outside of the stock-room, and the manufacturing operations on the parts begin in the space adjoining. The turret lathes for castings and the screw machines for bar stock are placed as indicated in Fig. 2 in a place close to the stock supply, so that the bar stock and castings go right from the stock-room to the machines. As the operation immediately following the turret lathe work on castings is often hand reaming, a bench for this purpose is provided close to the turret lathes. The reamers to be used are kept on the bench, so as to be handy

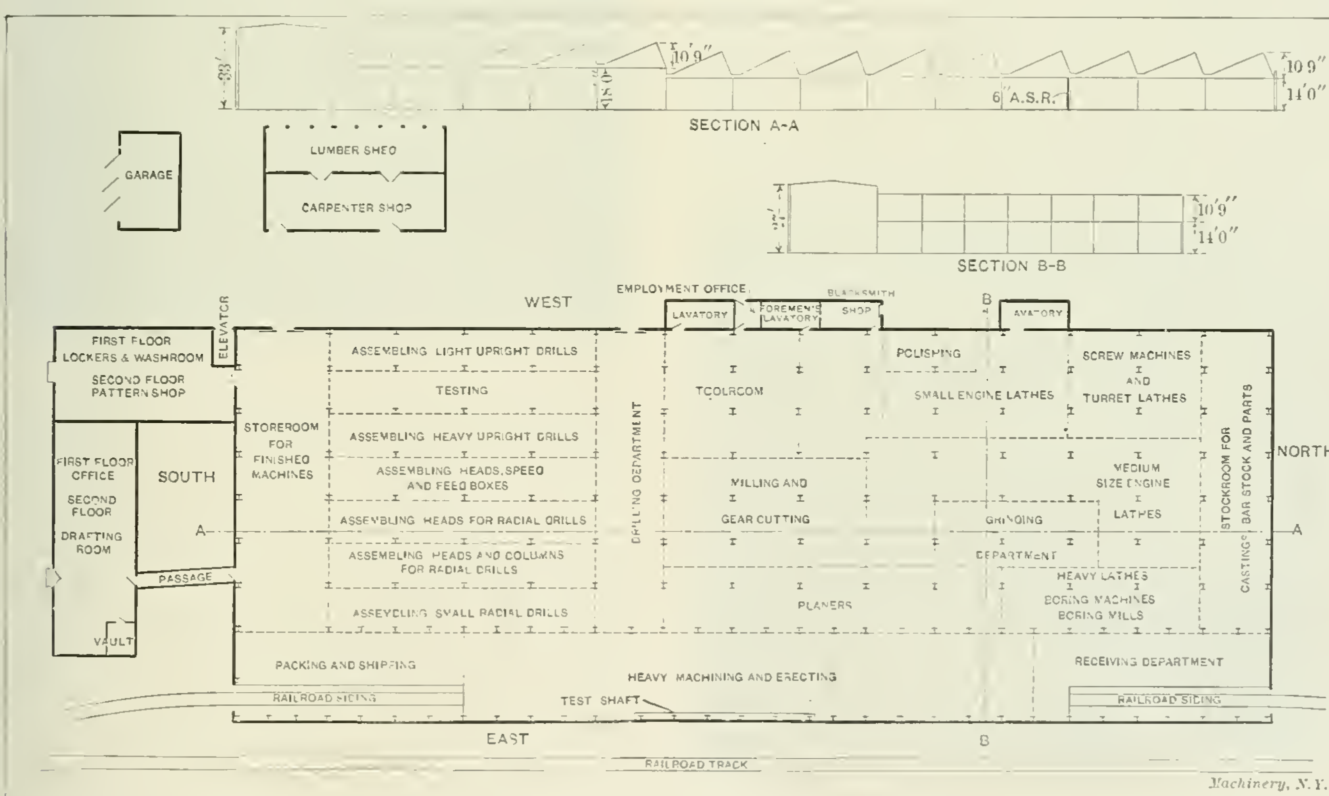


Fig. 2. Lay-out of the Plant showing Arrangement of Machinery, etc.

to the men, and every hole is tried with a steel plug after reaming, to insure that it is of the right size. If the reamers are found to be below size, they are returned at once to the tool-room for re-adjustment and grinding. Fixtures, tools and jigs are stored in several places throughout the shop, the idea being to keep each set of fixtures and tools close to the machines in which they are to be used, so as to save time in handling the fixtures and returning them to their respective places.

As turning operations are usually next in order, the engine lathes are placed immediately adjoining the turret lathes. In this department are also placed two turret lathes used

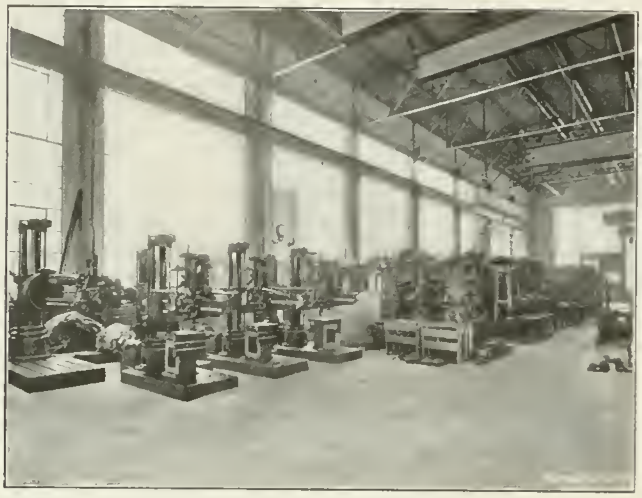


Fig. 3. South Bay—The Finished Stock-room

exclusively for the making of bronze bushings. It should be understood that there are no partitions or obstructions of any kind between the various departments, the dotted lines in the engraving merely indicating the boundary lines between the space set apart for each class of machines. After the small parts leave the lathes they arrive at the grinding department which is next to the lathe department; parts which are not ground go to the polishing department. In the space adjoining the space set aside for these machines are placed the gear-cutting and milling machines; in this department are also placed the keyseaters and broaching machines.

The right-hand end of the bay which adjoins the wide bay on the east side containing the railroad track, is equipped with

Fig. 4. Assembling Bay for Light Upright Drills

machines suitable for medium-sized work. In this bay are placed heavy lathes, large grinding machines, boring machines, boring mills and medium and small sized planers. This bay is served by several small cranes.

From these departments the work now goes to the drilling department, which is located cross-wise of the shop. From here the work enters the various erecting and assembling departments, all of which are indicated in the engraving. The south end of the shop contains seven bays running lengthwise of the shop, and one large bay running cross-wise, at the extreme south end. This large bay, shown in Fig. 3, is set apart as a store-room, in which the machines are placed after having been assembled and tested and while awaiting shipment. The first bay, from the west side, a view of which is shown in Fig. 4, is used for the assembling of the lightest upright drills made by the company. The third bay, Fig. 5, is used for assembling larger sizes of upright drills. The second bay is used for testing the machines assembled in both the first and third bays. As soon as the machines have been assembled in the first or third bays they are set back into the space in the second bay for testing, thus clearing the floor in the erecting departments, and permitting a new lot of machines to be assembled. All the assembling bays are provided with cranes for carrying the finished machines into the store-room at the south end. The fourth bay from the west is used for assembling heads and feed boxes for upright drills, and speed boxes for upright and radial drills, the machines being built strictly according to the unit system of construction. The fifth bay is used for the assembling of universal heads for radial drills, and the heads for large plain radial drilling machines. In the sixth bay small radial drill-heads are assembled, as well as back-gear brackets for large radial drills. In the seventh bay, shown in Fig. 6, and next to the large east bay (a part view of which is shown in Fig. 7) containing the railroad tracks, small radial drills are assembled, and the tables for large radial drills are fitted up. The small radial drills are tested where they are assembled, being driven from shafts which run lengthwise of the bay.

The large bay running cross-wise of the shop at the south end is 35 feet wide and is served by a 10-ton Toledo cage-operated crane.

Fig. 5. Assembling Bay for Heavy Upright Drills

This bay is higher than the remainder of the shop, the object being to permit the 10-ton crane to run at such a height that all the cranes from the assembling floors will be able to run under and deliver work directly beneath the large crane. The tracks of the small cranes, therefore, project 7 to 8 feet into the large end bay. The 10-ton crane places the finished machine in position in the stock-room, to remain until shipment, at which time it loads it directly onto the car. This bay is of sufficient height for the crane to lift the machine vertically to such a height as not to interfere with the machines standing near, the lifted machine clearing the top of the other machines, so that it can be moved over them. One half of the store-room is devoted to upright drills and one-half to radial drills. A scale is provided in the east bay, near the track, where it can be conveniently reached either by the 15-ton crane in the east bay or by the 10-ton crane in the south bay. The crating for shipment is done in the space adjoining the track, and the location of the scale makes it convenient to weigh the machines at the time of shipment, both before and after crating, when required. The entrance of the railroad tracks into the shop is closed by means of vertical rolling steel shutters.

The tool-room is located at about the center of the shop on the west side, and covers a space of 56 by 48 feet. It is surrounded by a counter both at the front and sides, the space underneath the counter being utilized for racks or drawers containing the small tools. The tool-room is equipped with

grinding machines, lathes, drill presses, an arbor press, a shaper, and a milling machine. Two benches are provided, one for the making and adjustment of small tools, and the other for the making of jigs and fixtures, boring-bars, etc.

Adjoining the tool-room is a small employment office centrally located. The reason for locating the employment office in a central part of the shop is to make it convenient to take the applicant to the department in which he desires to work. The foreman of that department usually himself interviews the man to be engaged, and then recommends him to the general foreman if he finds him suitable for the work on which he would be employed. The sanitary arrangements are also centrally located, and a separate wash-room with lockers is provided for the foremen. The blacksmith shop is also located on the west side of the shop; here the tool dressing and light forging and casehardening is taken care of. The carpenter shop is located a short distance away from the main shop, near the south end, so that lumber for crating machinery, etc., can be brought straight from the shop through the stock-room to the shipping floor. The wash-room and lockers for the employes are located on the first floor of a two-story building at the south end of the machine shop, as is also the main office. The floor over the wash-room is utilized for the pattern shop, and on the second floor of the office building the drafting-room is located. A fire-proof vault running clear through the two floors in the office building is provided, the lower part of which is utilized for the main office, and the upper part for the drafting-room.

Fig. 6. Assembling Bay for Small Radial Drills

The shop, as arranged, has a capacity for from 400 to 500 men, although at the present time its full capacity is not utilized, about 300 men being now employed. A comparatively small floor space is required for the efficient working of a comparatively large force when the shop is laid out systematically as described. The quantity of the product which can be turned out for an equal floor space is also greatly enhanced by the systematic planning of the shop.

Six line-shafts are provided for the machine tools, the line-shafts running north and south, and each having its own motor placed at a height of about six feet above the floor. The assembling floors are provided with motors for the line-shaft from which the machines are driven when tested, and from this line-shaft power is also derived for small machines used for fitting purposes. In all, there is about 1800 feet of line-shafting throughout the shop. Practically all the bearings in the line-shafts are Hyatt roller bearings. The power is derived from a central power station, located 500 feet north of the factory, in which the company owns an interest. Underground lead-covered cables carry the power to the north-west corner of the machine shop where the switchboard is located. The wiring in the shop to the motors is carried in conduits beneath the floor.

The shop is excellently lighted by 91 Cooper-Hewitt lights. The character of the lighting is well illustrated by the half-tone Fig. 8, which was made from a photograph taken at night, with no other means of illumination than that provided by the regular lighting. The heating is provided for by a hot-water system of the Evans-Almiral type; the heating coils pass around the walls and overhead coils are also provided. The hot water is obtained from the power house mentioned, and brought to the shop in pipes laid in a concrete duct. Drinking water is provided for by six "bubbling" fountains, conveniently distributed throughout the shop.

The machine shop and assembling departments are of saw-tooth roof construction, the roof bays running from east to west. These bays, however, extend only to the south and east bays which are built independently of the regular saw-tooth roof construction. The distance from the floor to the trusses supporting the roof over the assembling floor is 18 feet, and over the tool-room and machine department, 14 feet. Cast-iron hangers let down the stringers for the shaft hangers to a distance of 12 feet from the floor. This has been found to be the best height to give the proper length of belts for the machines. The reason for having the trusses in the machine shop two feet higher than the height required for the shafting is simply to provide better ventilation. The roof windows face north, the total length of the sash being 126 feet. The upper half of the sash swings out and is operated by a chain from the floor, the entire length of each sash being opened from one point. All the window sashes are of metal, and the roof is of reinforced concrete construction. The floor consists of 3-inch pine-boards nailed to sleepers underneath, which are laid into a 5-inch layer of tarred concrete. The top of the floor consists of 7/8-inch maple. Overhead automatic sprinklers are provided throughout the shop.

Fig. 7. East Bay—Part of Assembly Floor for Large Radial Drills

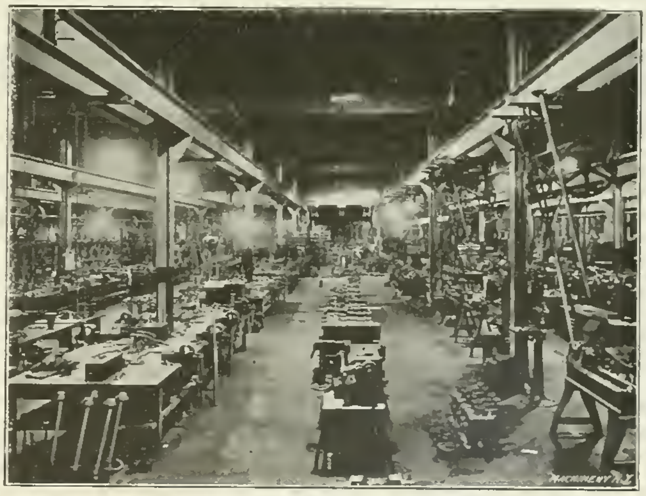


Fig. 8. Photograph taken at Night—Building illuminated only by Cooper-Hewitt Lamps

As will be understood from the previous brief description, considerable care was exercised in the design of this plant, and as mentioned in the introduction, it was possible to arrange the shop in the manner indicated only by laying out in detail the location of every machine before the size and general arrangement of the shop building was finally decided upon. The building was designed by the firm of Dodge & Day, of Philadelphia., Pa., in conjunction with Mr. Schauer, vice-president and general manager of the Cincinnati Bickford Tool Co., and the machinery lay-out was taken care by Mr. Schauer and Mr. Shafer, the superintendent. E. O.

TYPES OF MILLING MACHINE BRACES

By FRED. HORNER*

The column-and-knee type of milling machine affords a curious instance of the persistent retention of a design that is admittedly faulty. The knee, which fits against one vertical face only, has, in this overhanging position, to sustain its own weight and that of the superimposed slides, the table attachments or jigs, or dividing heads, and to resist the pres-

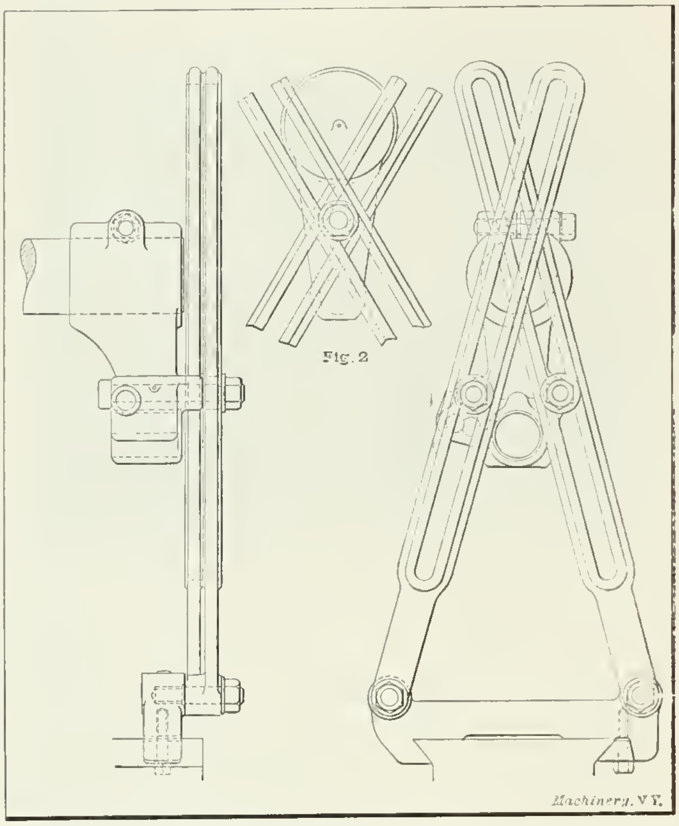


Fig. 1. Slotted Braces used on Brown & Sharpe Light Milling Machines. Fig. 2. Slotted Braces tied with a Single Bolt

sure of the milling cutter, without permitting vibration and chatter to occur. Yet the design, though unmechanical, is so useful that it cannot be supplanted by any other construction for the particular class of operations for which these machines are employed. If it were not for the fact that the knee must be capable of vertical adjustment, it would be easy

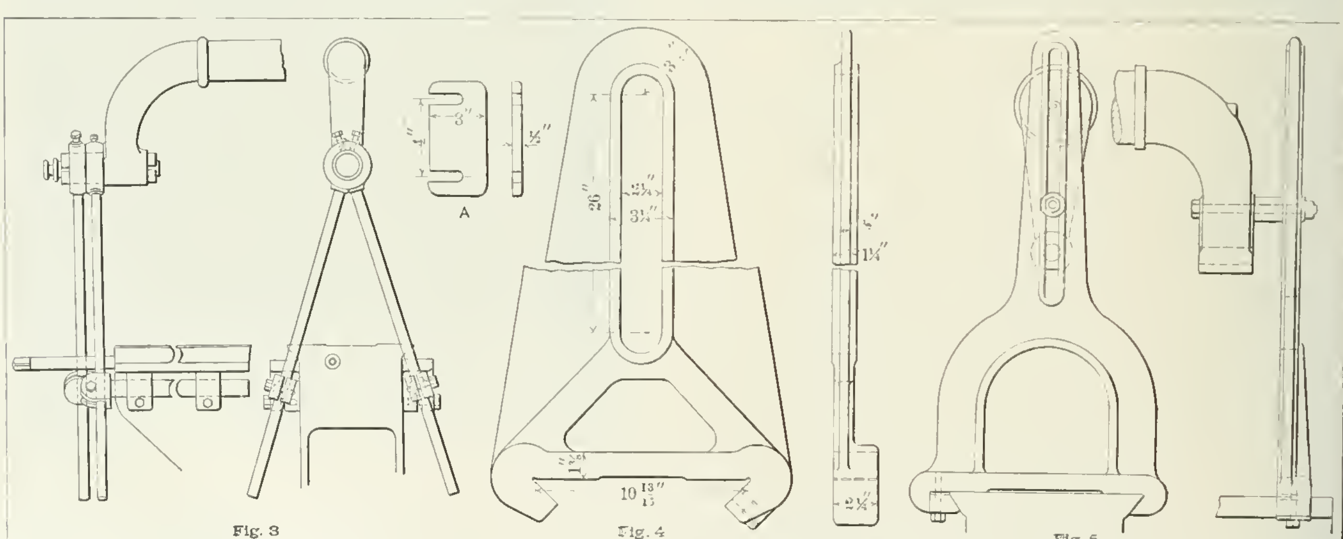


Fig. 3. Bracing made from Round Rods Fig. 4. Brace with Wide Central Slot Fig. 5. Arched Type of Brace

to provide a fixed bed underneath the longitudinal slide or table, but such a design at once greatly limits the range of the machine, and is only suitable for manufacturing operations of a repetitive or plain character.

The alternative to a movable knee is that of an adjustable spindle, moved up or down by its slide, but there are so many objections to this construction that it is but little employed. For the sake, therefore, of the great handiness of the column-and-knee machine, its defects are tolerated, and the inherent weakness is, as far as possible, compensated for by the employment of bracings, which tie the knee and the overhanging arm together, and also steady the outer bearing of the arbor. Such bracings naturally interfere to a certain extent with the operator's view of the work, and with the manipulations which have to be made; while for vertical feeding the bracing must be loosened. The inconvenience caused by the obstruction of the bracing is decreased in certain designs, either by adopting a perforated type of brace, or by placing it to one side, thus leaving the front fairly free of access. The latter type also favors the work being placed on the table with a portion projecting out at the front, as would

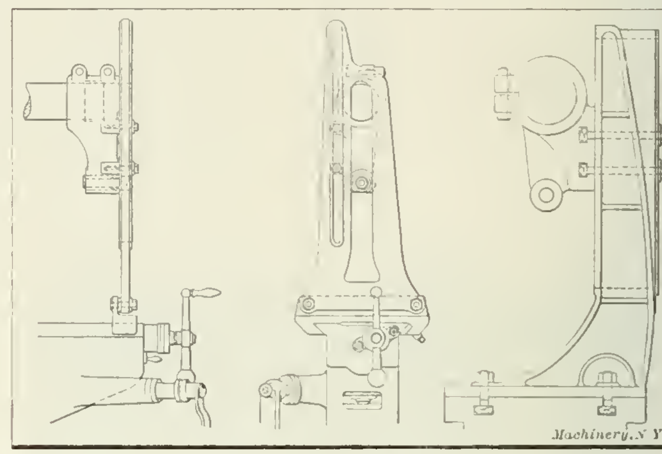


Fig. 6. Brace with Bolt Slot set to One Side. Fig. 7. Example of Brace set to One Side

be necessary when milling the foot of a pillar or bracket. As most of the intricate and difficult milling is frequently done on comparatively small and light pieces, the brace can be removed, when all objections vanish.

The easy adjustment and removal of a bracing is an important factor in machines where milling of a varied and frequently-changing class is done, and it will often be noticed that the lighter machines have their bracings secured by one or two bolts only, while the heavier types require four bolts in many instances to lock them to the arm and arbor support. This happens to harmonize both with the nature of the work done—light and heavy—and with the desired convenience of manipulation, since a small machine is subject to more frequent changes of work than a large one, which may continue on one class of operation or on long pieces for a considerable time.

The most popular type of brace which has been used in the past is that which is composed of two slotted bars or links,

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crossed over each other, and secured to the knee by a stretcher clamp, and to the overhanging arm with one or two bolts. This is a handy design, easily manipulated, light to handle, and causing but little obstruction. It does not, however, provide such a stiff construction as certain other types of bracings, and it is, therefore, largely superseded on designs of recent date, some firms having abolished it altogether on their machines, while others use it only on the smaller sizes of millers. The slotted arm is also in some instances made of increased width and material, as in the machines made by Kearney & Trecker Co., Milwaukee, Wis., and other machines of a similar type, the object of which is to resist the tendency to spring which such slotted bars exhibit.

Fig. 1 represents a typical bracing of the slotted-bar type, as used on one of the lighter styles of machines made by the Brown & Sharpe M'f'g. Co., Providence, R. I. The bars are pivoted on studs set into the knee clamp, which is secured by a wedge gib, and a couple of bolts passing through holes in the center-arm head bind the braces to this. In some designs of machines the two bolts passing through the arbor head are replaced by a single bolt, as shown in Fig. 2. This type though more rapidly manipulated than the other, does not afford such a good resistance to lateral motion of the arbor support. Sometimes a handle takes the place of the single nut, to avoid the necessity of using a spanner.

Another variation is that of inserting a bolt at the point where the braces cross as shown in Fig. 1, and binding them together with it, so as to provide a little additional security. It will be seen that the reason for separating the braces in this design, is not only to better resist the lateral or "ricking" tendency of the arbor support, but also to leave a clear opening for the passage of the arbor, should this happen to be extra long. When the braces cross as shown in Fig. 2, the projection of the arbor is prevented.

It is generally accepted that round bracing rods are distinctly unsuited for resisting vibration, unless they are made of abnormal proportions, and then a rectangular section meets the condition quite as well. It may be interesting, however, to illustrate one example of the use of circular rods to form a bracing. A bracing of this type is shown in Fig. 3, and is used on a German milling machine. The top end of each rod is enlarged into an eye, which fits over and is locked by a set-screw to the extension on the overhanging arm. A round rod on each side of the knee, clamped in split lugs, has a split lug at its end to hold the brace rods, so that adjustments in vertical and horizontal directions are possible.

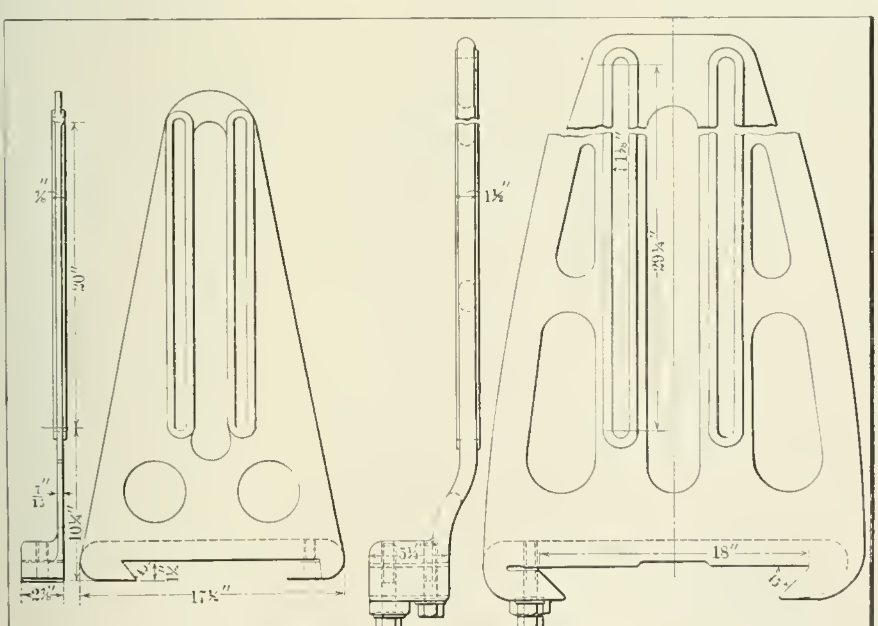


Fig 8. Brace used on the Hendey Miller. Fig 9. Example of Bracing bent outward

Coincident with the general stiffening and improvement of milling-machine frames, and particularly of the knees, there has been a general movement in favor of the adoption of braces which are of wide and stiff form, well ribbed or webbed, so as to present the best possible resistance to vibration. A good many variations in design are extant, a few of which will be illustrated and described in the following: These webbed braces may be divided into two classes, those with a single vertical slot, and those with two vertical slots, the latter being in the majority. A brace with a single slot, used on the milling machines built by the Oesterlein Machine Co., of Cincinnati, O., is illustrated in Fig. 4. It will be seen that the slot is wide enough to let the heads of the clamping screws (which tie it to the arbor support) pass through. A clamping plate *A* is slipped on under the screw heads, to press on the face of the brace. It is only necessary, therefore, to slide this plate away, when the brace can be pulled off without taking out the two bolts.

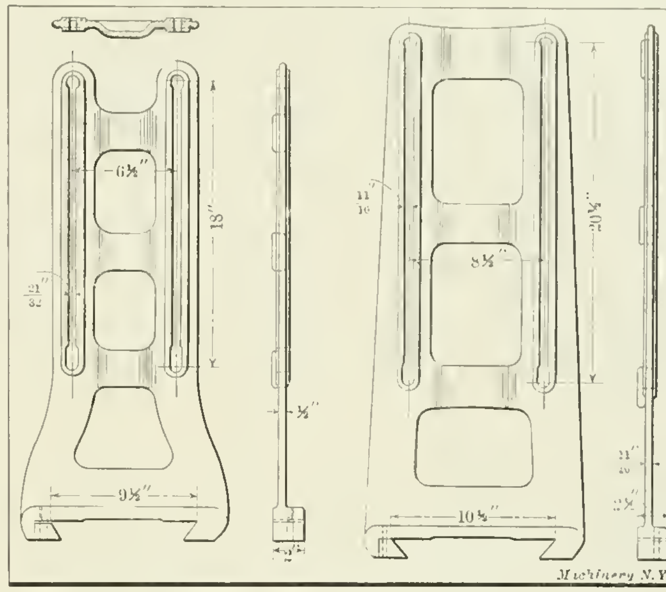


Fig. 10. Brace with Central Web bent outward. Fig. 11 Another Brace with Central Web bent outward

Fig. 5 is an English design of brace, of arched form, which is tied with one bolt to the curved end of the overhanging arm. Other variations might be illustrated, but they differ but little in form from that shown. The objection to the single central slot of normal width, is that the arbor support hole is obstructed by the brace; the only way of avoiding the difficulty is either to widen the slot, as in Fig. 4, or to adopt the arrangement illustrated in Fig. 6. This is the style employed on the line of plain and universal millers constructed by Messrs. J. Parkinson & Son, of Shipley, Yorkshire, England. In this type there is a clear wide slot down the center, so that the cutter arbor may pass through, and the adjusting bolt for the split-arbor bush be manipulated. The clamping slot is set to one side, and the screws pass through the lugs cast on the side of the arbor head.

The heavy millers made by the Hendey Machine Co., Torrington, Conn., have a wide brace of the form shown by Fig. 8. In this type there are four lugs on the arbor head, so that two screws fit in each slot. The R. K. Le Blond Machine Tool Co., Cincinnati, O., employs a wide type of bracing, as shown in Fig. 9, which is distinguishable by the fact that it is bent outward, as shown in the side view, so as to leave the maximum possible amount of space from the arbor support to the face of the column. Mention might also be made of the method of clamping the brace to the knee, the spring of the metal being utilized instead of fitting the usual separate gib strip. It will be observed that one screw is set lower than the other,

for convenience in using the spanner, as the heads happen to come close together.

The Owen Machine Tool Co., of Springfield, O., bends out the central webs of its braces, as shown in Figs. 10 and 11, the object of which is to gain a little clearance for the arbor head. The two illustrations show the smaller and larger sizes, respectively. Fig. 12 shows a brace taken from a German milling machine. It is rather elaborately ribbed, but the chief point about it is that it cannot be attached to the knee in the usual manner (on the edges of the ways), because the saddle is extended out to pass over the knee. The brace is, therefore, attached to facings on the sides of the knee, a limited amount of adjustment for the brace being provided by slots, as shown in the view to the left. The details of the operating screws and handles are omitted for clearness.

The Cincinnati Milling Machine Co., Cincinnati, O., employs a very effective type of brace shown in Fig. 14 on its heavy millers. The top of the brace is bored to embrace the steel arm, and two holes receive bolts which pass through them into the arbor support *A*. The clamp *B* is secured to the knee, and screws passing through the slots in the brace bind the latter to this clamp. This truss form of brace may be rendered more rigid when the knee happens to be set low

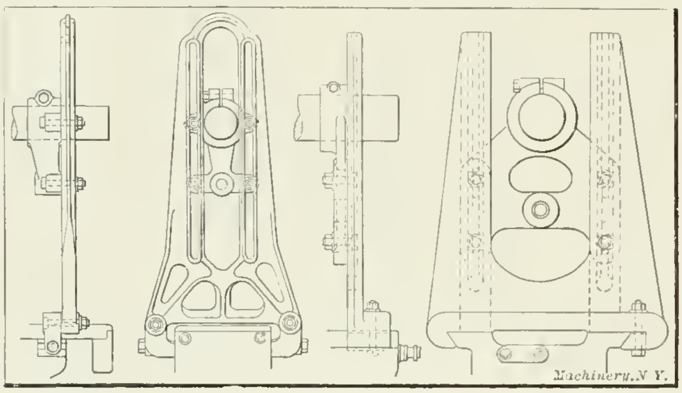


Fig. 12. German Example of Ribbed Brace. Fig. 13. Stand and Slide Brace with T-slots

by the addition of a diagonal brace *C*. The Cincinnati Milling Machine Co., in a letter relating to this brace, says:

"Our experience has convinced us that on a horizontal milling machine of the column-and-knee type, when doing ordinary work with a spiral milling cutter on an arbor, the pressure against the outer arbor support is approximately in line with the table travel. In other words, this bearing is subjected to tremendous side pressures. The vertical pressures are not so great. In fact, if the cut is of any considerable depth, the vertical pressure amounts to practically nothing,

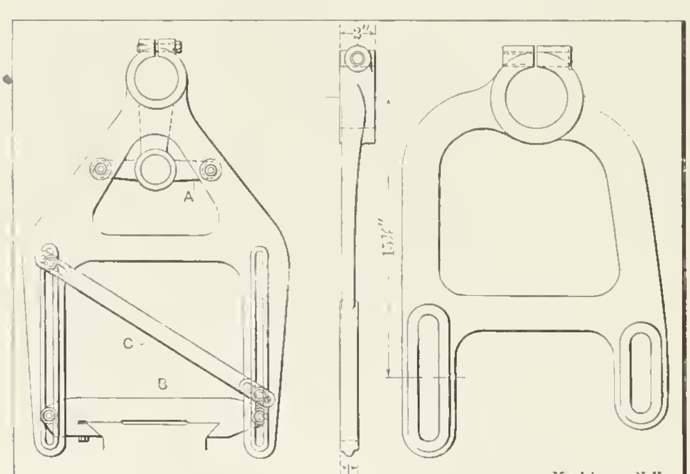


Fig. 14. Truss Form of Bracing. Fig. 15. Brace with Curved Slots

and in fact, it may be negative on account of the lifting action of the cutter. In view of these facts, we have designed the brace, for supporting the outer arbor bearing, especially for stiffness against these side pressures, and our experience with this form of brace has proven most satisfactory indeed."

Although straight slots are the rule in practically all braces used on ordinary millers, there is one exception, which occurs in a certain type of Brown & Sharpe plain machine. This has its cutter spindle adjustable vertically to a limited extent, and the one slot in the brace is curved as shown in Fig. 15, to accommodate the radial movement when the spindle is adjusted. Owing to the particular movement which takes place, one slot need not be so long as the other.

The double type of brace, Fig. 16, which is used on the

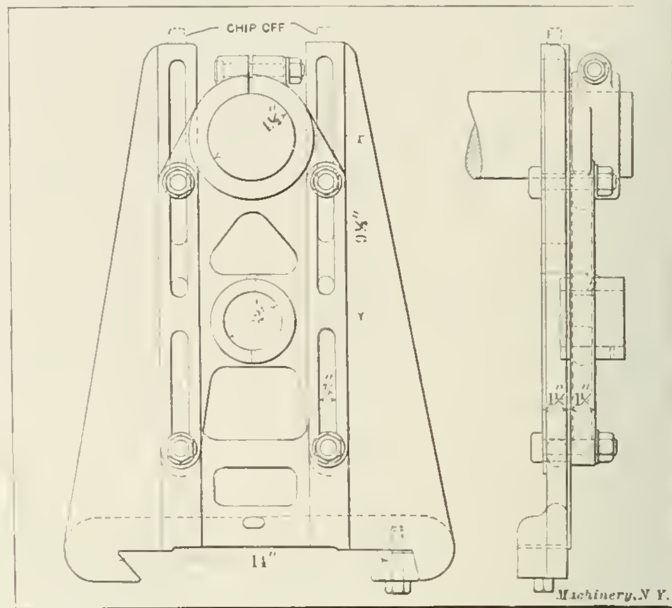


Fig. 16. Stand and Slide Type of Bracing used by Brown & Sharpe Mfg. Co

Brown & Sharpe heavy machines, constitutes a very rigid arrangement, there being ample bearing surface, and four bolts to bind the two portions together. By this construction an extra arbor support is afforded in the sliding part, so that the regular arbor head can be slipped along the arm to any position, for use as an intermediate bearing when using gangs

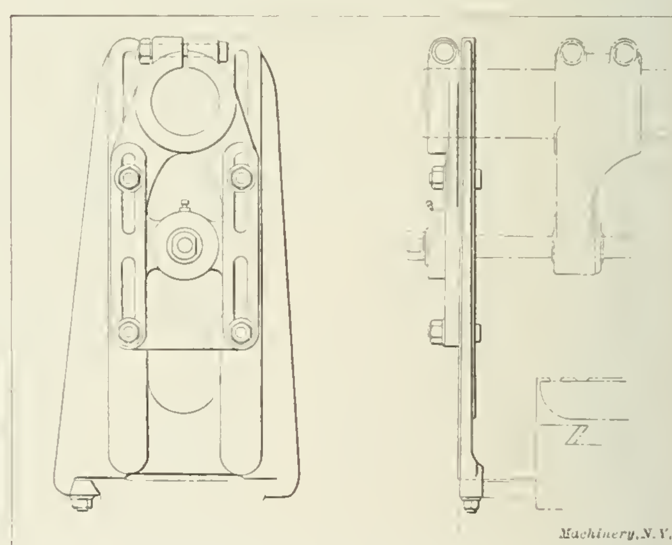


Fig. 17. Stand and Slide Type of Bracing used by Alfred Herbert, Ltd.

of cutters. Fig. 17 illustrates a similar type of brace made by Messrs. Alfred Herbert, Ltd., of Coventry, England, the parts of the machine being shown in dotted outline.

The Schweizerische Werkzeugmaschinenfabrik Oerlikon, Oerlikon, Switzerland, equips some of its millers with a brace as shown in Fig. 13. It will be seen that the principle is similar to that shown in Figs. 16 and 17, but instead of open slots in the fixed stand, T-slots are made, which affords a little more rigidity. Fig. 18 represents the same firm's open-slot design of bracing, the split boss of which grips the turned extension on the bent arm, so that it is unnecessary to have a second bearing-opening in the brace. Both of the braces manufactured by this company are made from steel, instead of cast iron.

Several machines which emanate from Europe have braces or steady-brackets modeled after the style shown in Fig. 19, with various modifications in detail. A T-slot runs up the face of the bracket, and a couple of bolts stand out to clamp the arbor head firmly against the bracket. As previously mentioned, this type of brace possesses advantages from the point of view of accessibility, and inspection of the cutter and the work. By making it of ample strength, the objection

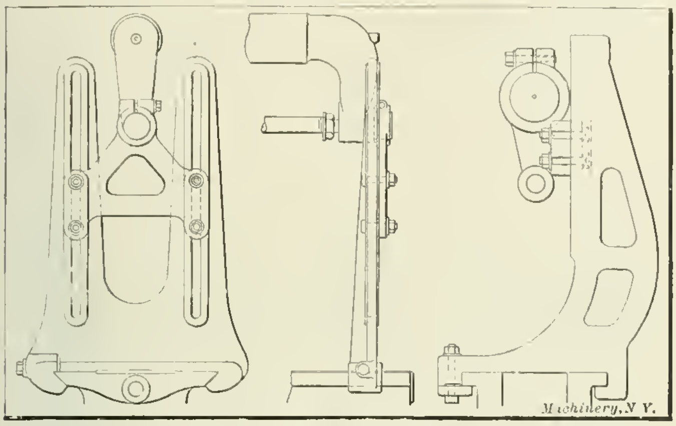


Fig 18. Another Stand and Slide Type of Brace. Fig. 19. Another Example of Brace set to One Side

to its one-sided character is greatly minimized. Frequently, instead of bolting the actual arbor head to the brackets as in Fig. 19, a simple split bearing, Fig. 23, is employed, and the arbor head is situated further along the steel arm. Alternatively, when the overhanging arm is cast with the arbor bearing in its bent end, the straight portion of the arm is prolonged to reach to the split bearing.

Fig. 7 shows a different design of bracket, in which the bolt

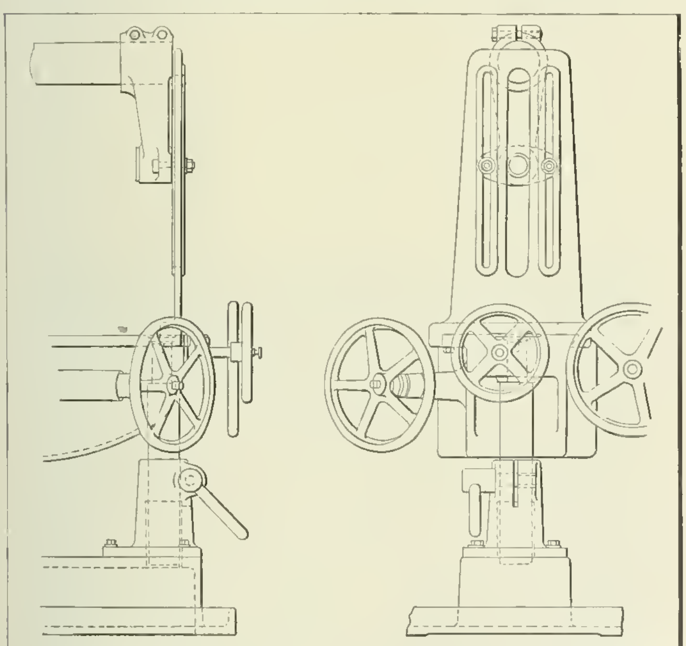


Fig. 20. Slotted Brace in Combination with Support under Knee

slot is cored through the frame, the heads of the bolts entering into T-slots in the arbor head. These T-slots are prolonged for a few inches to permit of adjustments to accommodate arbors of different lengths. The bracket, as will be noticed, is clamped to the knee by a pair of bolts entering into T-slots on the top face of the knee.

Knee Supports

We now come to the consideration of a different class of bracing, where more complete and effective support is afforded to the knee. This is done by obtaining a support from the base or foot of the framing, instead of depending upon the overhanging arm alone. It may be argued, with some degree of truth, that the elevating screw of the knee helps to support the latter against downward deflection; but it cannot be of much assistance in preventing vibration, or lateral twisting movements. Therefore, we find that several firms in Europe prefer to give the knee adequate support by some form of bracket or brace standing up from the foot, and either independent of the upper arm brace, or combined with it. The chief objection to the independent support is the extra complication, and the necessity for tightening and loosening several bolts each time the support has to be released for the purpose of adjusting the knee up or down. This, however, is largely a question of how often the changes are likely to be wanted; in some machines the work is of a fairly constant character, notably in certain types used for repetition work, and for gear-cutting, and the objections to having to loosen and tighten a number of bolts are not so important.

The favorite form of support beneath the knee is that of a bracket bolted to or cast with the knee, sliding against a

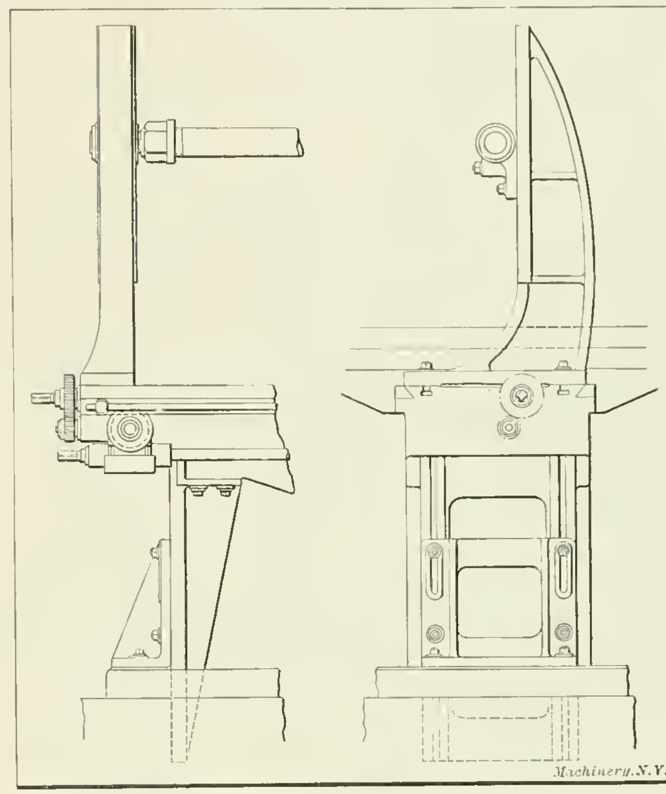


Fig. 21. Bracing set to One Side, and Knee Support

somewhat similar bracket on the foot, open or T-slots permitting of the necessary up and down motion. Either two bolts or four are used for clamping. Fig. 22 shows the class of support employed on some of the milling machines built specially for gear-cutting, by J. E. Reinecker, of Chemnitz-Gablenz, Germany. The knee in these machines overhangs to an abnormal extent, and the support is practically a necessity. One angle bracket is bolted beneath the front of the knee, and is clamped against a bracket on the foot by a couple of bolts. Another Reinecker type is illustrated in Fig. 21, applied to a large machine used for gear-cutting. The knee bracket is placed in the opposite manner to that shown in Fig. 22, and has to pass down through the foot of the framing. The end of the arbor (which carries the blank) is supported

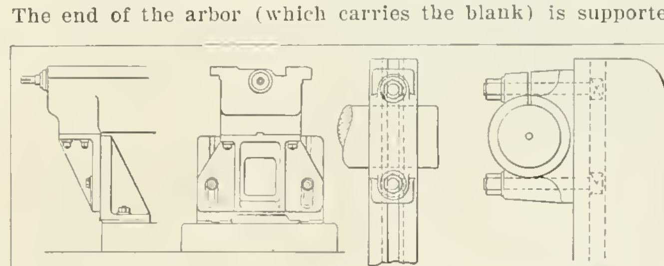


Fig. 22. Typical Support for Knee. Fig. 23. Split Bearing for Clamping Overhanging Arm

in a bearing, bolted against the steady brace, which is fastened to the top of the knee.

A very simple and neat knee support is adopted by Messrs. Greenwood & Batley, Ltd., Leeds, England, in which only a single handle has to be tightened and loosened, so that one of the objections to these supports is considerably minimized.

As shown in Fig. 20, a stout steel prop is shouldered into the knee, and held by a screw and washer. The prop passes down through a split bearing bolted onto the base. Although the knee projects out in this machine to a greater distance than usual, the support compensates for the overhang, and provides a rigid and easily altered fitting. A stiff webbed brace also connects the top of the knee to the arbor support.

These braces which extend from the foot right up to the overhanging arm, necessitate an extension of the base to a distance sufficient to provide an anchorage, and advantage is sometimes taken in this design to increase the length of the knee from the column to the outer end. The brace affords a rigid fastening, and supports the knee well besides tying it to the arm. In this type there is usually only a

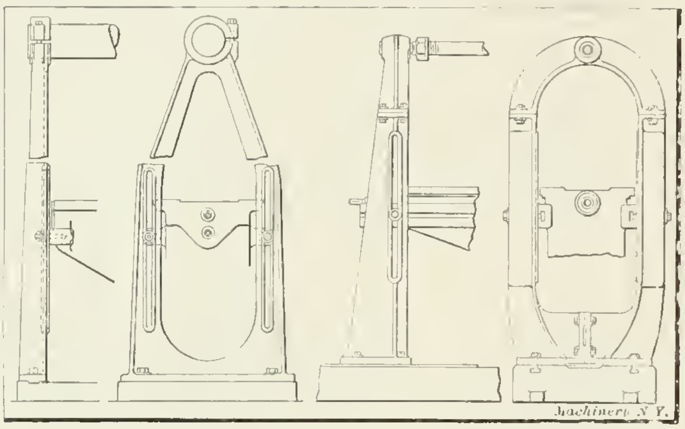


Fig. 24. Brace uniting Base, Knee and Overhanging Arm. Fig. 25. Loop Form of Bracing uniting Base, Knee and Work-arbor

couple of bolts to manipulate. A brace built by the Schweizerische Werkzeugmaschinenfabrik Oerlikon of Oerlikon, is shown in Fig. 24. This brace is bolted to the base, and is secured to the knee by a couple of screws. It continues up to the steel arm, to which is it clamped by a split lug. The arbor support is located further along the arm, and the brace remains in position during all the operations. A knee about 25 to 30 per cent longer than usual is fitted to this machine.

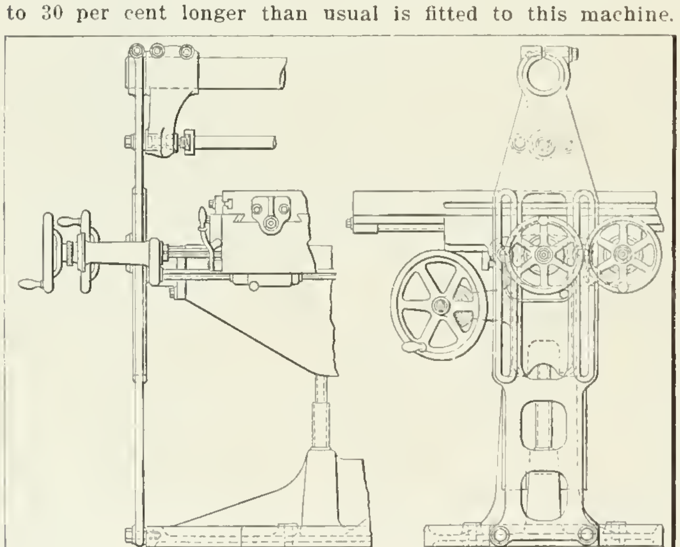


Fig. 26. Another Type of Brace uniting Base, Knee and Overhanging Arm

Some of the Reinecker machines used specially for gear-cutting are fitted with a loop design of brace, as shown in Fig. 25, comprising three sections bolted together. T-slots on the sides of the long knee receive the tightening screws, and the work arbor runs in the bearing at the top of the arch. T-slots in the base provide for a certain amount of adjustment to and from the column, and a rack and pinion device (not shown) is included when the weight of the brace renders other methods of moving it along the base difficult.

The last example, shown in Fig. 26, is taken from a plain milling machine built by H. W. Ward & Co., Ltd., of Birmingham, England. The upper part of the brace is designed to clamp the overhanging arm, and two screws also secure the arbor head, when the latter is brought out in contact with the brace.

METHODS OF TESTING TOOLS

During the last few years a great deal of creditable work has been done by various firms and individuals in order to determine the relative values of different kinds of materials used for making metal cutting tools, and different methods used in their manufacture. The methods of testing such tools—lathe tools, taps, twist drills, etc.,—may be divided into two distinct classes. In one case the tools are tested "to destruction," by employing excessive cutting speeds and feeds, and noting the time required to break the tool or entirely ruin its cutting edge. In the other case the tools are tested under actual working conditions, using such speeds and feeds as are suitable in everyday practice, and noting either the time elapsing between regrindings or the amount of work performed by the tool before its cutting edges are dulled.

There may be instances when it is desirable to determine the conditions under which a tool will break or otherwise become useless for further service, but as a rule it is safe to say that the more valuable and conclusive tests are those made under ordinary working conditions. There has as yet been no relation established between the time or stress required for breaking a tap or drill, for example, and its cutting qualities when used under regular shop conditions. Especially in the case of drills, it is, indeed, reasonable to assume that the drill which may break first in a comparative "destructive" test, would be the drill which, if used with reasonable care and not subjected to excessive stresses, could keep its cutting edge the longer and produce more work in a given time than the tool which in a destructive test might have seemed the better. Furthermore, drills and other tools are not intended to be used under conditions where breakage is imminent; in fact, any such usage is wasteful and any gain in production due to excessively forced speeds and feeds is more than likely offset by the increased cost of replacing broken tools. Hence the rational test of tools would seem to be a test in which, as far as possible, normal working conditions are duplicated, and in which the governing factors are so selected as to permit the tool to produce a maximum of work with the least possible chance of breakage.

This last method of testing tools has been thoroughly applied by the Union Twist Drill Co., Athol, Mass., in making comparative tests on twist drills. In order to make the tests as conclusive as possible, a very uniform grade of steel, 0.90 per cent carbon, is used for the test blocks to be drilled. These test blocks are 24 inches long, 6 inches wide, and 2¼ inches thick. The tests are made in a drill press of very strong construction, so as to eliminate, to as great an extent as possible, the tendency to spring the drill press frame out of shape and thus break the drill. A row of holes is then drilled by one of the drills to be tested, and another row immediately beside the first by the drill to be compared with the first. Then a row of holes is again drilled by the first drill, and one by the second, and so forth. The object of alternating the drills is to make allowance for any possible lack of uniformity of the metal at various parts of the test block. The tests are continued until each of the drills has been drilled and reground six times, and at the end of the sixth series of holes, the total number of inches that has been drilled by each drill is summed up and the results compared. It is understood that these tests are comparative only, but as fair a comparison as can well be imagined is made between different kinds of drills; and the test is made under the very conditions met with in regular shop practice.

The only reason why tools of this character should be tested to destruction would be to determine the factor of safety which they have when in use. This, of course, constitutes a useful and highly valuable test; but it does not give a clew to the relative cutting properties of the tools when used under normal conditions. It would seem that the reason why so many "destructive" tests are made on small tools is simply because the tools are so cheap that it is feasible to subject them to such tests. A boring mill, or a steam engine, is not subjected to destructive tests; yet, to thus test them would serve practically the same purpose—or lack of purpose—as the majority of destructive tests on cheaper appliances.

TRAINING OF MACHINISTS IN THE TRADE SCHOOL*

By JAMES A. PRATT†

The teaching of a trade in a school involves two fundamentals: First, the boy must be given a thorough training in all phases of the trade; and second, it should be so imparted that he will complete his course with a feeling of self-respect as well as a belief in his calling. If the school which devotes full attention to teaching a trade does not do the first, it fails in its purpose, while the young mechanic who does not regard his calling as worthy of his esteem, will not follow it to his own benefit or to that of the community in which he lives.

Quality of the Product

The school properly managed, which has three full years of a boy's time, between the ages of 16 and 21 years, has no reasonable excuse for sending from its doors, anything but well trained, intelligent and efficient mechanics. To do this, however, the officers and teaching staff must believe in each other, be practical teachers, apply efficient methods of work and have a supreme desire to teach trades. This sounds like a broad demand, but as a matter of fact, these requirements are not in any way beyond the possibility of fulfilment. The machinist's trade at Williamson is taught with these factors under consideration, and the results to be mentioned later warrant the claim that an excellent variety of journeyman is produced.

Fig. 1. Orders for Each Machine filed on the Order Section of the Instructor's Desk

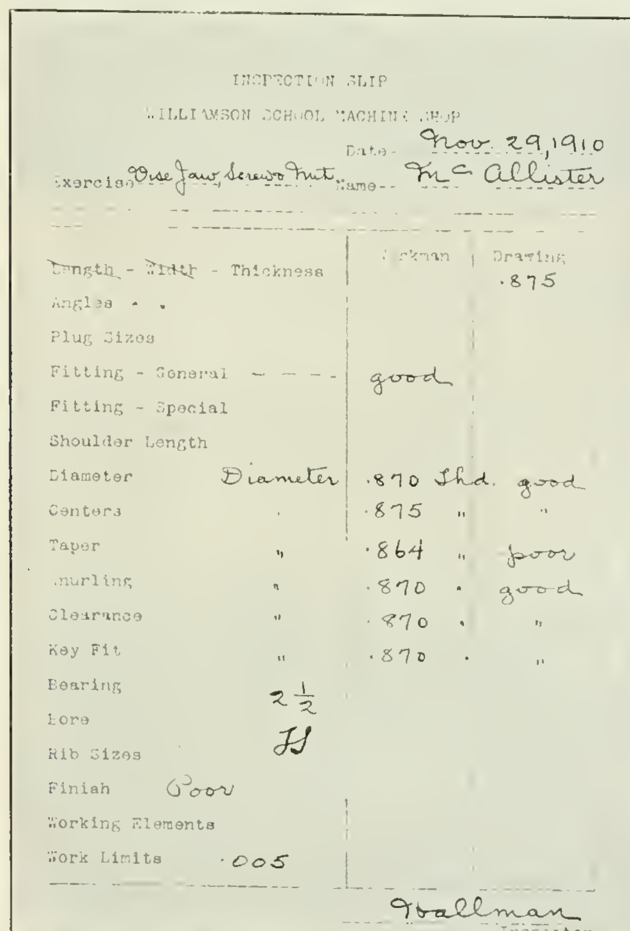
Fig. 2. Class-room Scene during Shop Talk on a Gear-shaper Mechanism

Purpose of this Article

The aim in presenting this article is to give an outline of the method followed in producing a mechanic in an organization where the skilled worker is the only product; there are no detracting influences, and the management devotes as much attention here to the efficient development of the apprentice as does the directing force of the industrial plant to the economical production of high-grade material articles of commerce. Time cards, cost sheets, manufacturing methods, jigs and fixtures are made and used, to lessen time and cost incidentally, but primarily to make the apprentice familiar with them, that he may have control of himself, in his many different connections with the industrial world as a mechanic. After he has become familiar with the particular system in use at the school, he has explained to him other systems to be found in various plants, and the proper attitude which he must maintain towards such accessories of a producing organization. In using jigs and fixtures, their purpose in the plant is explained, and the points to be observed in setting and handling are made clear, the intent being to teach the apprentice the possibility of seeing errors ahead and thus avoiding the loss of work.

Notes on the System Used

The shop system is such that not only are results in work obtained, but at the same time the boy receives a consecutive, well ordered training. The whole trade is taught on the exercise basis, some exercises being abstract and some concrete. A piece of work is regarded as an abstract exercise when it serves no other purpose than the training of the apprentice; it is a concrete exercise, when in addition to serving as a means of instruction, it is put to use in a machine or some piece of equipment about the school.



INSPECTION SLIP
WILLIAMSON SCHOOL MACHINE SHOP
Date Nov. 29, 1910
Exercise Vise Jaw, Screw Nut Name McAllister

	Workman	Drawing
Length - Width - Thickness		.875
Angles		
Plug Sizes		
Fitting - General	good	
Fitting - Special		
Shoulder Length		
Diameter Diameter	.870 Shd.	good
Centers	.875 "	"
Taper "	.864 "	poor
Knurling "	.870 "	good
Clearance "	.870 "	"
Key Fit "	.870 "	"
Bearing $2\frac{1}{2}$		
Bore		
Rib Sizes JJ		
Finish Poor		
Working Elements		
Work Limits .005		

Wallman
Inspector.

Fig. 3. Job Inspection Slip for Inspecting and Grading Quality of Work

Whether the exercise is abstract or concrete makes no difference in the method of handling it in the shop, as all the day work in the plant is carried on under the factory system; that is, each boy is trained as an operator of one machine, then of another, and so on, taking the proper section of exercises at a particular time on each tool or at the bench. The apprentice does not remain at the machine or bench until *all* of the exercises have been finished, but until a *section* of the exercises has been finished. These sections are divided into: First, elementary; second, speed; and third, ad-

* For additional information on this and kindred subjects previously published in MACHINERY, see: "Education and Development of the Apprentice," December, 1910, engineering edition; "The Development of Machinist Apprentices," October, 1910, engineering edition; "McKinley Manual Training School, Washington, D. C.," January, 1910, "Educating Apprentices at Drifton," February, 1909, engineering edition; "The Fitchburg Cooperative Industrial School Course," October, 1908; "Evening School of Trades—Rindge Manual Training School, Cambridge, Mass.," July, 1908; "The Lawrence Industrial Trade School," December, 1908, engineering edition; "Education for Industrial Workers," September, 1907, and other articles there referred to.

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vanced. This applies to each machine. The beginner always commences at the bench, doing enough exercises to gain control of himself, to become accustomed to accuracy, and to eliminate the tendency to nervousness which is always an element of the untrained or poorly trained person's experience, when in an untried position.

There is no fixed time in which all the pupils finish these elementary exercises, different boys taking different periods of time; but the average season at the bench, previous to taking up the machines is about eight weeks. After this the learner alternates between the machine and bench sections throughout his whole course, the last series of bench exercises being jig, fixture and die work. This arrangement develops in the apprentice a wide range of in-

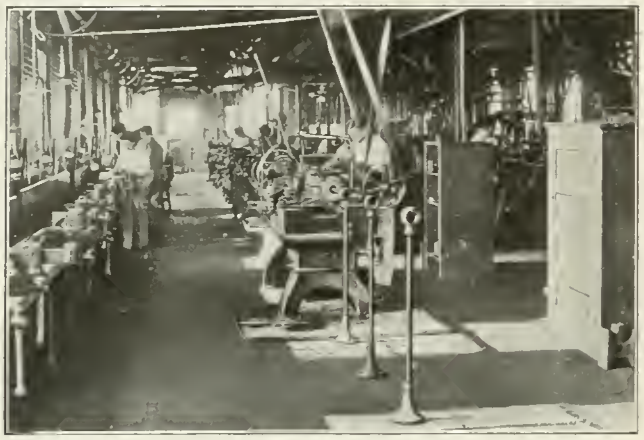


Fig 4. General View of Machine Shop

sight and a keen sense for detail, which is entirely lacking in the boy who works for months along the same lines, with only slight variation of constructive detail.

Assignment of System

From the foregoing it will occur to the reader that some method of determining what exercises are available on a given job must be in use; also whatever scheme is in service must be rapid in application and easily maintained. When a boy is out of a job, the question before the instructor is not simply that of giving him more work, but rather of giving him work from which can be gained an exercise that will be a reasonable advance on his previous experience. An il-

Fig. 5. Three Advanced Apprentices working on Blanking and Piercing Dies

lustration of an actual job in the shop will best serve to show how this phase of the work is handled:

An order is received by the instructor to make two complete saw guards for the pattern shop. On the day of receipt of this order, after his class has left him, the instructer looks over the prints and finds that the shop work can be done on the lathe, vertical boring mill, drill press, and the assembly work at the bench. Shop orders are made on four blank sheets of paper as follows:

LATHE

Pattern Shop Saw Guard

2

Parting	Straight turning
Centering	Backresting
Facing	Thread cutting
Shouldering	Running fits

Three more such orders are made out, giving boring mill, drill press, and assembling exercises, respectively, under the job heading. These slips are then filed on the order section of the instructor's desk, a view of which is shown in Fig. 1, where may be seen a set of orders for each machine in the shop. The lathe order referred to indicates to the instructor that he is to make two saw guards complete, and he has on the job certain available exercises as listed on the lower part of the order. Now a lathe-hand comes to him for a job, and the instructor immediately notes the nature of the boy's last exercise, picking out the next one for an advance from the list contained in a course outline book.

In leafing over his orders, the instructor does not look at the job, but rather at the exercises listed under each job, and if the lathe-hand needs any one of those named for a particular piece of work, he is assigned to cover that exercise; *e.g.* if the apprentice, in the order of learning his trade should next take up the use of the backrest, the instructor would give him the lathe work on the pattern shop saw guard mentioned above, or any other job which required the use of the backrest, taking his order slips to guide him in the selection. When the job has been assigned, the order for it is destroyed.

Inspection and Its Effect on Boy's Record

After the lathe-hand has completed his work, he puts a tag on it, which gives his name, and the job goes to the inspection room, where it is inspected, a slip being made out by the student inspector for each exercise covered by every boy; the instructor checks the inspection, and determines the mark

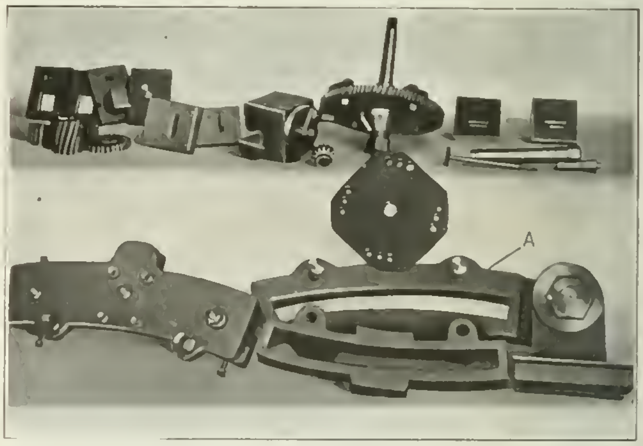


Fig 6. Dies, Cutters, Jigs and Fixtures, completed or in Process of Completion, representing the Work of the Apprentices

of the apprentice from the quality and time. One of the inspection slips is shown in Fig. 3; the exercises on this job were speed work, and fitting of square threads; a study of this sheet gives an idea of its purpose, though it is nothing other than a slip similar to that used in most up-to-date shops. The mark which this apprentice received for the work was 2½ (seen over the instructor's initials F. S. on the slip), which means to the school authorities that the work was of a common average: 1, means excellent work; 2, good; 3, medium, but not satisfactory; and 4, poor. This outlines the method followed for all machines, and all kinds of exercises, including elementary, speed, and advanced sections.

Shop Talks

While the apprentice is carrying on the shop work, he is given a series of talks, showing the correlation of the principles of his instruction with other jobs of a similar class, but different in form. For example, in the shop talks is listed a series on machine tool types; during the junior year, the various tools of a type differing from those with which the school shop is equipped, are taken up and the method of operating is gone over, giving the apprentice a set of operator's general directions for handling the many different kinds of machine tools. Fig 2 presents a class-room scene when the shop talk was on the operation of the Fellows gear shaper; these talks are from twenty minutes to a half hour in length, the class taking notes as the lecture progresses. Each week these notes are marked for appearance and fullness, these marks being added to the boy's shop record.

Time in Shop and Equipment

The time spent in the shop is 23 hours per week for two years and three months, and 43 hours per week during the remaining nine months of a three-year course. The present shop equipment consists of lathes, planers, slotter, shaper, drill presses, vertical and horizontal boring mill, milling machines (plain and universal), flat turret lathe, grinder, and wet tool grinders; there is also a well-equipped tool-room, supplied with small tools and the necessary accessories. Fig. 4 shows a general view of the machine shop.

About three months of the senior year is spent on jig, fixture and die work; the course does not produce a toolmaker, but the work given in toolmaking is such as should be a part of every first-class machinist's training, and involves the making of blanking dies, as well as jigs and fixtures. The ultimate aim in this connection is to devote one year to toolmaking, so the young machinist may not only meet with success in the shop but in the tool-room as well. Fig. 5 shows three of the 1911 apprentices working on blanking and piercing dies while Fig. 6 presents some dies, cutters, jigs and fixtures recently finished, and in process of completion, giving an idea of the class of work being done at the present time, in toolmaking lines. Fig. 7 shows the milling jig seen at *A*, Fig. 6, set up on the machine and in operation; the piece standing up at the end, marked *B* in Fig. 7, is the work milled. The contrivance is a bridge milling fixture for finishing a curved slot, and an outside surface true to such a slot.

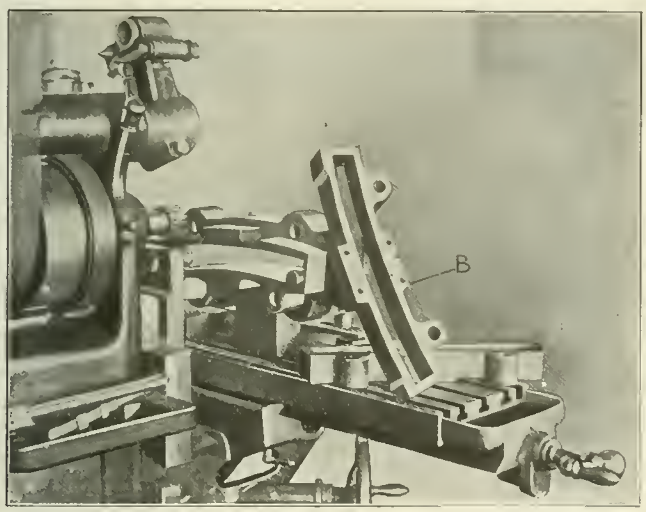


Fig 7. Drilling Jig shown in Fig 6, set up and in Operation

Fig. 8 shows the apprentice on the horizontal boring mill, when he was setting up to bore the bridge piece of the fixture just mentioned. An examination of the halftone shows him to be using the bar and height gage method of locating for accurate boring; for the purpose of this article, no further details of the process are necessary.

Speed Exercise and Its Meaning

Fig. 9 is presented for the purpose of giving an idea of the way in which the speed exercises are handled by the teacher in the class. The apprentice, for the development of the faculty of covering repeated operations rapidly and with ease, requires different instruction from that necessary for mastering the first principles of a process; to this end, he must do quite a number of pieces of the same kind, while the instructor centers his effort, not on the teaching of trade elements, since these should have been mastered previously, but on methods of arranging the tools and work in such order as to eliminate unnecessary motions, having tools always in readiness, and on the development of the ability to make every movement count towards a desired end. The aim in all the speed exercises is to teach the student to concentrate his attention specifically on a fixed set of movements, and develop the ability to select the minimum number of steps necessary to the carrying out of any particular job. Fig. 9 shows an apprentice covering a speed exercise on the flat turret lathe.

The Spirit of the Work

A school shop is in no way different from any other machine shop, nor is there any reason why it should be; the output, however, instead of being reckoned in cash, is studied from the standpoint of better citizenship, and a higher earning power of the individual. Every effort is made to teach the honest, faithful boy a trade; he is not dismissed simply because he is dull, or because of the fact that natural tendencies are unfavorable to him; the one fixed requirement at a trade school is an honest desire to become a capable, well trained mechanic, and a willingness on the part of the boy to be guided by those of broader experience than himself.

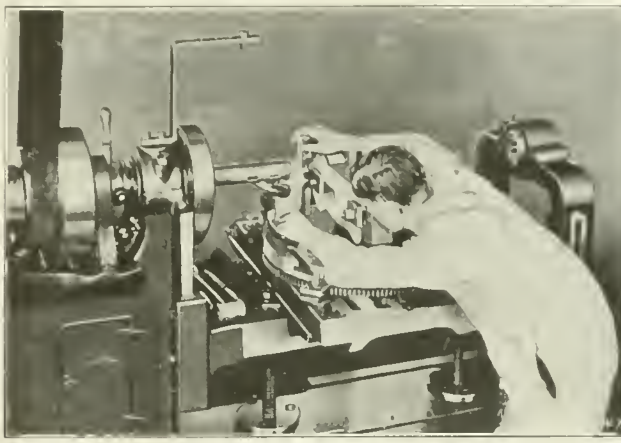


Fig. 8 Apprentice setting up Jig for Boring on the Horizontal Boring Mill

Training for Jobbing

Since it is by no means a certainty that our young machinist will go to work in a shop running under the factory system, he must be trained as well for the jobbing shop, where he takes a job directly from the beginning to its completion, on all the machines, and through all the fitting, assembling, etc. This work is done at night, during the latter part of the third year, when there is none but the senior class in the shop. All the tools are then available for their use, giving a larger number of machines per boy. The apprentice at night works on a different job, has another time card, and the teacher gives his attention to developing the ability of the boy in changing from one tool to another without loss of time, the selection of the proper machine or method for doing the job most rapidly, and ways of keeping the work always on the move. Before taking this practice the boy should be trained as an operator of every tool in the shop, after which comes quite logically, the correlation of a number of machines on a given job.

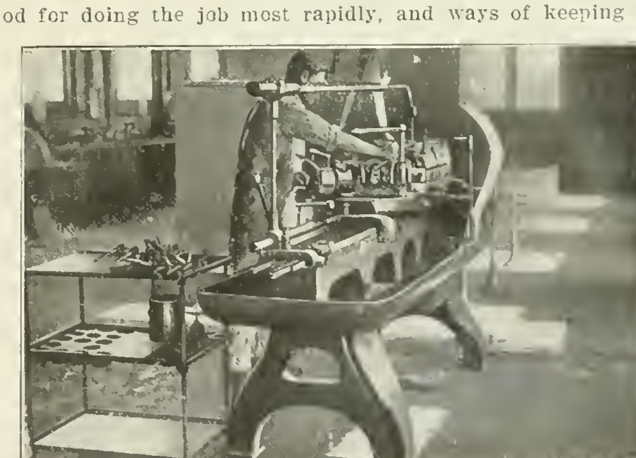


Fig. 9. Apprentice covering a Speed Exercise on the Flat Turret Lathe

Academic Work

Every apprentice receives instruction in academic work; this will not be gone over in detail, but the general outline following gives a very good idea of this requirement in trade schools. In planning academic work for such schools, there must be kept clearly in mind the fact that the organization is to be neither a secondary school, nor a college, but rather

a place where young men are fitted for life's work. To this end, the course should be of such a scope as will enable the young mechanic to readily read a drawing from which he may have to work, use mathematics in the practice of his trade, obtain a general knowledge of the development of his native land, and to use the English language with a reasonable degree of correctness.

Cost Considerations

One of the criticisms of high-grade trade school training which is often made is the cost, the statement being made that the man who is trained in a trade, must be developed at a relatively small outlay, because no community which must support its school on a tax basis is willing to make large expenditures, as the ultimate earning capacity of the mechanic does not warrant such a policy. This may or may not be good social economy, but in any event, such statements are not made by men who really know how to manage a trade school on the basis of economy and efficiency. It is a fact that where credit is given for the work done as exercises, no school in existence can show the low cost operation per pupil of the trade school, while at the same time it sends into the world a type of young American which is esteemed both by the manufacturer and society at large. These results depend, however, on the school having absolute control of the work used as exercises, a free hand to teach the trade in a first-class manner, a capable staff of officers and teachers, and a willingness on the part of all concerned to shape the course of affairs without hobbies or pet theories, to the end that capable and efficient mechanics be produced.

The number of persons who say a trade cannot be taught in a school is becoming fewer each year; while it is true that many trade schools do not make capable journeymen, it is equally true that many shops take apprentices, and after the stipulated period of service the young man is not regarded as a workman by any other firm than the one with which he served his time. Again there is no clearly defined conception of just what a machinist is, but the school may feel safe in stating that it turns out mechanics when the employer will take a boy directly from the school shop, and after an unprejudiced trial, give him, on the basis of his work, the same rate of pay that he gives any young machinist whom he may hire. If, as has been the case at Williamson, an employer takes a boy after a three-year apprenticeship, and gives him the same rate of pay as he commonly gives a boy who has served a four-year apprenticeship in the shop, then the school must be doing better than the shop for the boy, since it has taken one year less of his time to bring him to a given earning capacity, and at the same time it has offered him with his trade a good general education, which has not been the good fortune of the shop boy, unless he has been so situated as to employ a private teacher. If the school boy cannot meet the requirements of the employer, it is not of course wise for a school to claim that it turns out mechanics, since the ability to "make good" must, in justice to all, be the one criterion by which the young mechanic shall be judged.

* * *

RADIAL GRINDING FIXTURE

The accompanying illustration Fig. 1 shows the general construction of a convenient radial grinding fixture used in the shops of the L. S. Starrett Co., Athol, Mass. Fig. 2 is a sectional view showing the design of the grinding head. The grinding fixture is attached to a No. 3 Ames bench lathe. It consists of five main parts—a base *A*, a pivot *B*, a swivel *C*, a slide *D*, and a grinding head *E*. It will be seen that the construction of the pivot stud *B* is along the same lines as commonly used on watchmakers' lathes, the angles on the stud being selected so as to approximate the form of the Schiele curve, which is the theoretical form for the most efficient type of thrust bearing. The angle on the upper part of stud *B* is 3 degrees on each side, and the angle at the bottom 45 degrees, as indicated. The swivel joint is carefully enclosed to prevent any grinding dust from entering its bearings. The screw-operating slide *D*, for obtaining different radii and also for adjustment for different sizes of grinding wheels, has 10 threads per inch and is provided with a micrometer collar for obtaining fine adjustments. The grinding head shown in detail in Fig. 2 is provided with two thrust bearings of the same form as that used for the swivel stud. The bearings are entirely enclosed by brass dust caps. The design is of an approved and thoroughly tested form

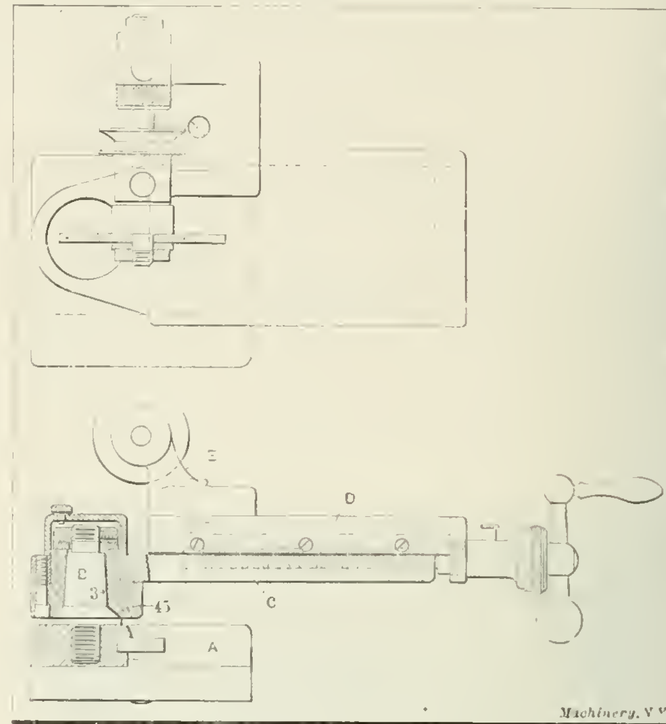


Fig. 1. Radial Grinding Fixture used in the Shops of the L. S. Starrett Co.

for high-speed spindles. The steel bushings in which the spindle runs are hardened and ground all over, and are a tight fit in the cast-iron head. The spindle is also hardened.

The action of the device is clearly indicated in Fig. 1. The swivel *C* with slide *D* and grinding head *E* can swing completely around stud *B*, so as to grind any part of a circular

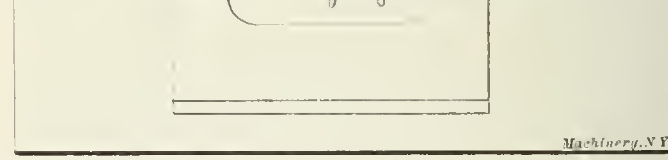


Fig. 2. Section through Head of Radial Grinding Fixture

arc. The radius of the arc is determined by the distance from the vertical center line through stud *B* to the cutting face of the grinding wheel.

* * *

LARGEST CRANE IN EXISTENCE

The largest crane in existence has recently been erected at Govan on the river Clyde, Scotland, for the Fairfield shipyards. The jib head of the crane is of the hammer-head type, built on the cantilever principle, and stands 160 feet above high-water level. The jib, with a total length of 270 feet, extends 169½ feet outward from the center and can be used at any point within a circle of 336 feet diameter. The crane, on slow gear, can elevate 200 tons at an arm of 75 feet, and a load of 100 tons at an arm of 133 feet.

THE UNIVERSAL JOINT*

By ALTON L. SMITH†

If two revolving shafts are placed so their center lines intersect, but are not in the same straight line, they may be connected by a universal joint which will transmit the motion from one to the other. This joint is often called a "Cardan joint" or a "Hooke's coupling" after the Italian who first described it and the Englishman who first applied it. Its form varies according to the particular use to which it is put, but all forms reduce in principle to the one shown diagrammatically in Fig. 1.

The shafts *AB* and *HJ* are held in place by the rigidly connected bearings *M* and *N* which also prevent end motion. Where these shafts extended meet at *E*, there is a cross-shaped piece with equal arms *CD* and *FG* rigidly connected and intersecting in their middle points at right angles. A fork, *CBD*,

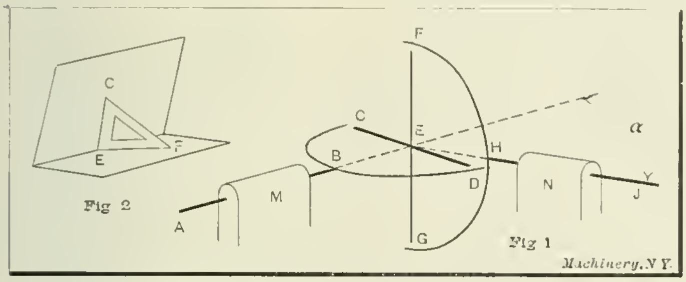


Fig. 1. Simple Universal Joint. Fig. 2. Illustrative of the Line of Intersection of the Two Planes

is attached rigidly to the shaft *AB* and connected to the cross-arm *CD* by rotary bearings at *C* and *D* so that *CD* is perpendicular to *ABE*. In the same way, a fork *FHG*, is attached to *HJ* rigidly and by rotary bearings to *FG* so that *FG* is perpendicular to *JHE*. At first sight, it does not appear possible that such a connection will transmit motion from one shaft to the other, but the reader can prove this easily to his own satisfaction in the following manner: As *CD* is perpendicular to *ABE*, when *AB* revolves, *CD* moves always in a plane passing through *E* and perpendicular to *ABE*. In the same way, *FG* moves always in a plane passing through *E* and perpendicular to *JHE*. These two planes intersect in a straight line whose position does not change, and *E* always remains at the

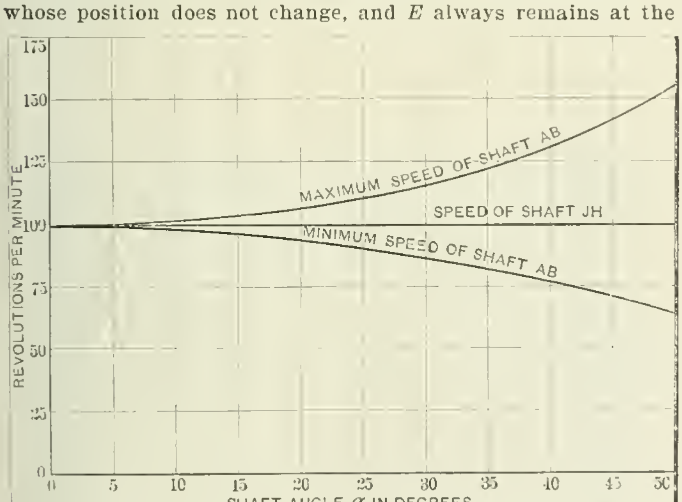


Fig. 3. Graphical Representation of the Results shown in Table I

same point on this line. As shown in Fig. 2, there are two intersecting planes with a fixed point *E* in their line of intersection. A right angle *CEF* must move so that one side *EC* always lies in one plane, the other side *EF* lies in the other plane, and the intersection of the two sides is always at *E*. If the reader will open a book at any angle to represent the two planes and take a draftsman's triangle for the angle *CEF*, it will be found that it is possible to move the triangle according to the specified conditions.

A universal joint is sometimes made so that the four bearings *C*, *D*, *F* and *G* are not in the same plane. When this construction is used, only one of the two connected shafts can be held in place rigidly and permit rotary motion. Such a construction has only a very limited use.

Geometrically, the angle α in Fig. 1 could be anything between 0 and 180 degrees, but because of interference of forks which must have material dimensions, the angle α must be something less than 90 degrees. At just 90 degrees, the mechanism would fail, because, as can be seen from Fig. 1, rotation of *HJ* would simply turn *CD* on its fork bearings without any tendency to rotate *AB*. When α is nearly 90 degrees, the mechanism cramps because the force tending to cause rotation is dissipated in friction. Practically, the

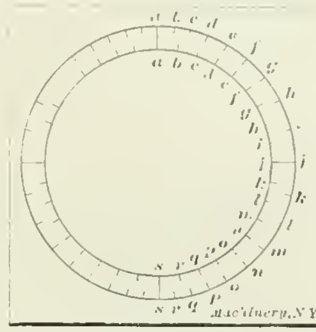


Fig. 4. Graphical Representation of the Results shown in Table II.

angle α should not greatly exceed 45 degrees when loads are transmitted at very slow speeds, as for instance in opening and closing small valves by hand. When the load is very small the angle may be as high as 60 degrees, and some special joints admit of as high an angle as 70 degrees without interference of parts. At higher speeds, the angle must be less if durability is to be insured, for the inertia effects produce high stresses in the bearings and forks, thus necessitating larger dimensions for them which, in turn, produces interference unless the shaft angle is reduced.

TABLE I. COMPARATIVE SPEEDS OF DRIVING AND DRIVEN SHAFTS

Speeds of shaft AB when shaft JH runs at 100 R. P. M. for Various Shaft Angles

Shaft Angle, Degrees	Max. Speed 100 sec α	Min. Speed 100 cos α	Variation R. P. M.	Shaft Angle, Degrees	Max. Speed 100 sec α	Min. Speed 100 cos α	Variation R. P. M.
5	100.38	99.62	0.76	30	115.47	86.60	28.87
10	101.51	98.48	3.06	35	122.08	81.92	40.16
15	103.53	96.59	6.94	40	130.54	76.60	53.94
20	106.42	93.97	12.45	45	141.42	70.71	70.71
25	110.34	90.63	19.71	50	155.57	64.28	91.29

The use of this coupling is often prohibited by the variation of velocity ratio of the connected shafts during a single rotation. If shaft *JH* runs at a constant speed of 100 revolutions per minute, shaft *AB* will make 100 revolutions also, but it is found that during one part of a revolution *AB* will run faster and during another part slower than *JH*. In Fig. 1, suppose shaft *JH* to be the driver and let its initial position be as shown, with *FG* perpendicular to the plane *AEJ*. Let θ be the amount of angular turning of *JH* from its initial position. Then it can be proved that

$$\frac{\text{Ang. vel. of shaft } AB}{\text{Ang. vel. of shaft } JH} = \frac{\cos\alpha}{1 - \sin^2\alpha\,\sin^2\theta}$$

This equation gives the relation of the two shaft velocities during one revolution. It can also be proved that with shaft *JH* running at constant speed, shaft *AB* has its minimum speed when fork *FHG* occupies the position shown in Fig. 1, and its maximum speed is when the fork has turned through 90 degrees from this position. For the first position, the angular velocity of shaft *AB* is equal to the angular velocity of shaft *JH* multiplied by $\cos\alpha$. For the second position, the angular velocity of shaft *AB* is equal to the angular velocity of shaft *JH* multiplied by $\sec\alpha$. Table I gives maximum and minimum speeds for shaft *AB* for various values of the shaft angle α, assuming that shaft *JH* drives at a constant speed of 100 revolutions per minute. Fig. 3 shows the same thing graphically.

While a slight fluctuation in the velocity ratio might not be objectionable, there will often be objection to the variation in the relative angular positions of the two shafts which accompanies it. Table II shows the angular advance and lag of shaft *AB* for successive angular positions of shaft *JH* when

* For further information on the subject see the editorial "Bad Practice in the Use of Universal Joints," September, 1910, and the article "Universal or Flexible Joint Couplings," April, 1902.

† Professor of Machine Design, Worcester Polytechnic Institute, Worcester, Mass.

the shaft angle is 45 degrees. The zero position of shaft JH is that shown in Fig. 1. If ϕ is the angular motion of AB corresponding to θ, the angular motion of JH, then $\tan \phi = \cos \alpha \tan \theta$. Fig. 4 represents the values of Table II graphically; divisions on the inner circle show the angular positions of shaft JH, while those on the outer circle show the corresponding positions of shaft AB.

The variation in velocity ratio and in the relative angular positions of the two shafts may be avoided if two joints properly arranged in series are used. Fig. 5 shows two shafts, A and C, non-intersecting and non-parallel, connected by a double Hooke's coupling in which B is the intermediate shaft. The ends of the connecting cross arms, as has been previously shown, follow circular paths. In Fig. 6, are shown the projections of the paths of c, d, a and b on a plane perpendicular to shaft B. As the plane of the circle described by a and b is oblique to shaft B, the projection of the path is an ellipse, while the path described by c and d being perpendicular to shaft B projects as a circle. From the construction of the joint, the cross arm cd is always perpendicular to shaft B, and therefore always parallel to the plane of projection shown in Fig. 6. The arm ab is actually perpendicular to the arm cd. From these two facts, it follows that in the projection, Fig. 6, ab and cd will always be at right angles for successive positions during the rotation of the connected shafts. In the same way in Fig. 7, there is a similar projection for the paths followed by ef and gh. If shafts A and C make the same angle with the shaft B, the projections of paths of ab and gh will be ellipses of the same shape. Without disturbing any other part of the arrangement, let the fork at the left end of shaft B be loosened and turned on the shaft, carrying a, b, c, d and shaft A with it, until cd projects at $c'd'$, Fig. 6. Now fasten the fork rigidly to shaft B again and let shaft B be turned through a small angle as indicated by the arrows. Points f and d' being on the same rigid rotating piece at the same distance from the axis, will each move through the same distances on their respective circular paths, and ff' will equal $d'd''$. Also, because the cross arms are always at right angles in the projections Figs. 6 and 7, and because the two ellipses are alike, then b' and g will move the same distances on corresponding parts of their elliptical projections and $gg' = b'b''$. As these ellipses are projections of equal circles, points b and g will move actually through equal space distances. Therefore shafts A and C have been revolved through equal angular displacements. From this it follows that if shaft A turns at constant speed, shaft C will turn at the same constant speed.

An inspection of Figs. 5, 6 and 7 will show that two conditions are necessary to produce this constant speed ratio between shafts A and C. First, shafts A and C must make the same angle with shaft B; second, the forks on shaft B must be placed relatively so that when the plane of the one at the left end contains the center lines of shafts A and B, the plane of the right-hand fork must contain the center lines of shafts B and C. It will be seen from this that a great variety of positions may be selected for shafts A and C. One of the commonest arrangements is that when the shafts A and C are parallel; in this case, the forks on shaft B will be placed in the same plane. This arrangement has been utilized for the carriage feed on milling machines.

TABLE II. RELATIVE ANGULAR POSITIONS OF SHAFTS

Relative Angular Positions in Degrees of shafts JH and AB during one Revolution for Shaft Angle of 45 Degrees

	AB Lags				AB Leads		
	JH	AB	Diff		JH	AB	Diff.
a	0	0	0	j	90	90	0
b	10	7.1	2.9	k	100	104	4.00
c	20	14.43	5.57	l	110	117.24	7.24
d	30	22.21	7.79	m	120	129.24	9.24
e	40	30.68	9.32	n	130	139.88	9.88
f	50	40.12	9.88	o	140	149.32	9.32
g	60	50.76	9.24	p	150	157.79	7.79
h	70	62.76	7.24	q	160	165.57	5.57
i	80	76.0	4.00	r	170	172.9	2.9
j	90	90.0	0	s	180	180	0

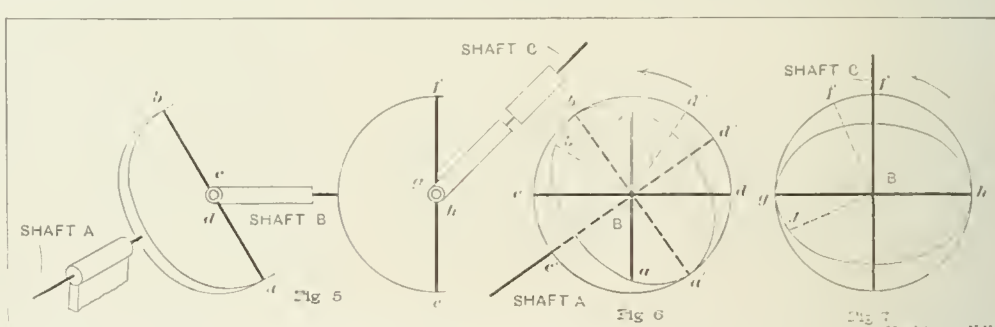
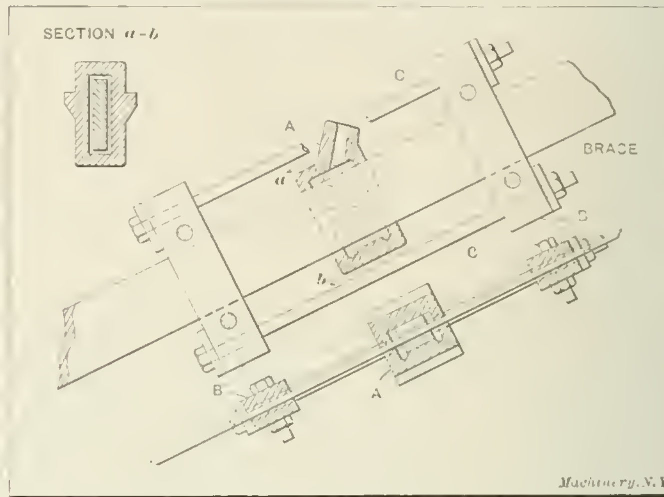


Fig. 5. Two Non-intersecting and Non-parallel Shafts connected by Double Universal Joints. Fig. 6. Projection of ab and cd on a Plane perpendicular to Shaft B. Fig. 7. Projection of Arms ef and gh on a Plane perpendicular to Shaft B

* * *

TIGHTENING STAYS IN STEEL STRUCTURES

An efficient means of tightening up slack members in bridges and similar structures has been developed by Mr. Albert Haskenkamp, Essen, Germany; the process is described in *Reactions*. Previous to its introduction, a brace that needed shortening required to be removed and upset in the forge.



Patented Apparatus for Applying Thermit to Shortening Bridge Stays

The new method, which employs thermit, consists in encasing the brace at some convenient place with a two-piece shell, as at A in the illustration, luting the joints with clay. Straps B are clamped around the brace, above and below the shell, and are connected to each other by bolts C, which draw the two clamps together. Thermit is ignited in a flat-bottomed crucible, and at the end of the reaction is poured into the mold, the slag being allowed to enter first so as to coat the bridge member with a protective layer, in order that none of the metal will come in contact and adhere. This liquid mass being poured at a temperature of from 3000 to 4000 degrees F., brings the steel to a red heat, when the clamps can be tightened, upsetting the section at the heated part. If the shortening is but slight, no tightening is required, for the heated member, tending to expand, is restrained from so doing by the clamps and automatically upsets.

In the case of double braces where it is desired to upset only one of them, the other member may be surrounded with refractory material as insulation, confining the heat to that part of the brace which requires shortening.

TESTING A CYLINDRICAL GRINDER

PRACTICE OF THE LANDIS TOOL CO.

By FRANKLIN D. JONES

The accurate nature of the work for which a grinder is ordinarily employed, combined with other requirements that are essential to a machine of this type, make it necessary to finish practically every part used in the construction with considerable precision; but notwithstanding the precaution taken in the finishing of each unit or member that goes to make up the completed machine, slight errors are unavoidable, some of which are due to inherent imperfections in the manufacturing tools used, while others result from differences in the skill and judgment of the workmen. These errors would be quite insignificant if considered independently, but when the machine is assembled, even very slight inaccuracies sometimes become serious because they accumulate or add themselves together, thus causing a disalignment of one or more important parts—all of which is familiar to every mechanic who has had experience with precision work. The methods employed in the final inspection of the cylindrical grinders built by the Landis Tool Co., Waynesboro, Pa., for detecting these accumulative errors and other minor defects will be referred to in connection with the accompanying illustrations which show the testing tools used and their application.

The work of inspecting a grinder does not, of course, begin when it is assembled, but some of the more important tests cannot be made until the machine is erected and ready for operation, and while those which precede are essential, most of them are of an obvious nature and need not be referred to. The attention of the inspectors is focused principally on the relation between the wheel carriage and the platen with its work-centers. The wheel carriage must travel in a straight line and parallel with the top surface of the platen; the work-centers must be in alignment with each other and parallel with the platen; and the top surface and front edge of the platen must be true plane surfaces within close limits, to permit adjusting the headstock and tailstock to different positions without affecting their alignment. Of course it is neither practicable nor necessary to align the various members to absolute perfection as shown by the indicators, but the limits of variation are so small as to be scarcely appreciable.

The first inspection to which the assembled headstock and footstock are subjected, is illustrated in Fig. 1. This inspection takes place in the fitting department before the parts are assembled on the finished machine, and the test shows the position of the spindle with relation to its base. The test indicator used is adjustably mounted on a large base, and its indicating point is first brought into contact with the underside of the spindle center as shown. The spindle is then reversed in its bearings and a similar test is made on the opposite side. The variation shown by the indicator is noted, and if it is greater than the allowable limit, the base is scraped to make it parallel with the spindle. After this operation, the parallelism of the spindle with relation to a front locating projection *A* is determined as shown in Fig. 2. For this test the gage is attached to a special base which also has a projection or lip as shown. By bringing the indicator into contact with the front side of the spindle center and reversing the spindle as before to test on both sides, any disalignment with the locating projection is shown. The necessary adjustments in this direction are made by scraping the inner surface of part *A*, and the latter is kept square with the base while being scraped, by testing bar *B*, Fig. 1. The spindles of the headstock and footstock are both tested in this manner to determine their alignment with each other, as well as with the base. These tests are made on a special surface-plate instead of on the machine platen, as it is more convenient and prevents the finished platen from being marred. The taper hole in the headstock spindle for the work center, is also tested in the fitting department to determine whether or not it is concentric with the exterior of the spindle, by applying the gage to the work-center, as in Fig. 1, and turning the spindle by hand.

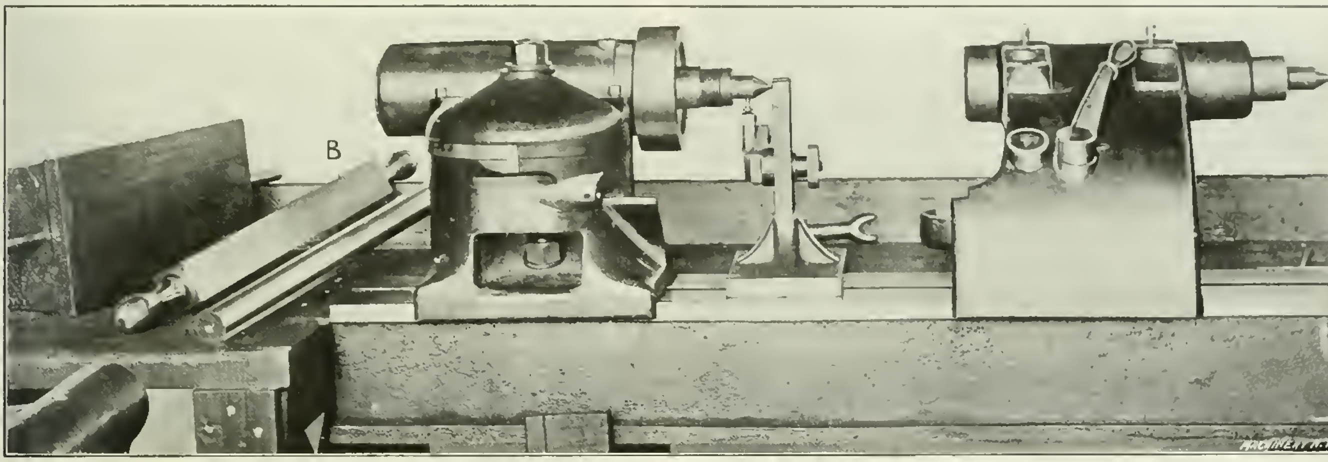


Fig. 1. Preliminary Test to determine Parallelism of Headstock and Tailstock Spindles with Base

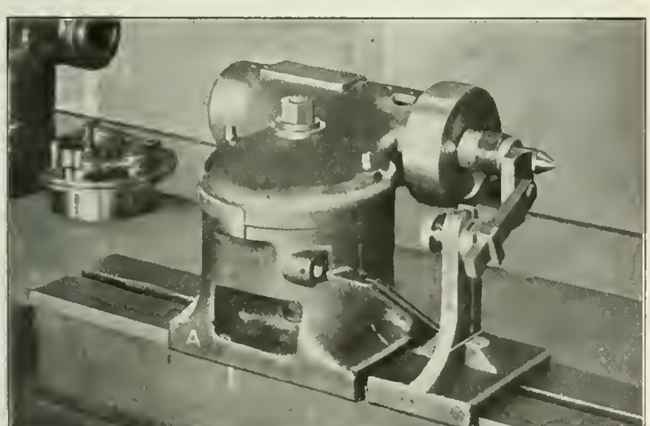


Fig. 2. Testing Parallelism of Spindle with Locating Projection in Front

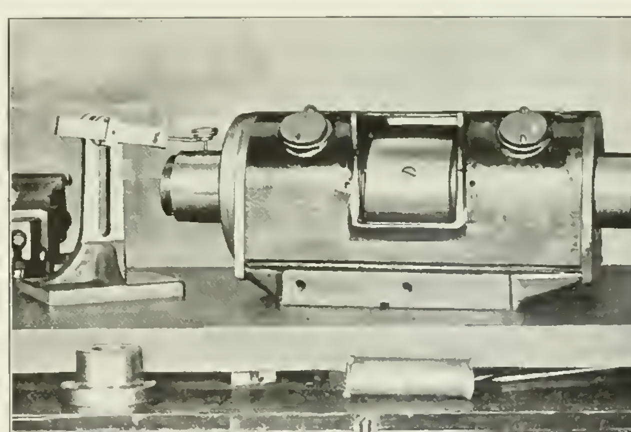


Fig. 3. Testing Wheel Spindle for Parallelism with Base

The wheel spindle of a grinder is, of course, a vital part of the machine, and owing to its high rotative speed and the necessity of eliminating all play and vibration, the bearings must be fitted very carefully. These bearings are tested on

* Associate Editor of MACHINERY.

the heavy cast-iron table or bench shown in Fig. 4, by attaching the base and assembled spindle to this bench and rotating the spindle by a belt from an overhead drum, as shown. As the test speed is from two to three hundred revolutions per minute faster than the regular working speed, any imperfections in the bearings are soon detected by the excessive heat generated. After each spindle is run for a time, it is removed

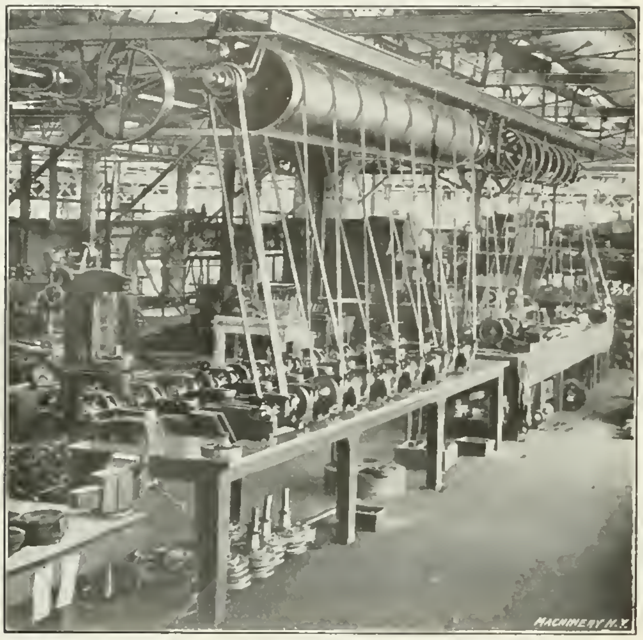


Fig. 4. "Running in" Wheel Spindles prior to Assembling

Fig. 5. Testing Top of Platen with Reference to Wheel Carriage Travel

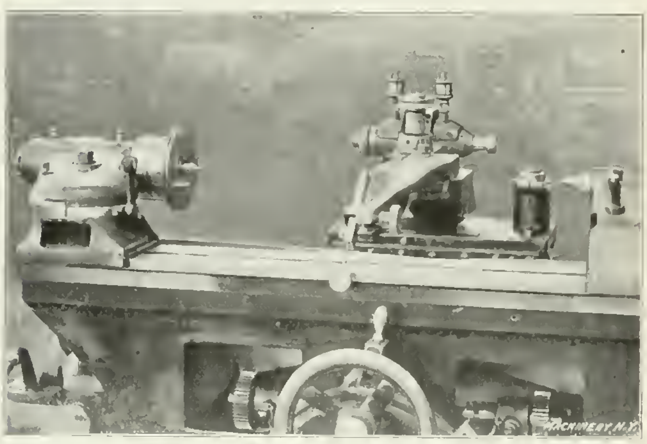


Fig. 6. Aligning Front Edge of Platen

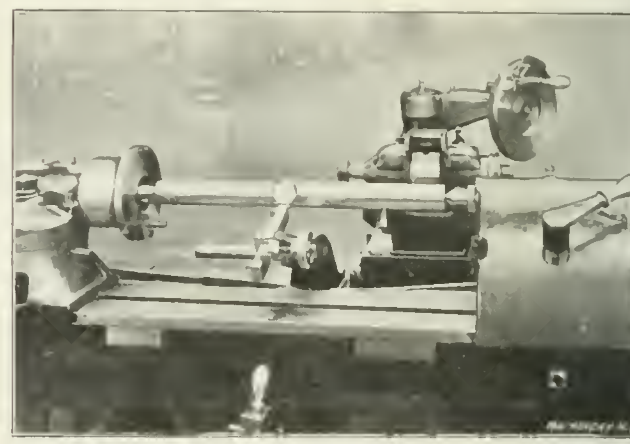


Fig. 7. Testing Alignment of Work-centers with Carriage Travel

Fig. 8. Testing Parallelism of Bar between Centers with Platen

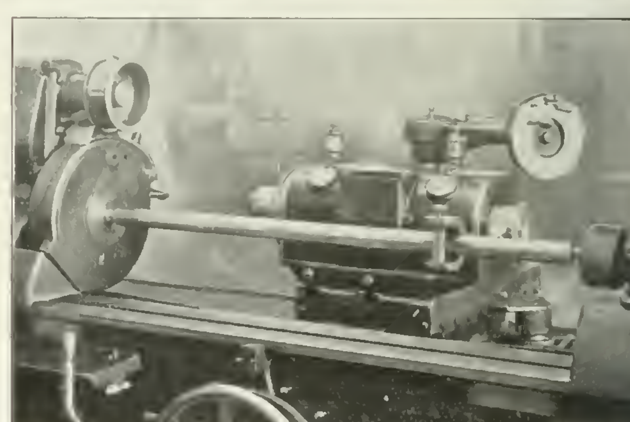


Fig. 9. Testing Wheel Spindle Alignment on Plain Machine

and any high spots which show on the phosphor-bronze bearings are carefully scraped; in this way a good bearing is obtained under conditions more severe than are encountered in actual practice. The spindle is then run for several hours to make sure that it will operate indefinitely without becoming heated above a normal temperature. The wheel spindle is also given a preliminary test in the fitting department to see if it is parallel with finished surface of the base. Collars of the same diameter are placed on each end of the spindle and the test is made as shown in Fig. 3.

When the grinder is assembled, the alignment of the various members with relation to one another, is determined by a series of final tests which locate any accumulative errors and insure an accurately constructed machine. Prior to these tests, the wheel carriage and its reciprocating mechanism is operated for two or three days by a special motor in the testing department to give the machine a smooth action and the wheel carriage a more perfect bearing on the ways of the bed.

The top surface of the platen is first tested with relation to the travel of the wheel carriage as shown in Fig. 5. A bracket is bolted to the wheel carriage to which is attached an adjustable arm and a dial indicator. When the indicator is traversed along the platen by moving the wheel carriage, the

dial shows whether or not the platen surface is straight and parallel with the carriage travel. The front edge *E* against which the headstock and footstock are located, is then tested with the indicator adjusted to the position shown in Fig. 6, the indicator being traversed by the wheel carriage as before. The platen is swiveled to bring this front edge parallel with the carriage travel, after which a steel pointer or knife-edge is screwed to the bed in a position coinciding with the zero position of the graduations for indicating tapers. This test also shows whether the front or locating edge is perfectly straight.

The headstock and footstock are next clamped in position and a long test-bar is placed between the centers as shown in Fig. 7. The wheel carriage is then traversed with the gage in contact with the side of this bar, which shows if the work centers are in alignment laterally with the wheel travel. As this test is made with the swiveling platen in its central or zero position, the alignment must be practically perfect, for otherwise the machine will grind taper instead of straight or cylindrical as indicated by the scale. The test shown in Fig. 8 is next made to determine the alignment of the centers with reference to the top of the platen. The gage is applied to the top of the test-bar and it is mounted on a broad base which is moved along the platen. The base having a projection that bears against the front edge of the platen, is then substituted to test the alignment of the bar with this edge. Inasmuch as the headstock and footstock spindles were tested previously in the fitting department, as explained, these final tests prove the accuracy of alignment, and working conditions are practically duplicated by having a test-bar mounted between the centers. Of course, the errors shown by these tests would in any case be very small.

The next operation on a universal machine is not strictly a test, but rather a method of locating a datum line at *L* (Fig. 10) on the wheel carriage for setting the graduated swiveling wheel-slide to any angular position with reference to the work-centers. The swiveling slide is graduated by a special machine before being assembled. To locate the datum line, the slide is swiveled around to the position shown, and it is set parallel with a test-bar between the centers by traversing it with an attached indicator in contact with the side of the bar. When this indicator shows that the movement of the slide is parallel to the test-bar, a line is made on the carriage exactly opposite the 90-degree division. The coincidence of this datum line with any of the other angular graduations, when located as described, shows the exact angle that the travel of the wheel-slide makes with the work-centers when the latter are set for straight grinding. Fig. 9 illustrates the method of testing the wheel spindle of a plain grinder for parallelism with the travel of the wheel carriage. Closely fitting collars having the same outside diameter are placed on each end of the wheel spindle as shown, and a V-shaped gage with an indicator attached to its end is brought into contact with first one and then the other of these collars by moving the wheel carriage along its ways. The position of the wheel spindle in a vertical plane is also ascertained by bringing a gage that rests on the platen into contact with the upper side of the collars, as illustrated in Fig. 11.

The tests which have been described in the foregoing have to do exclusively with accuracy of alignment, which is, of course, absolutely essential to a machine of this type. These tests, however, constitute only a small part of the inspector's work, as all details, including the attachments, etc., are examined for defects either as to size, adjustment, or operation. To insure that every part is properly examined, "inspection sheets" are used that contain a list of all the important requirements which experience has shown to be essential to a well-built grinder. As each test listed for the details of various members is made by the inspector, it is checked off the inspection sheet for that particular machine, provided the part comes up to the required standard. In this way a record is kept which eliminates any chance of incomplete inspection, and the inspector's check-mark, which is practically an O. K. signature, tends towards more careful and conscientious work than would be obtained otherwise. This inspection sheet, which is eventually filed, also contains the drawing numbers of the various assembled and detail parts as well as other information of a miscellaneous nature which is often needed for future reference. The grinder, after the work of inspection is complete, is run for a few hours on all the various speeds and rates of traverse as a final test to insure perfect operation.

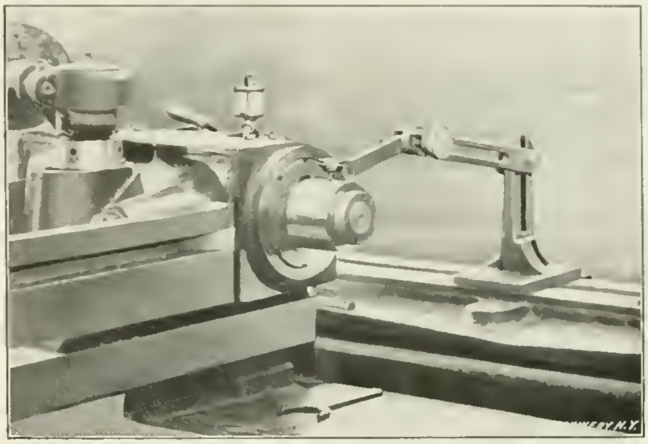


Fig. 11. Testing Position of Wheel Spindle with Reference to Platen

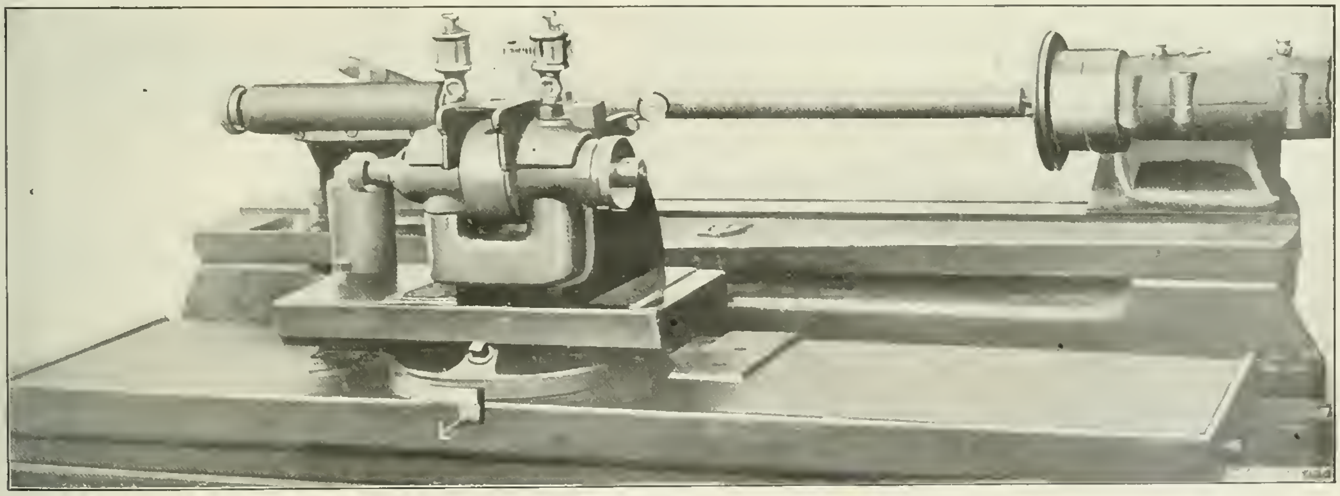


Fig. 10. Setting Wheel-slide Parallel to Work-centers for Locating Datum Line of Angular Graduations

* * *

Some interesting conclusions reached by Prof. Kammerer of Charlottenburg, Germany, after conducting over one thousand tests on belt drive, are reported in *The Wood Worker*. The more important of these are as follows: The effective pull on a belt is not reduced by centrifugal force to the extent commonly believed; the coefficient of friction increases with the speed and reaches values far in excess of those usually assumed; the maximum efficiency of transmission is not limited by the speed; and at any speed the sum of initial tension and centrifugal force is constant. Other conclusions derived conform with generally accepted data.

THE DESIGN OF DIE-CASTING MACHINES —ALLOYS FOR PRESSURE CASTINGS*

By E. F. LAKE†

Die-castings have become fairly well known in the past few years, but the machines, metals and methods employed in their manufacture are as yet very little known. This is due no doubt to the fact that the apparatus and methods employed have been zealously guarded as secrets by those engaged in their manufacture. It may be surprising to many to learn that the commercially successful manufacture of castings from alloys in metal die-molds has not been accomplished through any recent invention, nor has it been the result of any individual's efforts. Like most other industries, this has been a gradual growth, through a period covering more than sixty years. The machines have been slowly perfected, and the alloys for the castings have been continually improved. Thus it is now possible to make dense, sound die-castings from alloys, nearly as strong as brass, and the writer has a process by which a very strong bronze can be cast in die-molds.

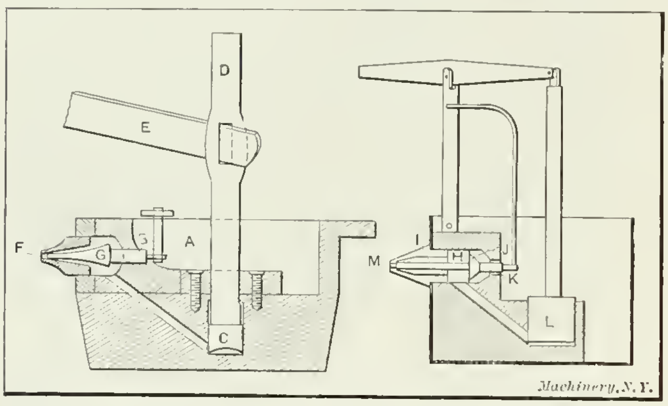


Fig. 1. Type-casting Machine built in 1849. Fig. 2. Improvement in the Type-casting Machine, made in 1856

Historical Development of Die-casting Machines

The first machines or methods along this line were used to manufacture bullets and type; the one being used to murder man and the other to educate him. Most of us are familiar with the iron hand-molds, in which we used to make bullets as boys. Thus it will be hardly necessary to illustrate these. Many inventions were made and patents taken out in the years preceding and following the American rebellion, the Mexican war and the American revolution.

Of the type-casting machines, the first one that we can obtain an illustration of was patented on March 27, 1849, by J. J. Sturgiss. A sectional view of this machine is shown in Fig. 1. This illustrates the basic principle on which most of the die-casting machines in use today are built. In this machine the molten metal flows from the pot *A*, which is surrounded with heat, through the opening *B* into the cylinder *C*. Plunger *D* is then forced down by the lever *E*, which is operated by a cam and connecting-rods, and forces the metal out of nipple *F* into the type-mold. Piston valve *G* is then forced forward to squeeze the metal into the mold and also cut off the liquid stream, so it will flow back into the pot.

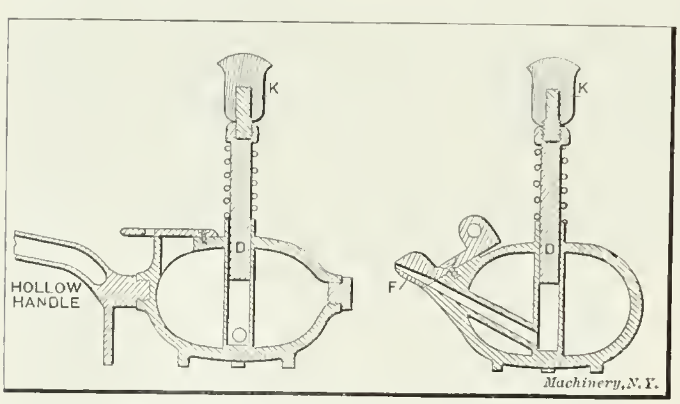


Fig. 3. Small Hand-operated Machine built in 1872

This was followed in 1852 by another patent by W. P. Barr covering other points on a machine which worked in practically the same manner as that shown in Fig. 1. As shown in Fig. 2, E. Peluze patented an apparatus on similar lines in 1856. His improvement over the two former machines was in the piston valve *H*. In this, valve *I* was moved back until beveled surface *J* closed opening *K*, through which the molten metal flowed. Plunger *L* was then forced down, and this made the metal flow through nipple *M* into the type-mold. After this, piston valve *I* was forced forward, the same as in Fig. 1, and for the same reasons.

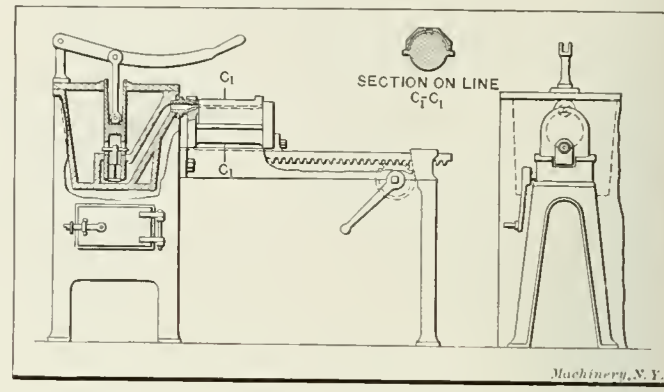


Fig. 4. First Die-casting Machine built for Miscellaneous Work (1877) set up for Casting Bearings

In 1872 a small hand machine was patented, as shown in Fig. 3. This was filled with molten metal from a melting pot, and when set on the bench, the palm of the hand was brought down forcibly on the wooden knob *K*. This forced down piston *D* and squeezed the metal out through nipple *F*. Other machines were invented in the following years for making medals, sewing machine bobbins and various other small articles. The type-metal apparatus was also improved by such inventions as that shown in Fig 6, in which a much better design and arrangement were made of heating chamber, melting pot, cylinder, plunger, etc.

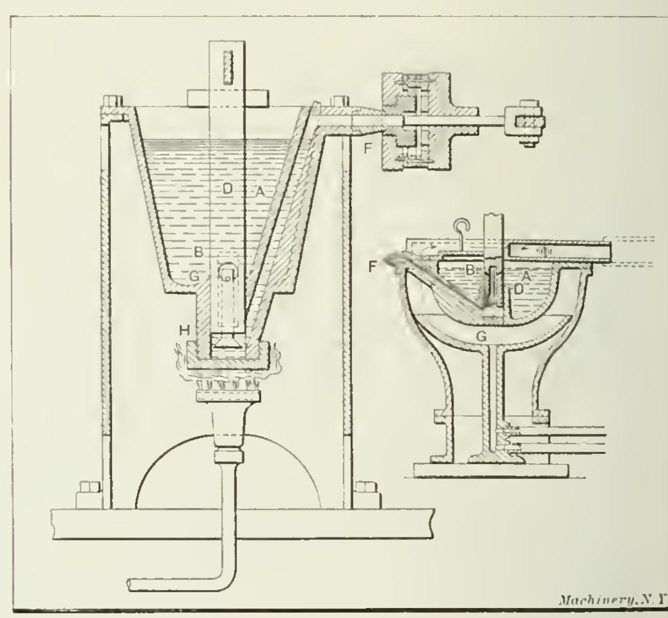


Fig. 5. Die-casting Machine patented in 1892. Fig. 6. Improvement made in 1888 on Machine shown in Figs 1 and 2

The first attempt to apply these principles to a more universal manufacture of castings, was made by C. and B. H. Dusenbury in the machine shown in Fig 4, which they patented in 1877. In this, the same principles as used on former machines were adopted for the melting pot, cylinder, plunger, outlet passage and nipple. In addition thereto, arrangements were made by which the die-molds that contained impressions for journal bearings were located on the machine, and exchanged for others when desired. Thus a wide range was given to the machine. The method of moving

* For additional information on die-casting machinery, see the following articles previously published in MACHINERY: "Die-Casting and Die-Casting Machines," May, 1911, engineering edition; "Die-Casting—1 and 2," January and February, 1911.

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the mold away from the nipple so it could be opened and closed was accomplished by the gear and rack.

Little was done with this method of casting until after C. W. Weiss was allowed some claims, on March 8, 1892, on practically the same machine that was patented by the Dusenburys in 1877. This is shown in Fig 5. From this time on, the die-casting business has steadily grown until it is now quite an important factor in the manufacture of many products. The many improvements have given us automatic machines that insert wires, bushings, clock wheels, etc., of steel, bronze or other strong metals, into the molds; then close them, cast the alloy, and eject the finished casting out of the mold. Between this and the simple hand-operated machine, there are belt-driven, motor-driven and semi-automatic machines used in the manufacture of die-castings.

Hand-operated Machines

The strictly hand-operated machines have been perfected to an extent that enables one man to turn out a large number of castings with an alloy that is not very high-priced. Thus a machine may be placed in a room or in any part of a shop where there is no power. The only thing required to operate it is a supply of gas to heat the melting pot and melt the metal, and a man. The output of these hand-operated machines is so large that it is only under very special conditions that the automatic machines can be economically operated. These conditions would require a very large number of castings from the same mold, and the castings

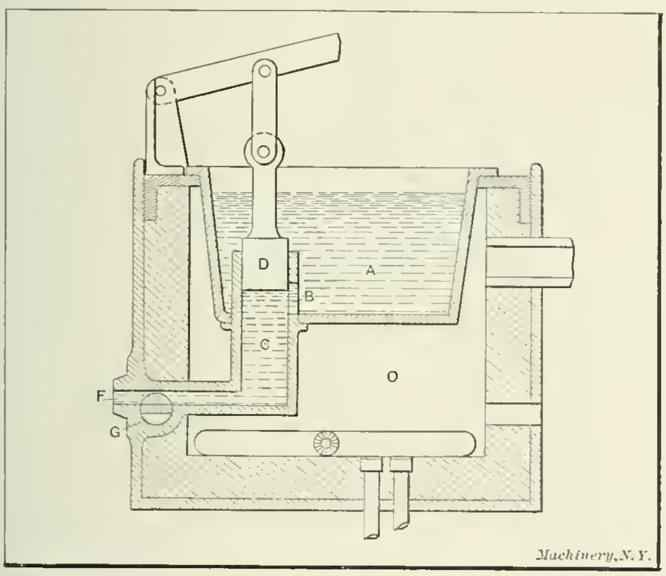


Fig. 7. Melting Pot with Side Outlet

could not be very intricate. With the hand-operated machines, however, very intricate castings can be made from the white-metal alloys generally used.

The modern hand-operated machine with its melting pot and method of forcing the metal into the molds has undergone many changes and has been the subject of a great deal of designing. In connection with it, valves and sprue-cutters have been made in several different ways. The ways and means of holding the molds for the cast and then opening, or parting them to eject the casting have also been improved in various ways. From the melting pot, the metal has been forced through the sides, top and bottom, and then into the molds. A cylinder and plunger has been the favorite method used and this has been designed in various styles and sizes. Some have used air for forcing the metal into the mold, but with no success.

Melting Pots and Plungers

In Fig. 7 is shown one of the latest styles of machines with the outlet from the melting pot in the side. In this, the burning gas in chamber O keeps the metal molten in pot A and it flows through passage B into pressure chamber C. From here it is forced by plunger D through nozzle F into the mold. Valve G is then turned over to stop up the passage and thus cut off the flow of metal. This style of machine brings the pressure chamber C down into the gas chamber where it is easily heated to the right temperature for casting. The metal that lies between valve G and the end of the nozzle F, however, has to be removed before it freezes and before the mold is opened. It is therefore necessary each time a casting is made, to move the entire mold away from nozzle F, while the sprue-cutter is in position for keeping the metal away from the casting. This extra metal then falls to the floor. This has been overcome in some machines, and hence one cause of trouble is removed. Another fault is that while plunger D is traveling past port B it forces the metal out into

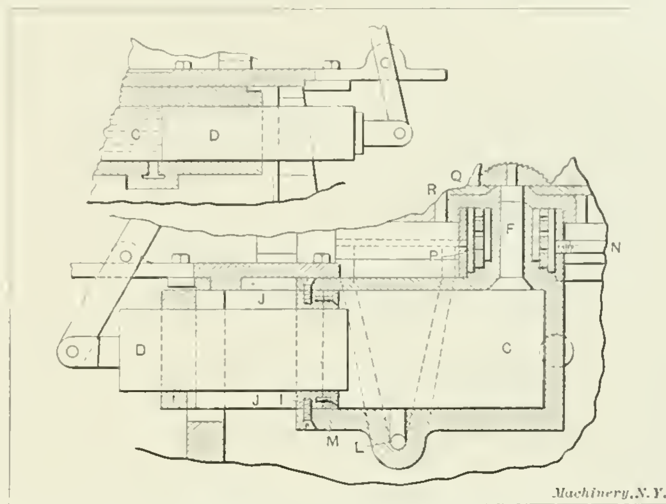


Fig. 8. Long Type of Plunger. Fig. 9. Plunger smaller then Cylinder—Auxiliary Heating Chamber for Outlet Passage

melting pot A and thus keeps it continually churned. This causes the dross and slag that should rise to the top to mix with the molten metal and enter the castings.

The plungers used with this type of machine differ considerably. The one shown in Fig 7, has a bearing surface as long as the diameter of the plunger. This "square" plunger gives very good satisfaction where it is covered with molten metal, as it is in this case. An extremely long plunger is shown in Fig 8. The construction of the machine is such that one end of the plunger comes out into the gas chamber, and therefore it was extended into the open air in order to overcome the excessive heat of the gas flames. Much trouble has been experienced with this type, from the metal freezing around the surface between it and the cylinder, thus causing the plunger to stick. This is largely due to the great difference in temperature between the two ends, and consequently plungers of this type have to be continually cleaned, as well as their cylinders.

To overcome this, the type of plunger shown in Fig. 9 was invented. It is smaller in diameter than the cylinder or

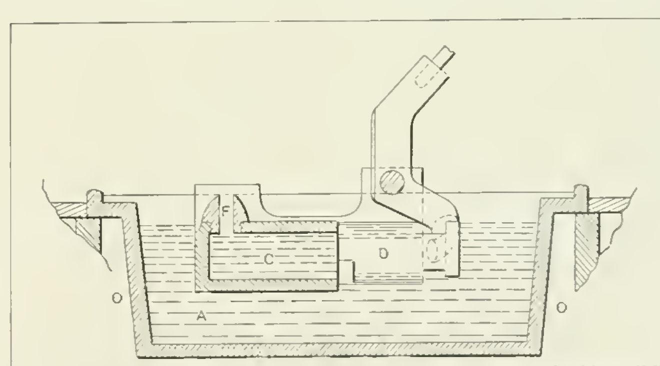


Fig. 10. Melting Pot with Outlet in Top

pressure chamber and travels in a rack composed of the two rings I, which are held together by ribs J. One of these rings fits into the end of the cylinder, and holds the rack in position. The molten metal flows into the pressure chamber through port L, and a valve closes this port when the plunger is brought forward to force the metal up into the mold. In the cylinder is located an asbestos washer M, for preventing any leakage of molten metal that might occur. This type of plunger largely overcomes the tendency of metal to freeze on the bearing surface, as its area is greatly reduced. Dross

also is not as liable to clog and stick the plunger in the cylinder. This design has, however, added the troubles encountered with an asbestos washer, which, owing to its non-cohesiveness, is continually crumbling away and flaking off.

Around the outlet or nozzle of this machine has been placed an auxiliary heating chamber. Gas enters through pipe *N*, surrounds the nozzle in passage *R*, passes through the perforated ring *P* and fills the inner chamber *Q*; after which the burnt gases pass out. This keeps the molten metal

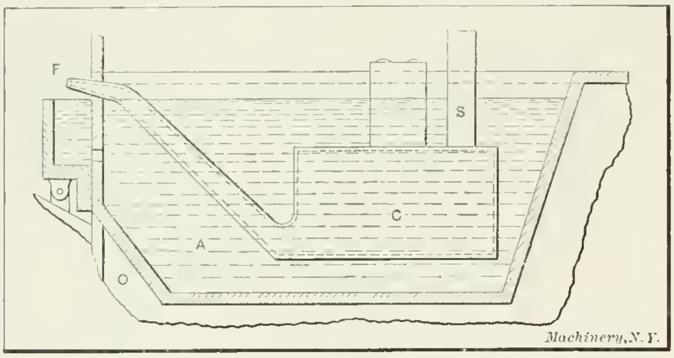


Fig. 11. Melting Pot with Air Pressure Chamber

that fills nozzle *F* from chilling when a casting is being made. This is one of the troubles often met with in this style of die-casting machine. Of course, when the sprue-cutter has severed the metal between the mold and the pressure chamber *C*, this passage empties when plunger *D* is pulled back. Passage *F*, however, is filled a large part of the time, as in making a casting it is necessary to bring the plunger forward as hard as possible, and hold it there while the mold is filling with metal and the sprue-cutter is being operated. Metal freezing in this passage causes a great deal of trouble which a heating chamber might abolish.

In Fig. 10 is shown another style of melting pot. This has a pressure chamber submerged in the molten bath, and the plunger is operated by a lever which passes out through the top of the bath. The nozzle also carries the metal through the top of the bath to the mold. In this type, the melting pot *A* is surrounded with gas flames at *O*, and the metal in the

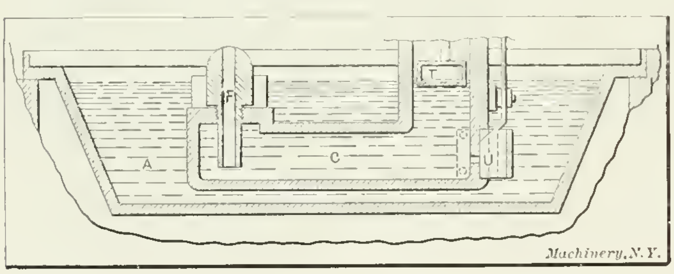


Fig. 12. Another Type of Air Pressure Chamber in the Melting Pot

pressure chamber has to be heated through the mass of metal in the melting pot *A*. It is therefore difficult to keep the metal in pressure chamber *C* as hot as that in melting pot *A*. The opposite condition should exist, *i. e.*, the metal should be hottest at the point where it is being forced into the mold. While several die-casting firms have used this type of machine, it has been the cause of much trouble.

Application of Compressed Air to Die-casting Machines

In Fig. 11 is shown a pressure chamber submerged in a melting pot, but instead of using a plunger, compressed air is driven into the pressure chamber through pipe *S*, and this forces the molten metal out through nozzle *F* and into the mold. This application of compressed air has appealed to many builders of die-casting machines owing to its simplicity of operation, its positiveness, and the fact that operating troubles, such as the plunger sticking to the cylinder, were overcome in the machine. All those who attempted it, however, were men who understood nothing of metallurgy or the nature of metals. With the exception of a few very rare elements, oxygen unites with every known substance. It has a special affinity for metals when heated, and the higher the temperature, the greater will be this affinity. It is one of the most injurious elements that can be injected into metals. By forcing air under pressure into pressure chamber *C*, as is done in this case, it is impinged directly upon the surface of the metal with considerable force, and thus greatly increases the amount of oxygen that the metal will absorb from this air. After the first few castings are made, the metal becomes full of small bubbles which increase in size with the number of castings made, and in a short time there is nothing to the casting but a shell of metal that is filled with bubbles. Many times such castings are marketed because the spongy formation of the center does not show on the outer surface, but the instant they are broken, their worthlessness is apparent.

In Fig. 12 is another type of the pressure chamber that is submerged in the melting pot, and thus has the coldest part of the molten metal passing through nozzle *F*, as is the case in Figs. 10 and 11. In this, air pressure has been used to force the metal up through nozzle *F*, but an attempt has been made to overcome the defects always encountered when using air. Float *T* has been placed in a compartment by itself, and the air is blown into this so that it will impinge upon the surface of the float, and only have a small surface of metal

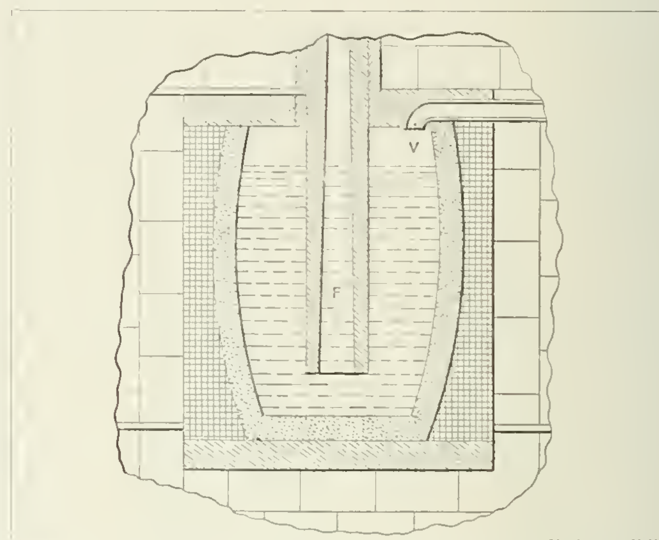


Fig. 13. Electrically Heated Crucible for Melting Pot

around the float to absorb the oxygen. Nozzle *F* was also made of a casting that projected close to the bottom of the bath in order to let out any bubbles and get only the densest metal in the pressure chamber. It was thought that the bad effects of air, or the oxygen in the air, would be overcome by causing it to travel downward and then across the pressure chamber to the nozzle *F*. While the bad features of air pressure were overcome to a certain extent, they could not be

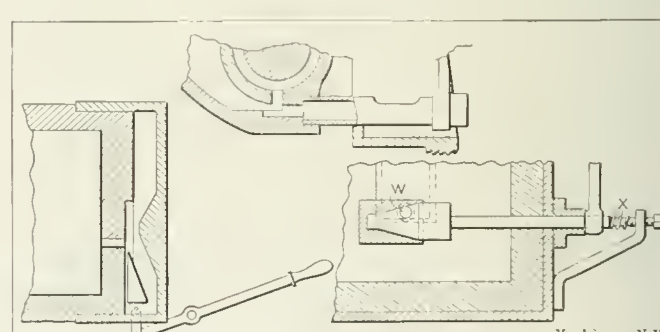


Fig. 14. Three Styles of Valvee used

entirely avoided as long as any part of the surface of the metal was left free to be attacked by the oxygen in the atmosphere. Thus, while this machine will make quite a number of castings before the metal becomes charged with oxygen, it is still only a question of time when that will occur, and then the castings will be weakened and probably spongy and porous. An automatically operating valve was placed at *U*, so that pressure chamber *C* would take metal in as fast as it was injected into the molds.

Electrically Heating the Melting Pot

Another type of melting pot is shown in Fig 13. In this design an ordinary graphite crucible is surrounded with a resistance coil, and placed in a brick-lined receptacle. An electric current is then turned on to heat the crucible and metal. The top of the crucible was sealed, and air was injected through pipe V to force the metal up through nozzle *F*. While the electric heating arrangement is a good feature,

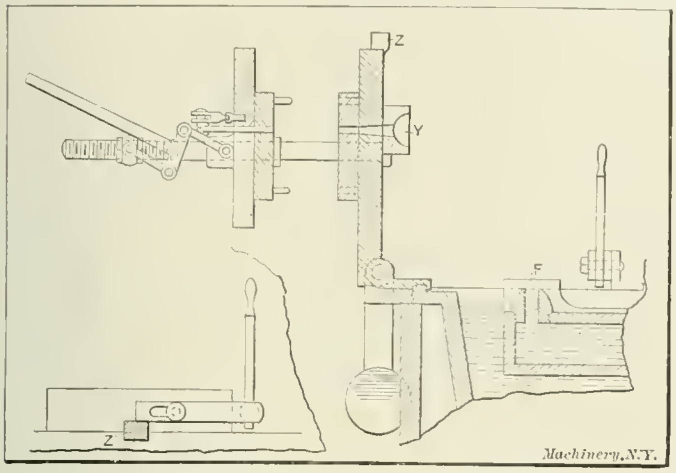


Fig. 15. Tilting Mold Table and Method of Parting the Mold

the air pressure attacking the surface of the molten metal would make this type a complete failure.

Valves

In Fig. 14 are shown three styles of valves which are used on die-casting machines. The one to the right, as can be seen, is cone-shaped and opens and closes the hole *W*. A sectional view through this hole is shown in Fig. 7 where the valve is marked *G*, and hole *W* represents outlet passage *F*. This valve is kept a tight fit by a spring located at *X*. It is easy to operate by connecting it to some of the other levers on the machine. The valve shown in the center of the illustration is operated automatically by chain and sprocket wheels, and closes its opening by turning half-way around.

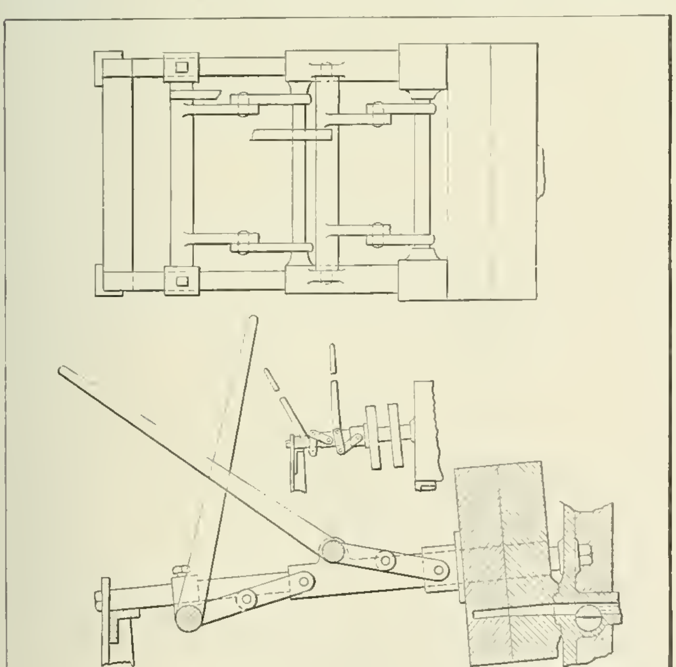


Fig. 16. Toggle-joint Arrangement for Parting the Mold and Drawing it away from the Spout

The bad feature of this valve is the large amount of surface which the molten metal comes in contact with, thus causing the valve to stick. The valve shown to the left is much more simple and has practically no wearing surface, it being merely a wedge shaped block that is forced into place by a beveled projection on a frame. This, however, can not be used in all places, and though its design is doubtless the best, its use is limited to the places where it can be operated.

Opening and Closing the Molds

The methods of holding the die-molds vary with the different styles of machines, and a large part of this variation is due to the different constructions previously shown. In the machines that eject the metal through the top of the bath, a platen is used on which to rest the mold, and these are usually fitted with tilting arrangements similar to the one shown in Fig. 15. In this machine, nozzle *F* is ball-shaped, and socket *Y* fits down over it when the table, with its die-mold, is in position for casting. The platen is clamped down by projection *Z* fitting under a piece that is moved by the upright lever, as shown by the sketch in the lower left-hand corner. The mold is divided into two parts. One part is fitted to a plate located on two rods that are bolted to the platen. A toggle-joint is then used to pull the two parts of the mold apart, so that the casting may be removed. This toggle joint is operated by the lever shown in the inclined position, and as will be seen, arrangements are made to take up any wear that might occur in this joint. The mold will thus be a perfectly tight fit at all times. This is a very important point in making die-castings, as the metal is squeezed into the mold under pressure, and if the joint were not a tight fit, this metal would squeeze out through the sides.

In Fig 16 is shown a method of holding the mold in position for casting on a machine that takes the metal out

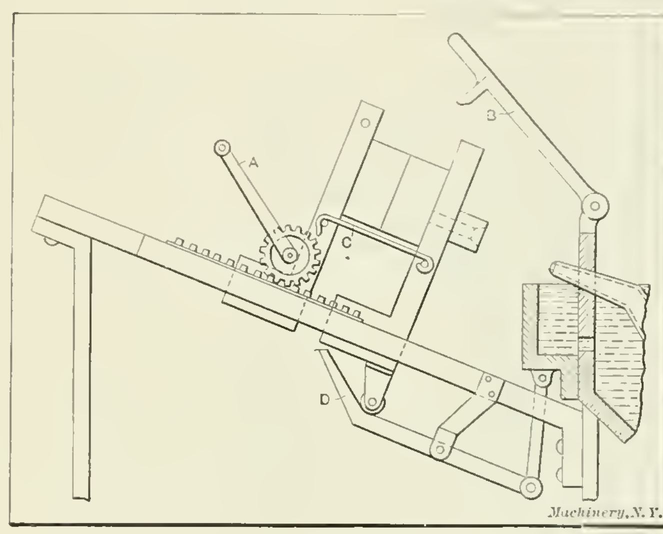


Fig. 17. Rack and Pinion used to part the Mold and draw it away from the Spout

through the side. One toggle-joint is used to close the two halves of the mold, while a second one is used to force the entire mold up against the nozzle. Why the toggle-joint, with all its faults, is used so much on die-casting machines is really a mystery, and yet it is probably due to the fact that the first machines invented were equipped with toggle-joints, and consequently nearly all designers followed this principle.

In Fig. 17 is shown a rack and pinion which is used for moving the mold away from the nozzle and also for parting it. In this illustration, lever *A* is used to operate the pinion which pulls the mold away from the spout. Hook *B* is then dropped down over the mold to hold it in position, while hook *C* is released and the two halves of the mold are pulled apart by the same gear and rack. In pulling the mold back, lever *D* is tripped and opens a valve that allows enough metal to flow into the pressure chamber to take the place of that which has been forced into the mold. While this tripping arrangement is good, and the gear, rack and pinion work successfully, the rest of the design is very crude, and it would mean very slow work in making castings. This machine, however, has not been commercially operated, and probably would not be without considerable re-designing. One of its worst features is the teapot form of pressure chamber with its air pressure. In Fig. 18, is shown still another method of opening and closing the mold, and clamping the two halves together. This also is crude and too slow in its operation.

Sprue-cutters and Ejectors

One of the necessary features on all die-casting machines that turn out perfect castings is the sprue-cutter. Two forms

of these are shown in Fig 19. The upper one is simply a rod that is pushed through the center of the casting. It implies that the casting has a center hole, and is very simple to construct and operate. If this hole is straight, it is immaterial whether it be round, square or any other shape. After the mold is filled, the sprue-cutter is pushed through it to separate the casting from the metal in the melting pot.

When castings have no center hole, the sprue-cutter can be placed at the end of the casting, as shown in the lower view. This mechanism makes it possible to stop the sprue-cutter at

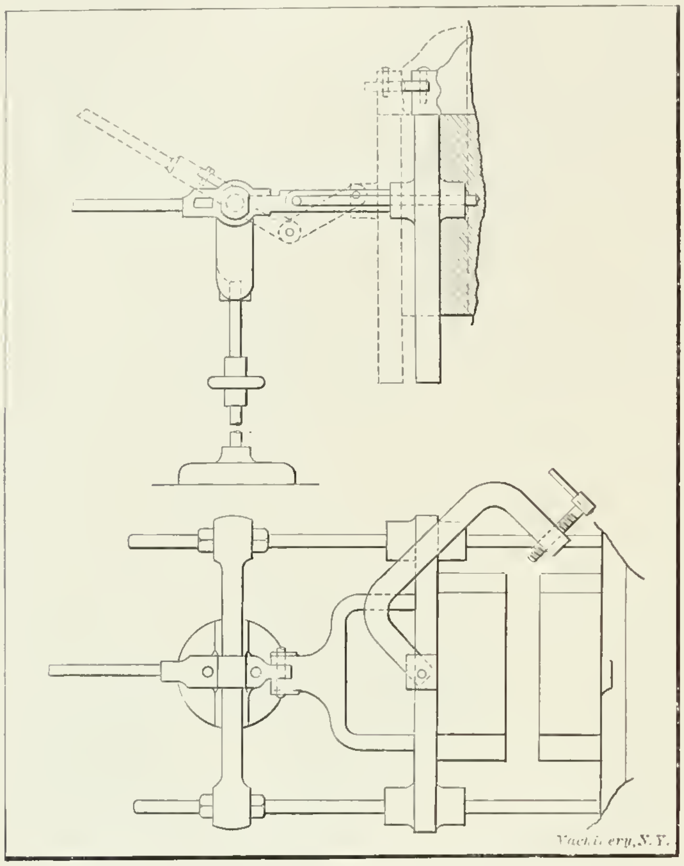


Fig. 18. Another Method of Opening and Closing the Mold

both ends of its stroke, the stops being adjustable to any position. The lever also gives the sprue-cutter, which must be a tight fit in the hole in which it operates, a straight push.

In another style of machine the sprue is cut with the platen, as shown in Fig. 20. In this, a piston working in the air cylinder *E* pushes platen *F* over far enough for outlet passage *G* to be out of alignment with the sprue hole in the mold, or the outlet in the lower part of the machine. This cuts off the metal, and leaves a pocket of metal in passage *G* which will equal the thickness of the platen. When it is held long enough for the casting to freeze in the mold, the metal in this passage will freeze and thus put the machine out of commission.

The principle of using air to operate different parts of die-casting machines, such as pressure levers, sprue-cutters, casting ejectors, etc., is very good; but considerable care in designing must be exercised to insure that no metal will be trapped in any part of the machine, and become solid. When this occurs it means that the machine must be taken apart and cleaned before it can be further operated.

In Fig. 21, is shown a casting ejector. This is fastened to one-half of the die-mold, and when the casting is complete and the mold open, the lever is brought down so that the small rods will push the casting out of the mold. The rods, of course, can be placed in any position desired, made of any size or shape, and are a very simple part of the die-casting machine. The casting ejector and the sprue-cutter must occupy positions very close to each other, and hence the levers that operate each one of these should be placed in easy reach of the operator.

Upright Die-casting Machine

In Fig. 22 is shown a complete upright machine that differs quite materially from the others shown. In this, the heating chamber, with its melting pot and pressure chamber, is supported on a cast-steel frame, and the molds are held directly underneath its center. The upper half *A* of the mold is fastened to the bottom of the heating chamber, and the lower half *B* is lowered away from it to get the casting out. The lower half of the mold rides on a cast-iron plate *C* which moves up and down on rods *D*. Lever *E* raises plate *C*, with its half-mold, by means of the toggle-joints *F*.

In operating the machine, the two halves of the mold are brought together tightly by pulling lever *E* outward. Lever *G* is then moved out to open outlet *M* of pressure chamber *H*, so that the metal will enter the mold. The lever *I*, which is above the machine, is pulled down to force plunger *J* downward, and thus squeeze the metal filling the cylinder, or pressure chamber *H*, into the mold. Lever *K* is then pulled up and forces the sprue-cutter *N* entirely through the upper half of the mold *A* and into the nozzle. Lever *G* is now pushed in to close the opening from pressure chamber *H*, sprue-cutter *N* pulled out with lever *K*, and the bottom half of the mold lowered by pushing in lever *E*. As this is done, small plate *T* beneath plate *C*, strikes plate *U*, which is supported from the base of the machine, and this causes casting-ejector *L* to push the casting out of the lower half of the mold. Hinged pieces *S* hold down the cover of the melting pot, so that when the two half-molds are brought together they will not raise the melting pot. One difficulty encountered with this type of machine is that of keeping outlet *M* free from molten metal, so that it will not drop on the casting and spoil it when the mold is opened for its removal. By making sprue-cutter *N* come up close to the metal cut-off *O*, this can be accomplished, but to make a tight fit of these two parts and keep it tight with the continued movements of the machine, while making castings, is not as easy as it looks. A very small drop of metal will often spoil the casting that is being made.

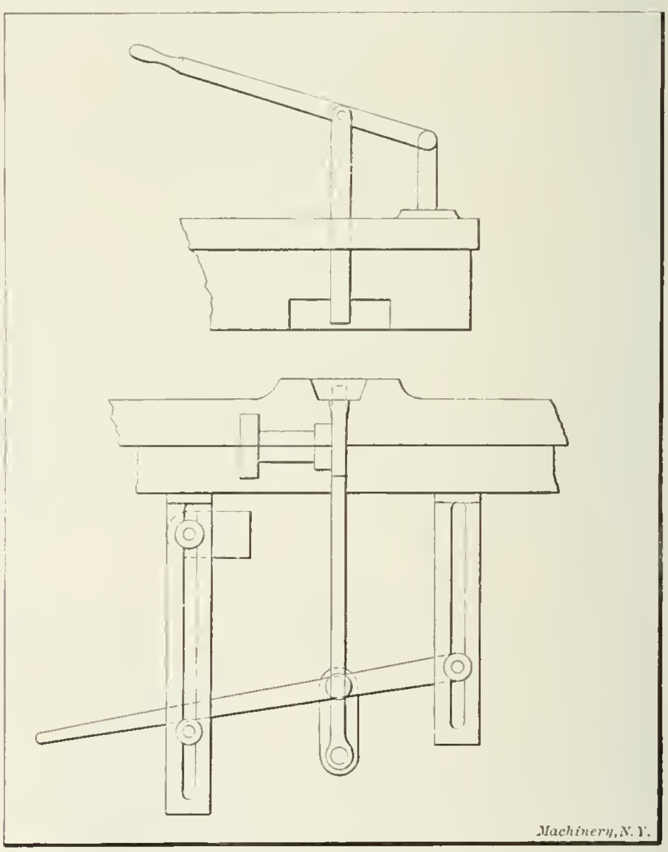


Fig 19. Two Forms of Sprue-cutters

Another bad feature is that the plunger *D* must move the distance shown by *P* before it forces the metal into the mold. While moving this distance it is squirting the molten metal out through ports *R*, and thus churning up the metal in the melting pot. This metal should be kept as quiet as possible. Another bad feature is that four levers must be moved independently for each casting that is made, and this makes the operation of the machine rather slow. These levers should be connected in such a way that the pulling of the two levers would be all that is required.

A machine of this type, however, could very easily be belt-

or motor-driven, and thus make its operation a boy's work. The work would consist of removing the castings and starting and stopping the machine. It could also very easily be made to operate automatically, and thus do away with even that much hand labor. The upright machine appeals to many on account of having the natural phenomena of gravity to assist in getting the metal from the melting pot into the mold. If the liability of molten metal dripping on the finished casting is overcome, this style of machine is very handy and easy to operate.

While many die-casting machines are made for belt or electric drive and semi-automatic or completely automatic, it requires an enormous output to make such a machine a paying proposition, for by gating the castings in molds a very large

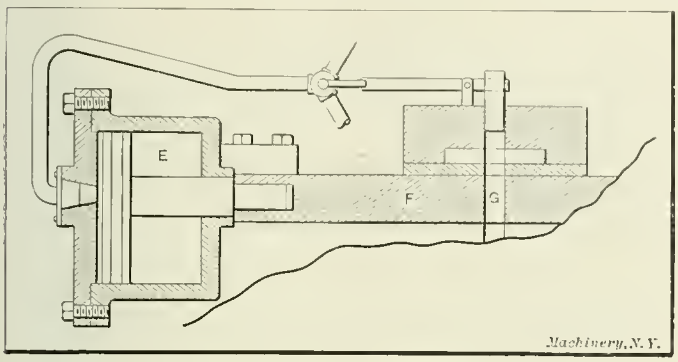


Fig. 20. Moving Platen to cut off the Sprue

output can be obtained with one man's labor on a hand-operated machine, but where thousands of pieces are to be made per day, the automatic machine will save this one man's labor, and can thus be made to pay.

Alloys for Pressure Castings

Many different alloys are compounded to make into castings in these machines. It is necessary to have an alloy with a fine, close grain that is free from porosity and low in shrinkage. Castings used for some purposes must have a high tensile strength and great hardness, and these can only be obtained at a sacrifice of ductility. Castings with a high ductility can easily be made, but the tensile strength and hardness must be sacrificed. This is also a general rule that applies to the

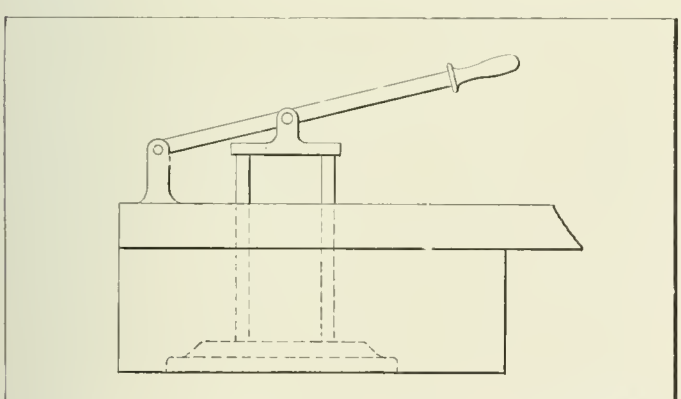


Fig. 21. Casting Ejector

manufacture and production of alloys and metals for all other purposes as well as die-castings.

Zinc, tin, copper, antimony, lead, aluminum, nickel, bismuth, magnesium and silver have been used and compounded in many different percentages to form alloys from which to manufacture castings. They have been used to manufacture castings for a large variety of purposes. The first five, namely zinc, tin, copper, lead and antimony are those most commonly used. Nearly any degree of strength, hardness, toughness, ductility, etc., can be obtained up to those inherent in the combinations that can be made. As yet, no one has marketed castings of the yellow metals or successfully made die-castings, on a commercial scale, from alloys or metals that have a melting temperature much above 1200 degrees F., or that have a strength equal to the bronzes. Considerable experimenting has been done and success is nearer than it was some years ago, even though the right method may not apparently be discovered.

Aluminum in small percentages is used in many of the die-castings. It acts as a purifier of the alloys, and causes it to flow more freely in the mold. To cast pure aluminum in die-molds or aluminum alloyed with small percentages of zinc or copper, or both, is very difficult. These alloys cannot be cast at all in very thin sections or with very fine detail in figured work, such as is produced in art castings. The lighter aluminum-magnesium alloys have also been experimented with, but these experiments have not met with much success as yet.

Much time and money has been spent by the different die-casting firms to die-cast manganese bronze, but this has been a failure, owing to the zinc oxide which forms on its surface when the alloy strikes the colder metal from which the die-mold is made. It is very doubtful if this feature can be overcome. One of the great difficulties encountered in casting metals of these comparatively high melting temperatures is the oxidization that the casting surface of the steel mold undergoes when its temperature is raised by the molten metal coming in contact therewith. This causes the mold to alter in

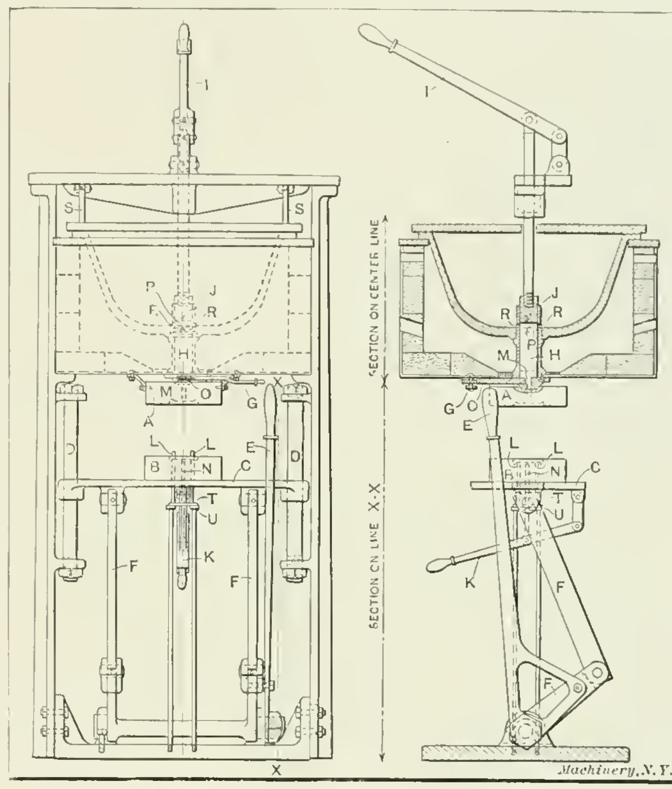


Fig. 22. Upright Machine for Making Die-castings

size and shape and thus destroy the accuracy of the castings. As this is an expensive way of producing castings, it is only by making them accurate as regards size and shape, and thus saving all machine work, that they can be made a commercial success. When this is done, however, the saving effected is so great that the die-casting machine and its products have become a necessity in manufacturing many parts of machines, instruments, etc., in the modern shop.

Aside from the die-castings made for bearings, zinc is the principal metal in die-casting alloys. An analysis of one of the most prominent makes of die-castings for use where no great strength or hardness was required showed 73.75 per cent of zinc; 14.75 per cent of tin; 5.25 per cent of copper, and 6.25 per cent of aluminum. Another prominent make that was used for similar purposes showed 72.70 per cent of zinc; 19.00 per cent of tin; 5.00 per cent of copper; 2.00 per cent of lead; 1.00 per cent of aluminum, and 0.30 per cent of antimony.

A die-casting that was somewhat harder than the two before given showed on analysis that the alloy was composed of 73.80 per cent zinc; 12.00 per cent tin; 10.60 per cent copper; 3.40 per cent aluminum, and 0.20 per cent iron, the iron being an impurity. Some very hard die-castings analyzed as follows: 46.20 per cent zinc; 30.80 per cent tin; 20.40 per cent copper; and 2.60 per cent aluminum. An alloy that was very high in zinc contained 93.00 per cent of zinc, 3.50 per cent tin, 2.00 per

cent copper, 1.50 per cent antimony, and 0.40 per cent aluminum.

[The sum of the percentages is 100.40. This anomaly is explained by the fact that after melting 93 pounds zinc, 3.5 pounds tin, 2 pounds copper, and 1.5 pound antimony, 6.5 ounces of aluminum is added as a deoxidizer.—EDITOR.]

Another alloy was composed of 90.00 per cent zinc, 6.00 per cent copper, 1.00 per cent tin, and 3.00 per cent aluminum.

While zinc and aluminum in certain percentages and under some conditions might make good die-castings, the aluminum cannot be very high or the alloy shows a tendency to disintegrate. An alloy composed of 50.00 per cent zinc and 50.00 per cent aluminum will disintegrate into a granular mass inside of a year. Such a mixture, even though possessing considerable strength at the time of casting, would very soon lose its strength and crumble up. Some of the die-castings made at present disintegrate, so that their strength is greatly weakened in the course of two or three years. This, however, is due to improper mixtures, as they can easily be made so that practically no disintegration will take place at all.

Zinc and tin mixtures also show an inclination to disintegrate, and hence some other material has to be alloyed with them to act as a binder. They are also inclined to be very brittle unless copper is added, and the molten metal thus given a greater ductility. The zinc and tin mixtures that contain a small percentage of copper are good for wearing parts and also for plating and japanning.

Antimony and bismuth have frequently been used in combination with lead to give the lead a greater hardness. Where no particular strength is desired, such an alloy can be used. The type metals that contain approximately 83.00 per cent lead and 17.00 per cent antimony have been cast in machines using steel molds for a number of decades. Practically all of the type metals such as standard, electrotype, linotype, etc., are easily manufactured into die-castings. These contain from 58 to 80 per cent lead, 4 to 25 per cent antimony, and 3 to 15 per cent tin. This gives a metal that is fairly hard and has considerable weight, but it is comparatively weak.

Alloys with high percentages of zinc, and a comparatively high copper content are very brittle, with little ductility and strength, while an alloy that is high in zinc and low in copper, *i. e.*, containing 90 to 92 per cent zinc and 8 to 10 per cent copper, shows a good resiliency and strength but no ductility.

Tin alloyed with lead and zinc casts freely and clean, and hence can be made to fill delicate parts of a mold. The zinc in die-castings usually runs from 70 to 90 per cent; the tin from 5 to 30 per cent; the copper from 2 to 20 per cent; the antimony from 1 to 5 per cent; and aluminum as high as 6 per cent has been used. While other metals have been used for making alloys for special castings, the ordinary casting can be produced from alloys made from these metals.

* * *

NEW ALUMINUM ALLOYS

In an abstract of a paper presented before the British Foundrymen's Association, which appeared in the *Daily Consular and Trade Reports*, mention is made of a new aluminum alloy. The result of adding aluminum to copper is to cause an immediate increase in both strength and ductility of the copper, the latter property reaching a maximum with 7.35 per cent aluminum. Beyond that point it falls, and when 11 per cent is reached the alloy is too brittle to be of any commercial value.

Heat treatment has little effect upon alloys that contain less than 7.35 per cent aluminum, but beyond that percentage they are stiffened by heat treatment at 1450 degrees F. Alloys with less than 7.5 per cent aluminum cannot be satisfactorily cold worked, though they are improved by hot rolling, while higher alloys are much improved by either hot or cold working. Such alloys show no tendency to age even after standing a couple of years.

* * *

No man should be afraid of oil and grease while he is working around it, but that is no excuse for not cleaning up thoroughly when through with the day's work and before going into the streets.

A SHOP SYSTEM*

By M. M.

Much has been said in the columns of MACHINERY regarding shop systems, and for that reason, the writer takes pleasure in submitting a system of his own that is to be adopted in the works with which he is connected. It is a system that is anything but elaborate, being compact and concise, inasmuch as it puts all information regarding the affairs of the works under the complete control of the works superintendent, making him entirely independent of the various heads of departments in determining the progress of all work through these departments, and enabling him at a glance to

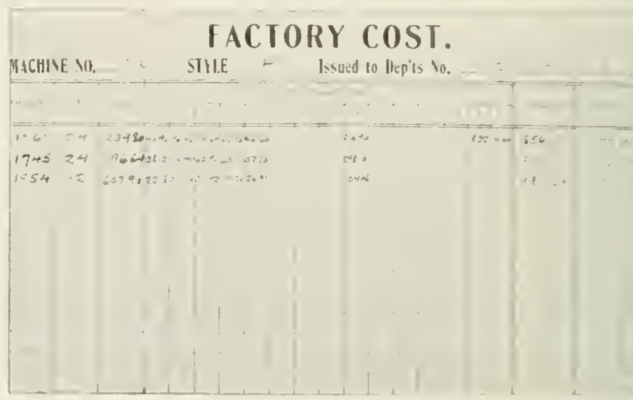


Fig. 1. Superintendent's Office Reference and Record Card of Machine Costs

stop or push such work as is important or is wanted in a hurry, at the same time giving him an authentic record of all facts pertaining to the cost of material and labor, and other particulars of equal importance. Not only that, but in case of emergency, it assures a promise of any special delivery, rush order, etc., with an accuracy that cannot be denied.

The fundamental principle of the system is not building the completed machine as a unit, but building the machine by the part. Considering that all our machines are standardized and fully detailed with complete drawings of all parts, this can readily be accomplished, and means the grouping together of the equipment in batteries best suited to handle

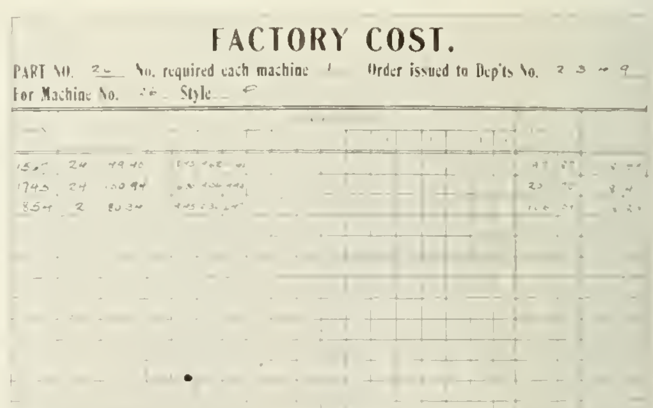


Fig 2. Superintendent's Office Reference and Record Card of Parts Costs

the work along these lines without any undue shifting around of material, keeping it in the correct rotation from department to department in succession until finally brought to the assembly. To do this the following departments known by number have been established:

- D Drafting-room;
- P Pattern shop;
- 1 Planer, boring mills and large radials;
- 2 Lathe;
- 3 Milling machine;
- 4 Shaper and drill press;
- 5 Tool and die making;
- 6 Grinding;
- 7 Experimental;
- 8 Small part assembly;
- 9, 10, 11, and 12 Assembly;
- 13 Miscellaneous.

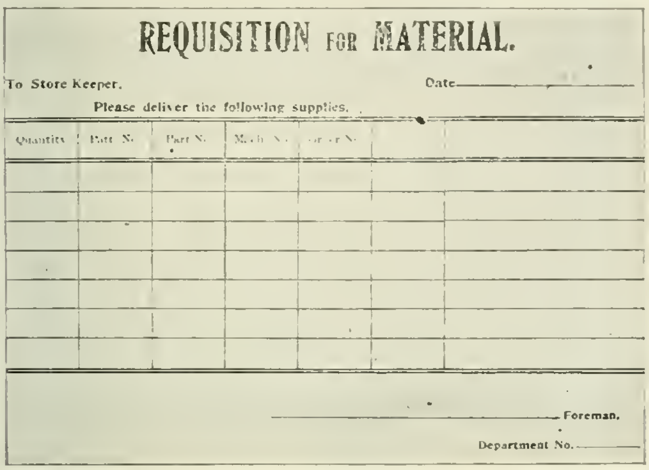
* For additional information see "A New Shop System" in five installments, March and April, 1898, and May, June and July, 1899.

The assembly departments, 8 to 12 inclusive, are equipped with the necessary small machine tools.

The mode of procedure is as follows: The sales department issues its order to the superintendent in the customary manner for a given number of machines of a certain type; all machines are known by number. The superintendent then secures from the drafting department a complete set of blueprints showing all the details, and from which the orders calling for these parts are issued to the various departments.

The following is a list of blanks and cards to be used, and which are herewith illustrated:

Fig. 1. Superintendent's office reference and record card of machine costs.
Fig. 2. Superintendent's office reference and record card of parts costs.



REQUISITION FOR MATERIAL.

To Store Keeper. Date

Please deliver the following supplies.

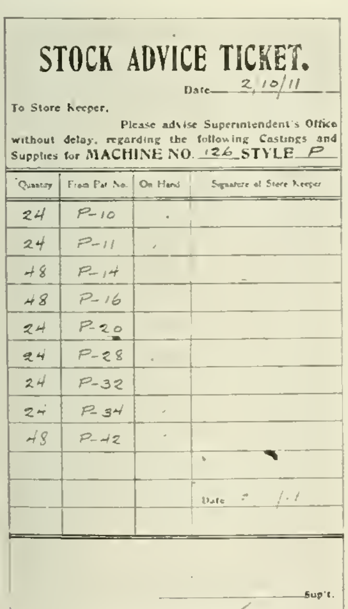
Foreman.

Department No.

Fig. 3. Requisition Blank

Fig. 3. Requisition blank.
Fig. 4. Superintendent's office stock advice ticket.
Fig. 5. Identification tag.
Fig. 6. Department shop order.
Fig. 7. Department partial shop order ticket.
Fig. 8. Daily time ticket.

When the superintendent receives the order for the machines, he will cause the order number to be recorded on a card like that in Fig. 1; eventually this card will contain a full record of all costs of the machine; it is known as the "Machine Factory Cost," and is printed on blue paper so that it may be readily recognized. This card is ruled into columns, and will contain, as before stated, all factory particulars, including the number finished, cost of material, cost of every department that has any work in connection with same, and finally the total cost of the order and the individual cost of each machine. Each successive order is recorded on this card, and a ready comparison of the fluctuations in operating expenses for departments are immediately noted for investigation with a view to ascertaining the causes.



STOCK ADVICE TICKET.

Date 2/10/11

To Store Keeper.

Please advise Superintendent's Office without delay, regarding the following Castings and Supplies for MACHINE NO. 126 STYLE P

Quantity	From Pat No.	On Hand	Signature of Store Keeper
24	P-10		
24	P-11		
48	P-14		
48	P-16		
24	P-20		
24	P-28		
24	P-32		
24	P-34		
48	P-42		
			Date

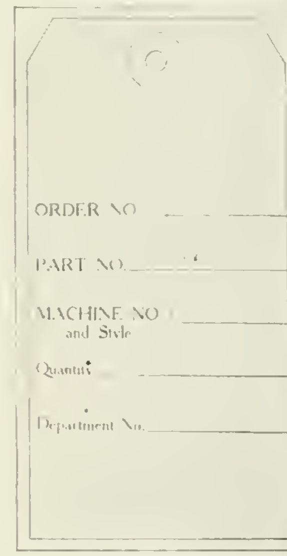
Sup't.

Return to Superintendent's Office

Fig 4. Superintendent's Office Stock Advice Tickat

The parts of each machine are numbered in rotation, and a separate record, as in Fig. 2, printed on yellow paper is kept of each in connection with the blue card above. This "Parts" card will eventually contain a full record of departments that handle the part, its weight, cost of material, costs of each department, and also the total and individual or average cost per part. Each successive order is recorded the same as on the card above, and the loop-holes in manufacturing due to negligence on the part of foreman or operator are immediately shown by the comparison of costs of labor, etc., in each department.

The large and heavy castings that represent the main parts of the machine are never kept in stock, and so are provided for immediately by the superintendent on a requisition blank like that in Fig. 3, sent to the purchasing department. These blanks are made up in book form, four on a page; they have perforated edges, and are made in duplicate, the copy remaining in the book as a part of the superintendent's record.



ORDER NO.

PART NO.

MACHINE NO. and Style

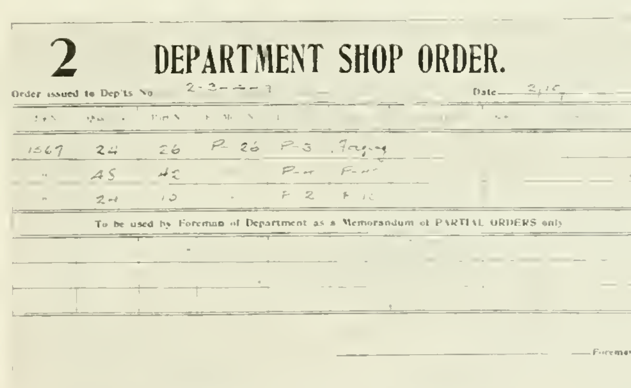
Quantity

Department No.

Fig. 5. Identification Tag

For the smaller parts or castings, the superintendent causes the list shown in Fig. 4 to be sent to the store-keeper. This list, which is printed on flexible paper, and put up in pad form, gives all particulars, and asks for the information indicated. The store-keeper, on receiving it, ascertains the number of parts or castings he has on hand as requested, fills in the date, signs, and returns immediately to the superintendent's office. Upon the advice thus received, the balance of supplies, if any, are immediately ordered by the superintendent through the purchasing department, using the blank before described, Fig. 3. By adopting this plan, a check is kept on all castings and supplies, which prevents the continual accumulation of such supplies, a condition that would occur if they were ordered on each successive order without first ascertaining whether or not any stock was available.

The parts being all provided for through the superintendent's office, department shop orders, Fig. 6, are now issued



2 DEPARTMENT SHOP ORDER.

Order issued to Dep'ts No. 2-3-4-9 Date

To be used by Foreman of Department as a Memorandum of PARTIAL ORDERS only

Foreman.

Return to Superintendent's Office when all work is finished.

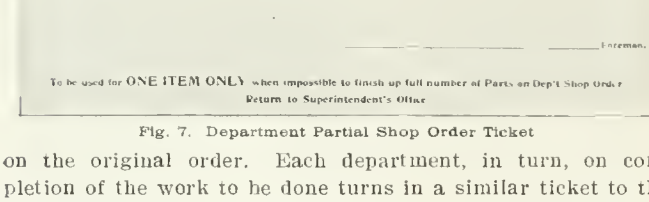
Fig. 6 Department Shop Order

to the various departments for all the parts to make up the completed machines. These orders have the number of the department printed in heavy black type in the upper left hand corner, and are printed on flexible paper (preferably white), so that they may be typed in multiple, to include all the departments handling or machining that particular part. As illustrative of its operation, an order is issued for 25 crankshafts for a certain style of press; orders are issued to departments 2, 3, 4, and 9. The lathe department No. 2 handles the work at the beginning; the milling department, No. 3, handles it after No. 2; and so on. Similar orders are issued to the first three departments, the orders being distinguishable by the number representing the department printed in the upper left-hand corner as above stated. A separate order, similar to the others, calling for the number of the complete machines, is issued to department No. 9, the assembly department of this type of machine. Consequently all parts machined eventually find their way to the assembly.

Upon the receipt of this order by the head of department No. 2, or the department that first handles it, a requisition on the store-keeper is issued on a blank similar to that shown

in Fig. 3, for the number of forgings required to fill the order, and as they have been provided through the superintendent's office, they are sent up to him, having a red tag, as in Fig. 5, attached to one of the lot to identify them. This tag contains all particulars as to quantity, part number, machine and style, and order number. As the work is completed in this department, this same tag or a duplicate is attached to one of the crankshafts already machined, and sent to the next department handling the same, which in this case is No. 3. The same procedure applies in this department; the work is then sent to the next, which is No. 4, with the red tag still attached. This department, in turn, sends the shafts when finished to the final department, No. 9, which is the assembly. Should one of these crankshafts, by any mischance, be spoiled or incorrectly machined through an error on the part of some mechanic, this system compels the foreman of the department to report this fact immediately to the superintendent, thus causing an investigation to be made as to how it happened, whether through negligence or accident, and gives no opportunity for anyone to quietly scrap it without the full knowledge of the superintendent. As the work is finished in each department, the shafts are sent on, the head of department sending them to the head of the next department, who acknowledges their receipt by signing his name in the space provided on the department shop order, at the same time filling in the date. This compels the receiving foreman to verify the number of pieces so that it tallies with the number on the red tag, Fig. 5. After obtaining the signature of the next department foreman, the shop order is returned to the superintendent and is filed, until all departments having any handling of this part have turned in their shop orders. All labor being completed on the part, the costs are transferred to the factory cost ticket, Fig. 2, which is then a complete record of actual costs.

At various times, through the crush of work and orders piling up, it may be found to be good policy in some departments, to make up only a part of the order. To record this, another blank, Fig. 7, called the "Partial Order Ticket," printed on brown paper is used by the head of the department in lieu of the regular department shop order, and after going through the same routine as the original order, being signed by the foremen of the departments, is turned in to the superintendent's office. As this is done the fact is recorded on the original shop order in the space provided for this purpose; this acts as a constant memorandum of parts still due


2

PARTIAL ORDER TICKET.

Foreman.

To be used for ONE ITEM ONLY when impossible to finish up full number of Parts on Dep't Shop Order

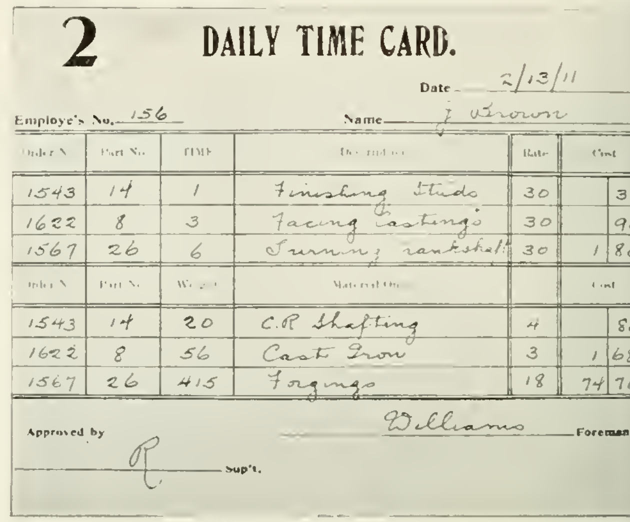
Return to Superintendent's Office

Fig. 7. Department Partial Shop Order Ticket

on the original order. Each department, in turn, on completion of the work to be done turns in a similar ticket to the superintendent; these are in pad form as issued to the heads of the departments. This partial order ticket as it is turned into the superintendent's office, forms part of the record and shows what progress is being made on this particular part through the works. The adoption of this plan enables the superintendent to take steps to push through and direct what parts are to be rushed, and avoids the holding up and delaying of parts in the various departments, for he has the information at hand to locate the part by looking up its department shop orders that have been returned to his office.

A "Daily Time Ticket" as shown in Fig. 8, is an absolute necessity. It is ruled and printed, as shown, provision being made for all particulars of both stock and time; it also forms part of the superintendent's record. These are collected daily and filed in respective order number rotation, and upon completion of any department shop order, all information is transferred to factory cost cards as before described. This daily time ticket is an important factor in determining actual costs, etc.

To sum up, a system such as this one is automatic in operation, and has much to commend it: First, there is a complete and actual record of labor costs by department; second, a constant check is kept by comparison and a means provided for locating any excessive expenditures due to negligence,


2 DAILY TIME CARD.

Date 2/13/11

Employe's No. 156 Name J Brown

Order No.	Part No.	Time	Description	Rate	Cost	
1543	14	1	Finishing Studs	30		30
1622	8	3	Facing Castings	30		90
1567	26	6	Turning crankshafts	30	1	80
Order No.	Part No.	Weight	Material Used		Cost	
1543	14	20	C.R Shafting	4		80
1622	8	56	Cast Iron	3	1	68
1567	26	415	Forgings	18	74	70

Approved by R Sup't. Williams Foreman.

Fig. 8. Daily Time Ticket

incompetent help or other conditions; third, the cost of each individual part or piece of every machine is recorded—information that can be advantageously used in computing cost of duplicate parts when needed; fourth, there is correct tally of material used for both part or machine, and actual cost of each; fifth, an additional feature is that after a complete record of all parts and machine have been established on the factory cost cards, Figs. 1 and 2, and the department shop order, Fig. 6, the information is all there to facilitate the issuance of any further orders for similar parts, by merely referring to them as a copy or reference.

* * *

The Buffalo & Allegheny Valley division of the Pennsylvania Railroad has arranged to compensate employes for suggestions relating to increased efficiency of operation or safety of passengers and employes, which upon investigation prove to be of sufficient value to warrant adoption. The suggestions need not be confined to the immediate duties of the employe or the department in which he works. Those which will be considered must embody ideas that have for their object one or more of the following ends: They should tend to increase the efficiency or improve the methods of operation; they must be beneficial from an economical standpoint, increase the safety and convenience of passengers and the safety of employes, increase the patronage of the company, or in any way promote the interests of the company, and may involve the use of new methods or modification of old ones. The suggestions must not contain personal complaints.

* * *

Fourteen 14-inch guns, costing over $127,000 each, with mounts, are now in process of construction at the Washington Navy Yard for the new battleships *New York* and *Texas*. The remaining six guns required to complete the two batteries are being built by the Midvale Steel Co. and the Bethlehem Steel Co. The length of the new guns is 53 feet 6 inches; weight, over 63 tons; powder charge, 365 pounds; weight of shell, 1400 pounds; muzzle velocity, 2600 feet per second; muzzle energy, over 73,000 foot-tons; effective range, 12 miles; cost of firing one shot, $700, exclusive of deterioration of gun; life of gun, 225 shots before relining is necessary. The cost of one gun exclusive of the mount is $74,700, the cost of the mount being $53,000.

MODERN CAN MANUFACTURING*

By HART PRESTON

Swift & Co., Chicago, distribute among stock-yard visitors a pamphlet describing its various methods and products, on the back cover of which is the head of a pig with the inscription "*nothing lost but the squeal.*" Aside from the packing industry and the Standard Oil enterprise, this expression can scarcely be more truthfully applied to any other line of manufacture than to that of tin cans. While many new inventions and perfected methods have practically revolutionized the can-manufacturing industry during the past decade, two factors are constantly bringing out new ideas and labor-saving equipment for this line of manufacture, one of these being *competition*, and the other, *progressiveness*. It may be of interest to state here that one concern in the tin-can business charges to profit and loss each year, an average of $75,000 expended for experimental work along these lines. This item, however, is offset by a much larger figure in reduced labor and manufacturing costs.

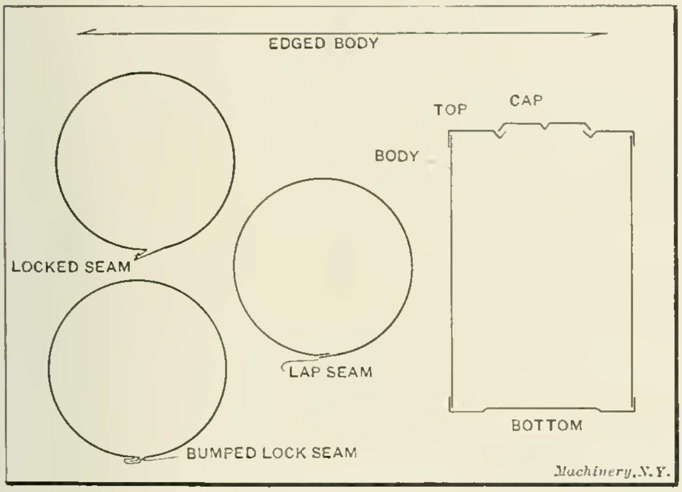


Fig. 1. The Seams used, and the Component Parts of a Round Can

Automatic Production of Round Cans

One of the most interesting processes of can-manufacturing is the rapid, automatic manufacture of fruit or packers' cans, which is the style of can used in the greatest quantities—for canning peas, tomatoes, corn, soups, condensed milk, peaches, pears and other fruits, vegetables and liquid canned products. Packers' cans are made in what the trade specifies as 1-pound, 2-pound, 2½-pound, 3-pound and 10-pound, or gallon cans, which increase in diameter in the order outlined, and which with the automatic equipment outlined in Fig. 2, are produced at an output of from about eighty of the gallon to about one hundred and ten of the one-pound cans per minute, or approximately fifty thousand cans per day. This output is the demonstrated normal working capacity of each of the various automatic machines required in the manufacture of the completed can, as shown in the group Fig. 2. These automatic machines have not only eliminated about eighty per cent of the number of operators formerly required for producing the same volume of work, but they also turn out neater and more dependable work.

Slitting and Trimming Machines

Each packers' can, as shown in Fig. 1, has four composite parts, *viz.*, body or cylinder, bottom, top and cap or center-plug for top, the cap, of course, being applied at the canning factory after the cans are filled. The body, top and bottom are all made and assembled automatically with the exception of removing the stock sheets of tin from the boxes, and reducing the sheets to blanks of the proper sizes in the gang slitting and trimming machines shown at *A* in Fig. 2. These gang slitting machines have a gang or group of circular cutters or knives operating in pairs, one on the upper and one on the lower shaft, the shafts being geared to each other and operating at the same speed, to insure accurate feeding and discharging. The knives are adjustable inwardly for trimming the edges or sides of the stock sheets and slitting or cutting them into strips of the various widths required. About four slitters are required for each group of machines as shown displayed in the "line" in Fig. 2. One of the slitters is used for trimming and splitting the sheets into strips of the proper width for the bodies, the full length of the stock sheet. Another takes these strips and cross-cuts or splits them into accurately sized blanks for the bodies; while the other two machines trim and split the sheets into strips for the tops and bottoms, which are cut out in the automatic strip-feed press shown in Fig. 3, and also at *B* in Fig. 2. For brevity let us hereafter specify "tops" and "bottoms" under the can-maker's common classification of "ends."

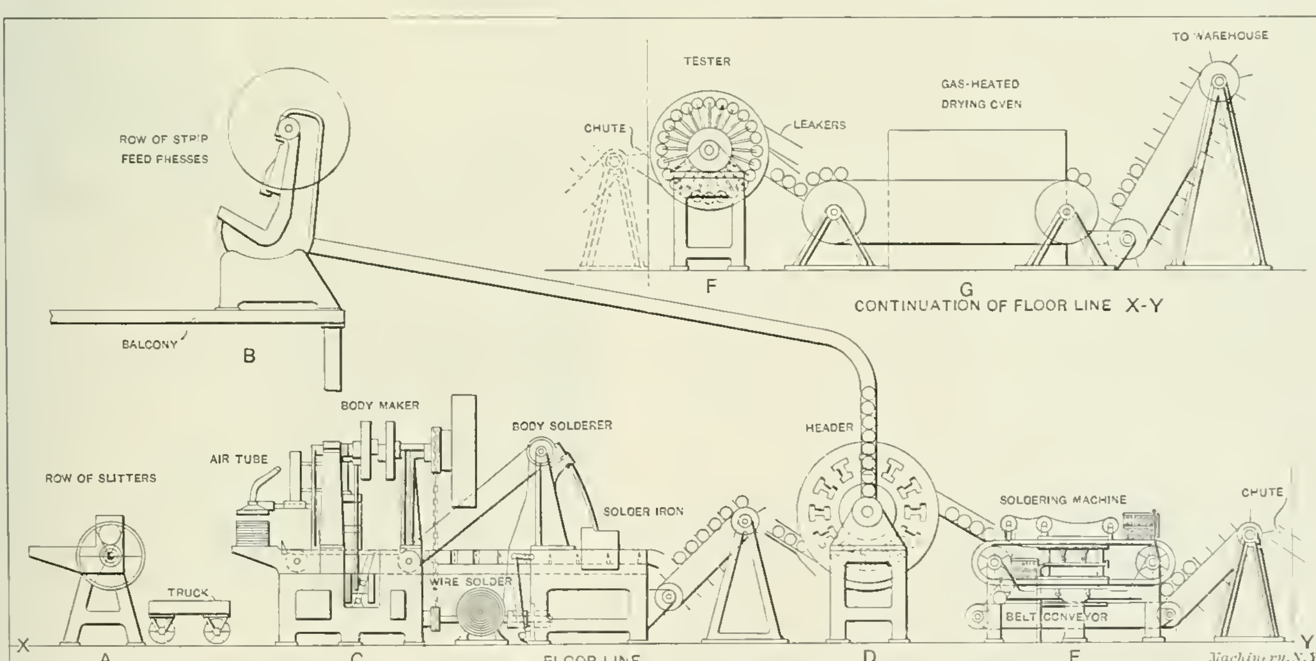


Fig. 2. Automatic Equipment used in the Manufacture of Round Cans

Automatic Strip-feed Press

The automatic strip-feed press shown in Fig. 3, is an open-back inclinable press, equipped with change-gears and automatic feeding devices, the latter being adjustable for various lengths of feeds according to the diameter of ends to be cut. This press is entirely automatic in its operation and runs continuously, all that is required of the operator being to keep the feed-table properly supplied with strips of the proper

* For additional information on can-making machinery previously published in MACHINERY, see "Making Solderless Cans for Food Products," September, 1909.

size, which come directly from the slitter. This press is equipped with automatic vacuum or suction feed provided with an automatic opening and closing valve, the action of which, together with that of the side-feeding arms, is controlled by the gearing shown on the left-hand side of the press.

The vacuum feed sucks or lifts one strip at a time up from the stack, carrying it up to a back-gage, at which point the valve is closed and the strip drops onto a lower plate attached to the side-feeding arm. This side-feeding arm, which is actuated by the cam and train of gears, automatically carries or feeds the strip forward into the dies the required distance at each stroke of the press. By the time the last end or blank

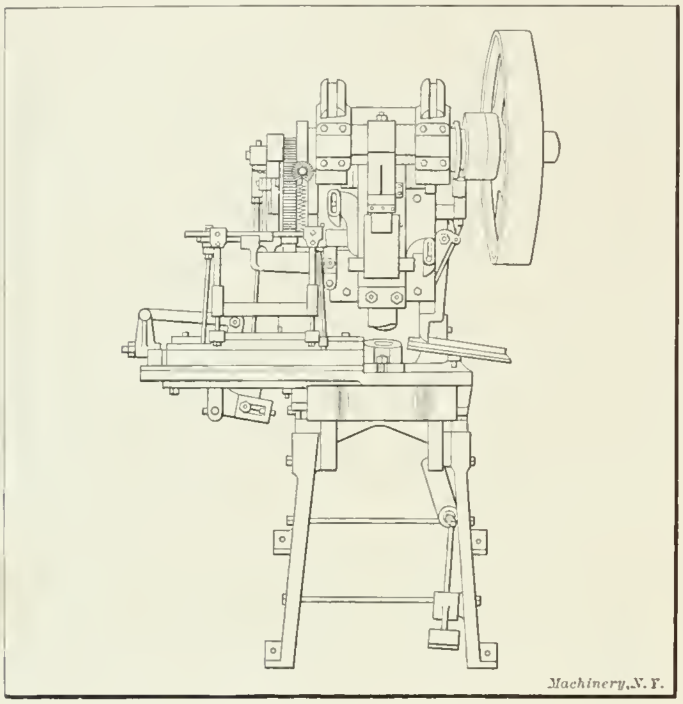


Fig. 3. Automatic Strip-feed Press

is cut out of the strip, the vacuum-feeding arms have again come forward, picked up another strip and the operation continues uninterruptedly. Each strip of scrap is automatically ejected or discharged at the side of the press by the finger provided for that purpose, which is operated by a toggle-motion governed by a small cam attached to the right-hand side of the frame, as shown in Fig. 3. The ends or blanks themselves "clear" or fall away from the dies by gravity, the presses being inclined or set at an angle. From this press the ends are conveyed through the chutes or conveyors to the header *D*, shown in Fig. 2. Several of these automatic strip-feed presses are required for blanking a sufficient quantity of ends to keep up with the speed of the machines performing the later operations on the can.

Body-making and Soldering Machines

While the ends are being cut and formed, the bodies or cylinders are being automatically edged, formed, bumped (see Fig. 1) and soldered in the body-making machine shown at *C* in Fig. 2. This machine is also equipped with an automatic vacuum feed, each strip having been previously prepared in the slitter to the exact size required for producing one body or cylinder. The vacuum feed sucks or lifts up one sheet at a time from the stack and deposits it in front of a set of feed-fingers, which carry the flat blank under and against a set of edging jaws, one of which is located at each side of the machine. These edging jaws automatically form the hooks or laps on the two sides of the blank, as shown in Fig. 1, when the blank is again carried forward in a similar manner, to the forming horn or mandrel, over which by means of two swinging jaws, the blank is formed or rounded and the hooks or laps are joined and bumped or clinched together. The body is then carried farther along this mandrel under a gas-heated elongated soldering iron or shoe of sufficient length to fully cover the entire length of the side-seam on the longest can body within the limit of the machine. This is to insure a ready flow and application of solder the full length of the seam.

The solder is fed to this soldering iron by an automatic cam-actuated feeding and cutting-off device, which feeds the wire solder directly from the reel to the machine; the cutting-off attachment having adjustment to suit the various sizes of "drops" or chips of solder required for the seams on the different lengths of bodies. Although, as stated, the solder cutting-off device is adjustable, the solder does not always flow uniformly, and therefore, at times forms a thicker coating at one point than at another. Also, in order that there may be enough solder applied to properly fill up the side-seam, it is necessary to cut off a trifle more solder than is actually required. To prevent losing this excess amount, an adjustable brush (which does not revolve) wipes or brushes off this surplus solder before the formed and soldered body finally drops into the conveyor, the latter carrying it to the heading machine, shown at *D* in Fig. 2.

Header

In the header, the bodies and ends are all brought together by means of the conveyors shown. As the bodies fall into place in the header-forms or jaws, they are followed an instant later by the ends; the header then automatically snaps the ends onto the bodies, slightly clinching or crimping the rims of the ends onto the bodies. This is accomplished by an eccentric on the end of each header-form or jaw, which is gradually forced inward and downward as the rotary motion of the machine carries these eccentrics against a set of cam rings attached to the frame of the machine itself. These machines are very simple, yet so positive in their operation that they even shape or round bodies which may be slightly distorted upon coming into the header.

It should be stated here that the header, as well as the body-maker and the other machines in the group, is adjustable to take in the various sizes of cans from the one-pound to the gallon size. The adjustments and changes on the various machines require from ten to twenty minutes. However, where the "line" is not run continuously on one particular size, they usually run for several days at least on a "run" or quantity of one size, and the changes are made at "off-hours" so as to insure operating each machine the maximum period during regular working-hours.

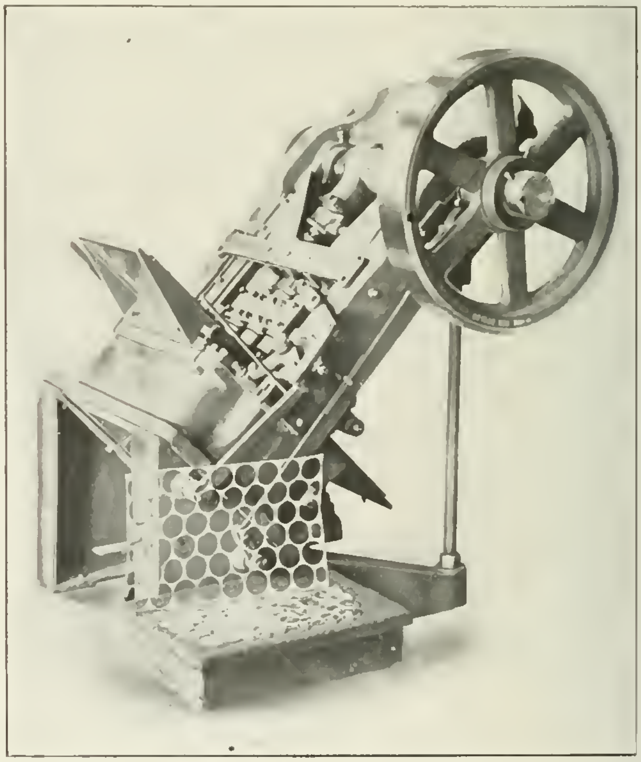


Fig. 4. Double-crank Press fitted with Gang Dies

End-soldering and Wiping Machines

Ejected from the header, the can is delivered by a conveyor to the end-soldering machine or floater shown at *E* in Fig. 2. Here the solder is applied to the top end or joint

as the can is being carried along or "floated" through the solder trough or bath situated along one side of the machine. After one end is soldered, the can is automatically inverted and carried to the other or lower side of the floater, where the bottom joint is soldered. The cans are rotated or kept in motion as they are carried through the solder trough by means of the friction imparted by moving chains, which lightly rest on and rub against the top surface of the can.

In this machine also care must be exercised not to waste any solder (one of the most expensive can-making supplies), as the circular motion of the can picks up and causes to adhere to it an excessive amount of solder; so after the top is soldered and before the can is transferred to the other side of the floater, the can is carried through the end solder-wiper shown at *E* in Fig. 2. This wiper by means of brushing-rolls which revolve at a high rate of speed removes the solder.

These solder wipers are now to be found in almost every can factory of any size, and although few of them sell at less than $500 it is a demonstrated truth that where used continuously, they wipe off sufficient surplus solder to easily pay for themselves within three to six months. As a further illustration of the actual merit and manufacturing cost-reducing value of these solder wipers, it is interesting to note that several manufacturers of these machines refuse to sell them, but merely lease them to can-makers on a royalty basis, computed on a fixed percentage for each pound of solder the wiper saves the can-manufacturers per year—and a great number of them are leased.

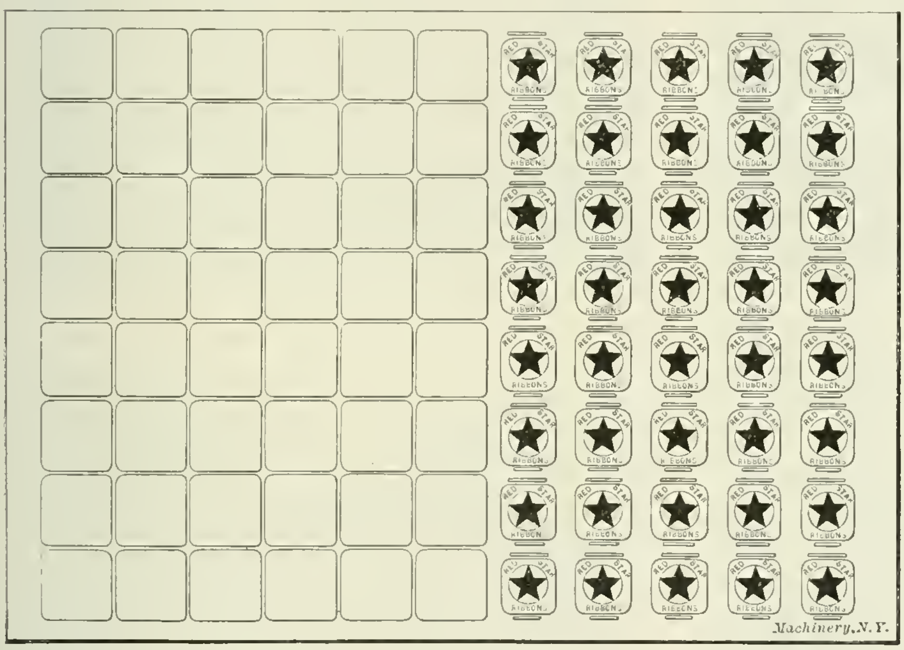


Fig. 5. Lithographed Sheet from which the Covers for Fancy Colored Square Cans are cut

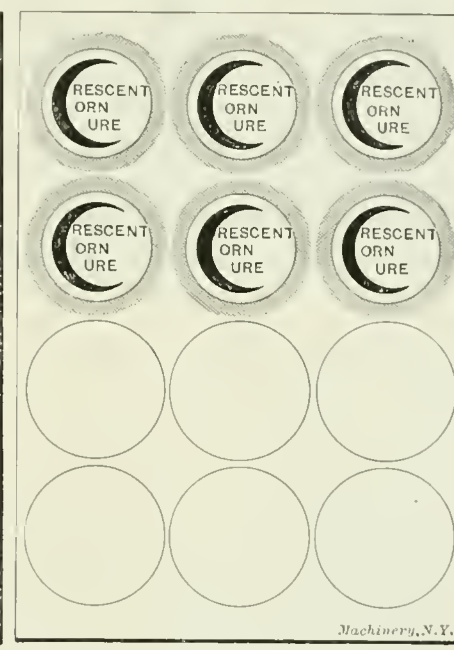


Fig. 6. Another Lithographed Sheet

Tester

From the end-soldering machine, the soldered can is conveyed to the tester, shown at *F* in Fig. 2, into which the cans are automatically fed, located, tested, and at the proper time, discharged either into the "good" or the "leaky" can chute. Most testers have a rotary motion, being either of the horizontal or upright design similar to a ferris-wheel. A pressure of from twelve to fifteen pounds is sufficient to detect the most minute leak. All modern testers use air-pressure for testing purposes. A separate feed-pipe or air-tube leads from the center of the main cylinder to each testing diaphragm or chuck, and if there is a leak in a can the valve in the chuck automatically closes, and throws out a little trigger or finger attached thereto, which during the travel of the main-frame automatically opens the chuck at the defective chute and drops the can into the latter.

If the can is good (not leaky), the trigger remains in position, and the valve is closed until the can reaches the good chute, when the pressure is for a moment automatically released, the chuck opened, and the cam dropped into the chute. Many can-makers use air exclusively for testing cans, while some of the most experienced still use the extra precaution of immersing the air-filled can in a vat of water. They claim for this that an experienced and watchful operator will more readily detect almost unnoticeable leaks, which would probably not be caught in an ordinary air-tester owing to the fact that the pressure is not applied through a long enough period, although this same pressure will instantly produce bubbles—the can-makers' "trouble-finder"—if the air-filled can is immersed in water.

Gas-heated Drying Oven

When cans are immersed in water it is necessary to thoroughly dry them before shipping, to prevent rusting. This is accomplished by conveying the cans from the tester to a gas-heated dryer or oven, as shown at *G* in Fig. 2, through which the cans are carried on a slow-moving conveyor. From this oven the cans are transported by carriers either directly into the cars or to the warehouse. So it will be seen that it is a literally true statement that from the time the blanks or strips for the various can parts are cut to size and fed into the first forming machines, no hand touches the cans until they reach the canning factory.

Gang Die Work

As strip-feed presses can only be economically employed on work up to about 4 inches in diameter, owing to the small "mill sizes" for standard sheet tin and the consequent comparatively short lengths of strips that can be cut from them, the larger diameter ends are usually produced in double-crank presses as shown in Fig. 4. These double-crank presses are fitted with gang or group dies by means of which a whole sheet of tin is cut up into various diameters of ends and caps at one stroke of the press (caps are almost universally produced with gang dies), the "cuts" for which are usually so gaged or laid out as to produce the greatest number of cut pieces, or, in other words, reduce the "scrap" or unused portion of the sheets to a minimum. Presses fitted with gang dies are usually mounted on inclined legs as shown, so that the stampings "clear" or fall away from the dies by gravity into a box at the rear of the press, while the scrap is removed by the operator, who then feeds another sheet into the press.

Square, Rectangular and Oval Can Manufacturing

The seams or joints on the bodies of cans are made in various ways, the two styles generally used being the "lap" seam and the "lock" seam as shown in Fig. 1; the latter, as will readily be seen, insures not only a stiffer construction, but also a more uniform joint. The lock-seam is almost universally used on round cans, while on square, rectangular or oval can bodies made automatically, the lap seam is generally used. The principal reason for this is that but a very limited number of "body-makers" have been perfected for successfully forming, bumping, locking and soldering square or odd-shaped can bodies, owing to the large number of cams and other

intricate and delicate motions and feeds to be developed for work of this character. The same statement applies to the other automatic machines required for the various operations on square and irregular-shaped cans, which operations must now be performed almost entirely by hand or only semi-automatically, this being the prime reason for the abnormal difference in the price of these and the round cans.

One of the worst features in connection with automatic can-manufacturing of today, particularly on square can work, is the fact that while a number of large builders have invented and perfected successful machines for producing can-bodies and other operations on cans, they, as well as private inventors of successful machines, have entered into agreement with a few of the largest can-manufacturers throughout the country. By this agreement the original inventors or builders, for a consideration, are prohibited from selling these machines to any but the export can-manufacturing trade. The results are obvious. Foreign-made square and other odd-shaped cans particularly are in many respects superior to those that can be produced by American competitors with the limited equipment they can purchase in this country for manufacturing their product.

De-tinning and Solder-making

The reader will undoubtedly be curious to know what is done with scrap accumulating in a can-factory. Where it is possible to do so, this scrap is cut up in "scrap shears" for convenient handling and is run through small power presses fitted with dies for cutting out roofing caps or washers, upholstery buttons, small trunk trimmings, etc. The scrap that is left is then de-tinned (by electrical and other processes) which operation consists of melting the pure tin off the original black sheet, the tin being used again as part of the solder mixture, and the de-tinned scrap sold to the foundries, which usually work it up into sash-weights or other low-grade iron products.

As previously stated, solder is one of the most expensive essentials of can-making. All the solder brushed from the cans by the "solder-savers", together with the sweepings, is carefully melted and refined and used over and over. Most of the large can-factories have their own solder-melting, rolling and cutting equipment with which they prepare, melt and mix the various solder mixtures and shapes they require. Tin and lead are used in varying proportions in solder for various grades of work. The solder is melted and then rolled or molded into ribbon, wire, triangular, flat bars or other shapes to suit the various classes of work.

Lithographed or Decorated Can Manufacturing

Lithographed or fancy colored can manufacturing is not only very interesting, but also about the most profitable work in this line of manufacture, there being about as much difference in the quality of lithographed tin work as in ordinary lithographed or printed work. Most people have the idea that lithographed or decorated cans are painted after being made up. This is not the case, except, of course, with large shipping cans, gasoline storage and other large "painted" cans, which are decorated by hand and are not only a lower grade, but also cheaper.

The sheets from which the various parts of lithographed cans and boxes are cut have the colors applied or impressed on them "in the flat" in a lithographing press, which is very similar to a large printing press, but far more costly. Tin lithographing presses will print from one to five colors at one handling, depending upon the size and design of the press used. The printing or transferring operation is performed by means of large close-grained stones, carefully smoothed off, cut to size and carved or engraved with the design to be transferred or imprinted on the tin.

For lard-pail bodies and similar large receptacles, one stone has but a single design cut in it, while stones for lithographing sheets from which are cut the covers or bodies of typewriter ribbon boxes, talcum powder boxes, etc., are engraved to produce at one handling a printed sheet such as is shown in Figs. 5 and 6. Both these illustrations show part of each sheet already cut out, to illustrate the econonomical printing and cutting of this class of work. In the sheets shown one-sixteenth inch is allowed between the successive cuts, which is the usual allowance for tin and other light stamping work. This amount should be increased in proportion to the thickness of the metal to be cut, so as to leave the scrap or uncut portion of the sheet sufficiently stiff to prevent it being drawn down into and plugging up the dies on the next cut. After being printed, the sheets are placed on large portable steel racks with wire shelves, one sheet being placed on each shelf. The rack is then placed in a gas-heated baking oven in which the colors are thoroughly baked onto the metal sheet.

The cutting and forming of lithographed work is performed in the same manner, and with tools of the same construction throughout, as are used on plain tin or other metal. The dies and other forming tools, however, must be made with a little greater clearance to allow for the thickness of the coating of paint and must be finished harder and smoother and with a greater degree of accuracy, so as not to scratch or mar the printed design.

This branch of can-manufacturing has been perfected to such an extent as to almost permit of calling it an art. Equally as much depends upon the design and the transferring or lithographing, as upon the actual cutting and forming of the various lithographed parts of cans, advertising signs, trays, plates, etc. In fact, on the plate-rails of many homes today are to be found lithographed tin or black-iron plates, which are almost impossible to distinguish from the expensive hand-painted china plates, although there is a difference in the manufacturing and selling prices of the two of from five hundred to fifteen hundred per cent. There is an even greater field for the development of automatic machinery for lithographed work than for plain tin-can work, as forming and soldering operations particularly are extremely difficult to perform with automatic machines on lithographed metal work, with any degree of assurance that the work, when finished, will not be scratched or marred.

* * *

ANNEALING SHEET STEEL

By ORONO

The reason that steel has not replaced brass in small factories to a greater extent in making shells and similar shapes, where it is necessary to anneal the material between the different operations, is doubtless due to the fact that it is much easier to handle brass than steel while annealing. To anneal steel successfully it is customary to place the articles to be annealed in a sealed pot, where they are heated to the proper temperature, and then allowed to cool, without removing them from the pot. It is necessary to keep the air from the steel while heating, to prevent an oxide being formed on the surface, which if allowed to form will increase the difficulty of finishing, where a smooth bright surface is desired. When there is not sufficient annealing to be done to make it profitable to employ this method, the use of brass is resorted to, as the same trouble is not encountered with the surface of the brass oxidizing when exposed to the air.

In attempting to cup small steel shells 3/8 inch in diameter and 5/16 inch high, made from 0.020 inch sheet steel, it was necessary to anneal them. The following method was adopted and proved satisfactory: After the drawing operation, the shells were tumbled in a barrel until they were bright and then brass plated. They were then placed in an open pot, heated to a dull red heat, and allowed to cool. The brass plate on the surface of the steel protects it from oxidization; this is accomplished in a manner similar to sealing the pieces in a pot when annealing. In shops equipped with a plating outfit, this makes a simple method of treating small steel work, as it can be tumbled and plated at slight cost.

* * *

A reinforced concrete boat provided with a gasoline motor has recently been built in Holland. The boat is nearly 15 feet long, and the remarkable fact about it is that the walls are only 0.52 inch thick. These walls, however, are strengthened by ribs. The concrete was given several coats of waterproofing compound. It has been in a number of collisions, but has not been disabled or made leaky.

REPAIRING LATHES AND MILLING MACHINES

By EDWARD K. HAMMOND*

Machine tools are frequently exposed to excessive wear owing to the conditions under which they are operated by unskilled workmen and, unless prompt steps are taken to adjust the machine and take up this wear, accurate work cannot be obtained and the tool is bound to suffer a rapid deterioration.

The average machinist is not familiar with the methods which are used to adjust and repair the machine tools which he uses; work of this kind is of a highly specialized character and many a machine has been pronounced worthless and has been discarded when, as a matter of fact, it could have been put into condition to fit it for a number of additional years of service if the machinists in the shop had understood the methods which would have enabled them to handle the work of putting it into proper adjustment. However, there is nothing difficult about these methods and any good mechanic can do the work if he is familiar with the method of procedure, which it is the purpose of this article to explain.

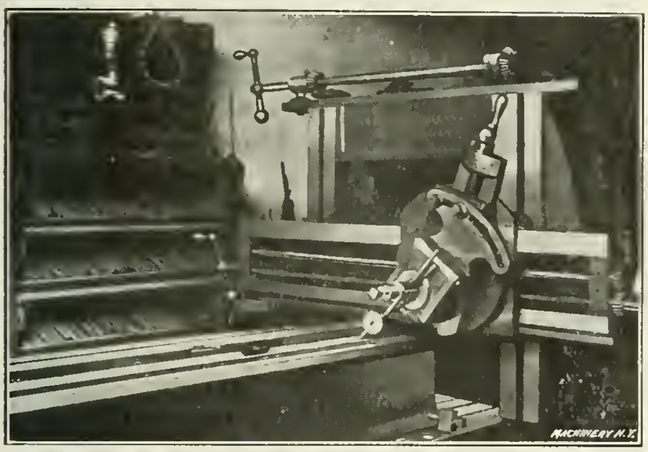


Fig. 1. Determining the Accuracy of Finish of Lathe Ways by Means of a Test Indicator

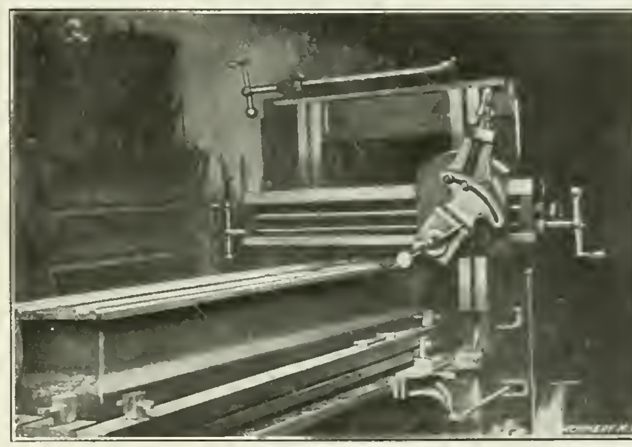


Fig 2. Testing Parallelism of the Outer Edge and Ways of a Lathe with the Test Indicator

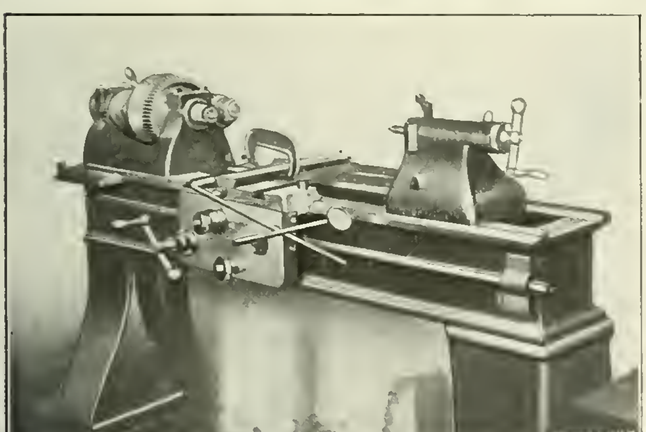


Fig. 3. Testing whether the Cross-slide is at Right Angles to Ways

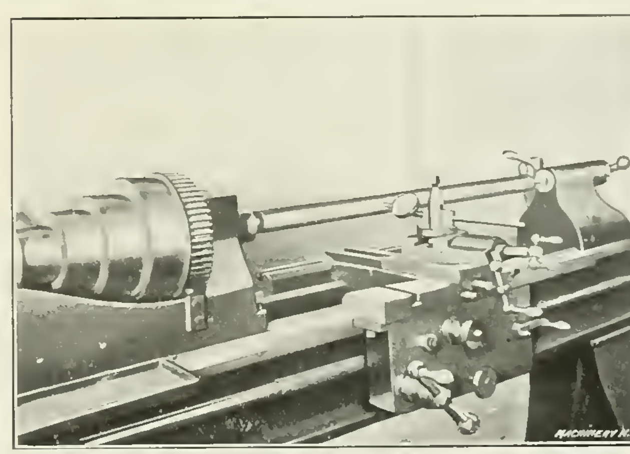


Fig. 4. Testing Accuracy of Alignment of Tailstock and Spindle

How to Adjust a Badly Worn Lathe

In the factory of the Lodge & Shipley Machine Tool Co., Cincinnati, each foreman is required to stay after the workmen have gone home on Saturday afternoons and determine the accuracy of the lathes which are used in his department. By this system, each machine is inspected once a month. The Lodge & Shipley Machine Tool Co. is one of the best known builders of high-grade lathes in America and with its intimate knowledge of the construction and operation of these machines, it is in a position to fully realize the importance of having each lathe which is used in its factory kept in proper adjustment.

There are many machine shop proprietors who would do well to follow this system, for a machine which is worked steadily, often under the most severe operating conditions, cannot be expected to give satisfaction when it does not receive constant attention, and in addition to the sacrifice of accuracy in the product, the tool is bound to experience a rapid deterioration in value.

In adjusting a lathe which has been badly worn, the first step is to dismantle the machine and refinish the ways. This is done by scraping or, if the machine is very badly worn, by first planing and then scraping the ways to a final finish. In cases where the machine has been badly worn and it is necessary to have recourse to planing, care must be taken to remove as little metal as possible, only that amount being taken off which is absolutely necessary to remedy the inaccuracy which exists in the ways. The outer edges of the bed are then planed to bring them in alignment with the ways.

A Brown & Sharpe dial test indicator is used to determine the accuracy of the refinished ways and also the parallelism of the ways with the outer edge of the bed. Most machinists are familiar with the dial test indicator, which consists of a graduated dial over which a needle is free to rotate. This needle is actuated by a small plunger which is held in contact with the finished surface of the lathe bed by means of a spring. The dial test indicator is mounted in the tool-post of the planer as shown in Figs. 1 and 2 and as it passes back and forth over the work, any inaccuracy in the finish of the surface causes the plunger to rise or fall. This movement of the plunger causes a corresponding movement of the needle of the dial test indicator. The dial of the instrument is graduated to read to 0.001 inch, and as the needle rotates over the dial, it shows any inaccuracy which exists in the refinished ways of the lathe bed in thousandths of an inch. The accuracy of the finish of the ways is determined as shown in Fig. 1. The dial test indicator is then brought into contact with the outer edge of the lathe bed and traversed back and forth to determine whether or not this edge is exactly parallel with the ways, as illustrated in Fig. 2.

After the bed has been accurately finished, the lathe is reassembled. The next step is then to determine whether the cross-slide is set exactly at right angles with the ways. In making this test, the Brown & Sharpe dial test indicator is mounted on a bar which is bent at right angles, as shown in Fig. 3. The compound rest is then taken off the lathe and

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the bar carrying the dial test indicator is clamped in the V-bearing of the cross-slide, as shown in the illustration, in such a way that the plunger comes up against the outer edge of the lathe bed which was refinished in the previous operation, as described. A C-clamp is used for this purpose which has a notch ground in it to fit over the bar carrying the indicator, in such a way that the bearing for the bar is formed between this notch and the vee of the cross-slide. The reading of the dial test indicator is now noted and the bar carrying it is then swung over so that the instrument comes up against the edge of the lathe bed on the opposite side of the carriage. The reading of the dial test indicator is again noted. If this reading is the same as that which was obtained on the opposite side of the lathe carriage, it shows that the cross-slide is at exactly right angles with the ways. Any difference in the two readings shows an inaccuracy in the setting of the cross-slide, and this inaccuracy must be removed

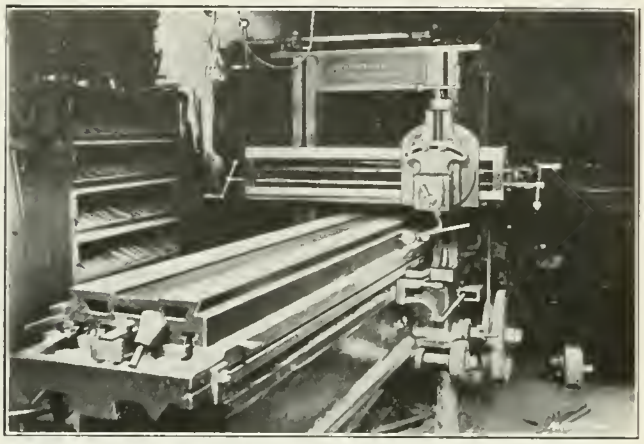

Fig. 5. Testing Slide of Milling Machine Table

by scraping the V-bearings until the test can be made with satisfactory results. The compound rest is then replaced on the machine. No difficulty will be experienced in maintaining the crosswise location of the test-bar in the V's during the half revolution, if proper precaution is taken.

If the spindle bearings show any signs of wear, they are scraped to a perfect fit. The next step is to determine whether or not the spindle is in proper alignment with the ways. In making this test, the faceplate and live center are removed from the spindle and a test-bar, which has been turned to a correct taper at the end, is placed in the spindle; with the exception of the taper end, this test-bar has been turned to an absolutely true cylinder. With the test-bar in position in the spindle, the dial test indicator is mounted in the tool-post of

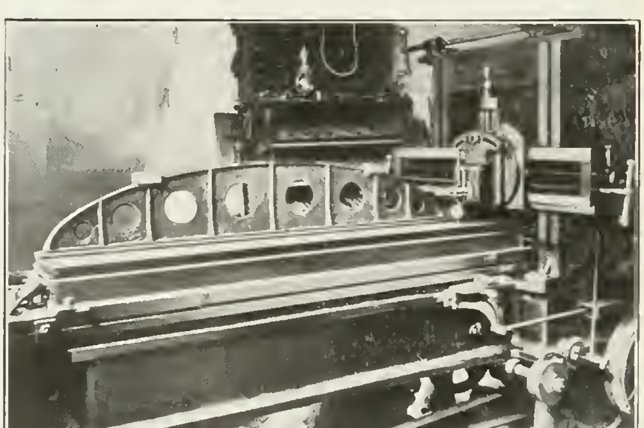

Fig. 6. Testing the Ways of a Milling Machine Table

the lathe and brought up against the test-bar, first at the top and then at the side. While in both of these positions, the lathe carriage is traversed back and forth so that the dial test indicator moves over the entire length of the bar. If the reading of the dial test indicator remains constant while being traversed at both the top and side of the test-bar, it shows that the spindle is in proper alignment with the ways. Any inaccuracy which is revealed by this test must be removed by scraping the V-bearings of the headstock. The test is then repeated until it is found that the proper adjustment has been made. The live center and faceplate are then replaced on the machine.

The next step is to scrape the V-bearings of the tailstock so that the tailstock lines up properly with the spindle. The accuracy of this alignment is determined by placing a test-bar between the centers of the lathe. The dial test indicator, which is still mounted in the tool-post of the lathe, is brought

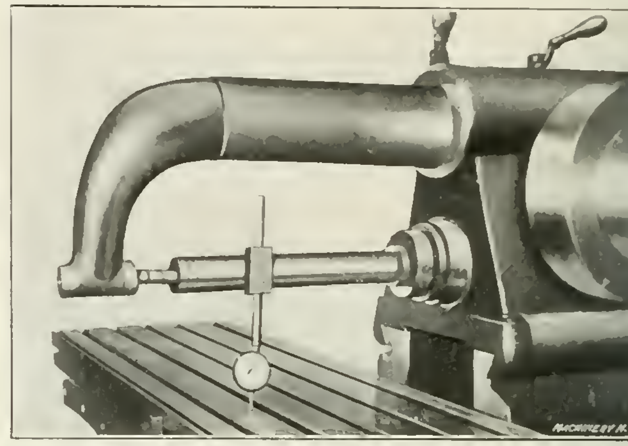

Fig. 7. Testing Longitudinal Alignment of Milling Machine Table

up first against the top and then the side of this test-bar, and the carriage is traversed so that the dial test indicator moves across the entire length of the test-bar while in both of the positions. If the dial test indicator gives a constant reading during its entire traverse at both the side and the top of the test-bar, it shows that the tailstock and the spindle are in proper alignment. However, if any inaccuracy is exposed by this test, the V-bearings are scraped until the proper adjustment has been secured, as shown by a constant reading of the dial test indicator when traversed over both the top and the side of the test-bar, as previously described.

A lathe which has been properly adjusted by this method

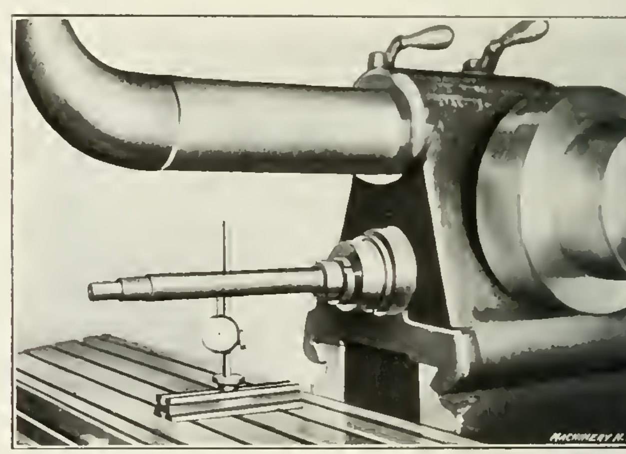

Fig. 8. Testing Crosswise Adjustment of Milling Machine Table

will be capable of producing perfectly accurate work. In operation, however, there is always a chance of disturbing the adjustment of the machine through unavoidable wear or excessive strains. To guard against this source of error, the tests which have been described above should be applied to every lathe in the shop at intervals of about a month. Where this precaution is taken, there will not be a possibility of a machine becoming badly worn, and all the adjustment which will be found necessary can easily be made by doing a little scraping. Such a course of action will be found the means of improving the accuracy of the product, and the time spent in tests and adjustment will be more than repaid in this way.

Methods used in Adjusting a Milling Machine

It is not generally known how easily a heavy casting can be drawn permanently out of shape. The popular conception is that such a casting is absolutely rigid and that it will break rather than bend out of shape; such, however, is not the case. Under the heavy loads which such castings are often

called upon to carry, a very appreciable change in shape takes place, and if they are kept in this strained condition for an extended period of time, the deformation of shape becomes permanent.

Milling machine tables are often damaged in this way. Through the inexperience of the operators who are often given charge of a miller, the work is sometimes clamped to the table much more tightly than is necessary; in such cases, the table is drawn out of shape and if it is allowed to stand in this condition for a considerable length of time, it is almost sure to be sprung permanently out of shape. If a table has been damaged in this way, the inaccuracy should be remedied by planing and scraping to a final finish. In very bad cases of this kind, however, where it would make the table too light if all of the error were removed by planing, the table should be taken off the machine and clamped to the table of a heavy planer in such a way that it will be drawn back into shape. After being allowed to stand in this way for several hours, it will be found that most of the error has been removed. The final finish is then obtained by planing and scraping, as previously described.

While the table is still mounted on the planer, it should be lined up with the dial test indicator, as shown in Figs. 5 and 6. The sides of the table are then replaned, where necessary, and they are then lined up with the bearings, as shown in the illustration.

The accuracy which has been obtained on the face of the table is determined by means of a Brown & Sharpe straightedge. Most machinists are familiar with this tool, which consists of a plate of metal finished on one side to a perfectly flat surface, with a rib cast on the back to hold it in shape; the rib also serves as a convenient handle in using the straightedge. The finished surface of the straightedge is used as a standard of reference in determining the accuracy of the finish which has been obtained on the table of the miller by the well-known means of coating it with red lead. The test is repeated, together with the scraping, until an accurate finish has been obtained. The saddle of the machine is then scraped to fit the table bearings.

The table is then remounted on the milling machine and the next step is to determine whether the spindle is in proper alignment with the table of the machine. This is done by mounting the bar which carries the dial test indicator between collars on the arbor of the machine, as shown in Fig. 7. The plunger of the dial test indicator is then brought into contact with the table and the latter is traversed through its entire range; a proper alignment between the spindle and the table will be shown by a constant reading of the dial test indicator for all positions of the table. Any inaccuracy which is exposed by this test must be removed by further scraping of the table at those points where the indicator shows that it is high.

The same test may be made by mounting the dial test indicator on the base and post, as shown in Fig. 8. A test-bar with the proper taper at the end is then placed in the spindle of the miller. The dial test indicator is then brought up against the test-bar at both the top and the side and the table traversed across; a constant reading of the dial test indicator shows the spindle to be in proper alignment.

While these tests and adjusting operations are not generally used by machinists, they will be readily understood from the preceding description and little difficulty will be experienced in doing the work. Like those which were described for use in adjusting a lathe, these tests may be used to advantage at regular intervals for determining the accuracy of the millers in the shop, and by taking the necessary steps to prevent a machine from getting badly out of adjustment, the wear and consequent depreciation in value of the equipment will be reduced to a minimum. This system will also prove valuable in improving the accuracy of the work which is turned out in the shop. The use of these methods has been the means of preventing many a good machine tool from being discarded as worthless, merely because it was a little worn and consequently somewhat inaccurate.

* * *

A two-speed planer and a one-speed man makes a misfit. A two-speed man and a one-speed planer makes another.

MACHINE SHOP PRACTICE—1

THE MAKING OF REAMERS*

By J. C. CUSTER†

The subject of reamers has so often been discussed in the trade journals, and so many have contributed towards a settlement of the question of how a reamer ought to be made, that by this time nearly everyone should be able to make a good reamer. It therefore seems almost useless to add anything further, and the writer should not have attempted to say anything on the matter, had not, in an editorial note accompanying a brief remark on the milling of reamers in the August number of MACHINERY, the views of others been solicited. An additional reason is that the rank and file in the machine shop is constantly augmented by new recruits in the trade who know nothing about the making of reamers, but have to go through a training similar to that of their seniors before them, in order to acquire the skill and the knowledge that they are supposed to have at the end of their term of apprenticeship.

The writer wishes it to be understood that he does not claim to know anything about reamers that is not known by hundreds of others, and the following pages are not written for the benefit of those who know, but solely for the benefit of the younger mechanic who does not know, but is willing to learn. With this in view, the writer shall give an account of some of his practical experience, and of his methods of making reamers that have given satisfaction. It is not claimed that the methods described are the only ones worth following; all that is claimed for these methods is that, if carefully and conscientiously followed, one will be able "to make good" in most shops. For the purpose of greater comprehensiveness, we will consider the entire process of making a reamer.

Kinds or Types of Reamers

There are various types of reamers, all of which are designated by appropriate names such as: straight, spiral, taper, adjustable, hand, machine, etc., reamers. These names indicate what purpose the reamers are expected to serve or how they are to be used, *e. g.*, we would expect an adjustable reamer to be made so that the size could be regulated to compensate for wear, or for the purpose of reaming a hole either "full" or "scant." If a reamer were to be used in a machine such as a drill press, then it would have a shank suitable for that machine, but if to be used by hand, then the shank would be made accordingly *i. e.*, supplied with a square for the wrench; this latter style is often called a "standard reamer."

The making of good reamers in a small shop, or in a shop poorly equipped for such work is expensive, and a good reamer can sometimes be bought for less than it would cost to make one.

Turning

Assume that it is required to turn the blank of a one-inch reamer, 12 inches over-all in length, to be used in a drill press fitted with taper sockets. The first work upon the stock is the centering, which may be done "in any old way," but if service and general appearance of the reamer are to count, then we should have a small center in the shank-end (a large center weakens the tang) and a large one at the reamer-end, so that if it becomes necessary, during the life of the reamer, to grind a small amount off the end, we may do so and yet retain the center for future grinding on the cutting edges. This feature is particularly desirable on taper reamers that have to ream a given size at the bottom of a hole. Through wear and repeated sharpening, the reamer will become too small at the end, so that it must be shortened or replaced by a new one. The sharpening referred to is machine-grinding; for stoning by hand we need no centers. Stoning, however, is bad practice, as one is apt to stone the taper out of true.

*The following articles on this and kindred subjects have previously been published in MACHINERY: "Irregular Spacing of the Cutting Edges of Reamers," May, 1910; "Irregular Spacing for Reamers," May, 1910; "Errors in Grinding Tapered Reamers and Milling Cutters," December, 1909; "Milling Flutes in Reamers with Irregular Widths and Depths," December, 1909; "An Adjustable Reamer," December, 1909; "Squares on the Ends of Taps and Reamers," April, 1909; "Setting-angles for Milling Angular Cutters and Taper Reamers," November, 1908, engineering edition; "Grinding Reamers," November, 1907; "Reamers," August, September, October, November, and December, 1907; "Adjustable Reamers and Taps with Inserted Blades," July, 1907; "New Method of Milling the Flutes in Reamers," February, 1907; "Reamer Clearances," June, 1904.

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After centering, ascertain what size shank the drill that is to be used in connection with the one-inch reamer is fitted with, and then turn the same size shank on the reamer; the reason for this is plain. If the reamer is to be ground all over, turn the blank about 1/64 inch over-size. The shank-end of the blank should be faced off to an angle corresponding with the drift used in the drill press, usually about 8 or 9 degrees. The corner at the reamer-end is chamfered, the chamfered surface measuring about 3/32 inch in width and being at an angle of about 45 degrees. This angle is of little importance as far as cutting qualities are concerned, but it should be uniform in order to simplify future grinding of the ends of the teeth. The reamer proper should have a length of about 2½ inches. The straight part of the shank (the "neck" between the reamer portion and the taper shank) should be smaller in diameter than the reamer. The smaller we turn this part, the lighter will be the tool, but the bigger we leave it, the more suitable will be the stock for something else when the reamer is worn out. In regard to the taper part of the shank, refer to some table or hand-book giving dimensions of standard taper shanks;* these shanks are usually fitted to a "taper-shank gage" found in nearly every shop that makes its own small tools.

Taper Reamers

We need say but little about the turning of the blank for the ordinary taper reamer, but it should be noted that a taper reamer intended for roughing differs but slightly from one intended for finishing. Sometimes it is made in "steps." In this case, first turn the blank to the proper taper; then cut a series of grooves about ½ inch apart, 3/32 inch deep and about 3/32 inch wide. These dimensions may have to be modified according to the taper and the size of the reamer. Now set the tailstock as for straight work, and turn each section or step straight. In this way a taper reamer that does not have a gradual increase in diameter, but which increases by small steps, is obtained. The teeth cut only at the ends of each step. Another way is to make the roughing reamer like a finishing reamer except that the teeth are "nicked." This nicking is done in the lathe by turning a groove having about 1/2 inch lead, 1/16 inch deep, using an oil-grooving tool about 1/16 inch wide. It might be presumed that this groove should be cut with a left-hand spiral to prevent the reamer from feeding into the work too fast, but for good practical reasons, however, this groove should be cut with a right-hand spiral (on a right-hand reamer), because this gives the teeth a positive rake at the nicks along the flute, while a left-hand spiral gives a negative rake which causes trouble after the reamer has been in use for some time.

A very good roughing reamer may be made by cutting a right-hand spiral groove having about ½ inch lead, and then turning the lands between the convolutions of the groove straight, so that the blank is "stepped" spirally. This is done (leaving the lathe set as for taper turning) with a square or broad-nosed tool, using the same feed as used for cutting the groove—½ inch per revolution. The edge of the tool must be set parallel with the axis of the work. The "stepped" style of reamer costs somewhat more to make, because each step must be backed off individually, but the extra labor is well spent. This reamer may, however, be relieved towards the back when turning the blank by setting the broad-nosed tool so as to produce a back relief, instead of setting it exactly parallel with the axis. This would eliminate the necessity of backing off in the grinder, but the backed-off reamer gives better satisfaction.

It does not seem necessary to go into further details in regard to the turning of reamers. When turning the bodies of adjustable reamers with inserted blades, it should be remembered, however, that the body should be about ⅛ inch smaller in diameter than the required size of the finished reamer, which allows each blade to project 1/16 inch from the body when the reamer is adjusted to size. The body of adjustable reamers is made of soft steel or cast iron.

*See MACHINERY'S Data Sheet Series No. 4, "Reamers, Sockets, Drills and Milling Cutters," or MACHINERY'S Reference Series No. 35, "Tables and Formulas for Shop and Drafting-room."

Milling

The milling or fluting of right-hand reamers (left-hand reamers are never used except for special screw machine operations when it is desirable to run the spindle backwards) should be done in a milling machine having the headstock or dividing-head to the left of the operator—like a lathe—and the work should be indexed around towards the operator. Some of the so-called "formed" reamer fluting cutters produce a weaker tooth than the ordinary angular cutter, as may be seen by a comparison of Figs. 1 and 2. If a straight-fluted reamer is cut with an ordinary angular cutter, having a vertical side, the cutter must be in good condition or a ragged tooth will result. The saddle should be set slightly past zero to prevent "back-cut."

A cutter combining several good features for the milling of straight-fluted reamers is shown in Fig. 2. This cutter, by reason of the angular side, will cut a good tooth-face, and

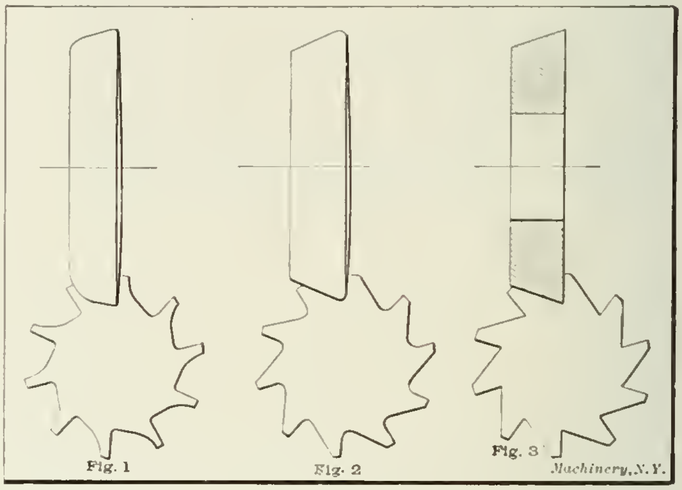


Fig. 1. Illustration showing Reamer Tooth produced by a "Formed" Reamer Cutter

Fig. 2. Tooth produced by Cutter having an Angle of 2 1-2 Degrees on Face and Round Corners

Fig. 3. Tooth produced by Cutter with Straight Face and Sharp Corners

produces a strong tooth as shown. Another advantage is that it can be set radial or slightly "ahead of center" simply by sighting past the side of the cutter while we bring the work into the line of sight. A scratched line on the top of the tailstock over the axis of the centers facilitates such setting. Reamers for steel and cast iron have the face of the teeth either radial or slightly ahead of the center, but reamers for brass or bronze give better satisfaction if the face of the tooth makes an angle of 5 or 6 degrees with the radial line, being that amount ahead of the center.

A strong tooth and flutes of sufficient depth to give room for chips are the essential features of a reamer; both of these depend on the number of teeth and the shape of the fluting cutter. In the smaller sizes there is no choice in regard to the number of teeth, as a fluted reamer with less than six teeth does not work well, and it surely cannot be made with more. Straight reamers should have an even number of teeth so that the size of the reamer can be easily measured.

Formed cutters for fluting reamers have usually stamped upon them the size of reamer and the number of teeth for which they are adapted, but experience has taught the writer that the number of teeth indicated is in many cases too fine for a large class of work in ordinary machine-shop practice. Among the equipment for milling reamers at the disposal of the writer, is a formed cutter intended for ten teeth in reamers of from 1 1/16 to 1 1/2 inch diameters; this is a suitable number of teeth for the 1⅜ and the 1½ inch size, but it seems too fine for a 1 1/16 inch reamer. "Many hands make light work" must not be understood to mean that many teeth make light and easy reaming. Some of the readers may be surprised when they are told that nearly every day the writer sees reamers in operation that have but two teeth reaming holes up to eight inches in diameter, and doing good work quickly. An illustrated description of this reamer is contained in the Bullard Machine Tool Co.'s (Bridgeport, Conn.) catalogue.

Reamers are usually fluted in one operation, but if we want

to cut a well proportioned eight-tooth reamer, 1⅛ inch in diameter, with a cutter designed for a ten-tooth reamer of the same size, then a second operation becomes necessary. In the first place, we cut the face of the teeth to the proper depth (all around), and in the second, we reduce the lands to the desired width.

Angle of Fluting Cutter

We will now consider the relation between the angle of the flute and that of the tooth of a solid reamer. For the sake of simplicity consider a reamer that has been fluted with an ordinary angular cutter, as shown in Fig. 3. If we were to cut teeth on a straight piece of work, such as a hack-saw blade, we would find that tooth and space would be of the same angle, *i. e.*, if we used a 50-degree cutter, the space would be 50 degrees and the tooth, likewise, 50 degrees. The same principle is demonstrated when cutting a screw in a lathe, using a 60-degree tool; we get a 60-degree thread. But if we waut to cut teeth on the surface of a cylinder, as, for instance, in a reamer, the face of the tooth being radial and parallel with a plane through the axis of the work, then the proposition is entirely different, and we no longer have tooth and flute of the same angle. There will, instead, be a difference of 360 degrees in the aggregate. Suppose we want to flute a reamer the tooth of which should measure 30 degrees. (From 30 to 35 degrees is a suitable angle for reamer teeth.) First we ascertain what number of teeth will be the most suitable. This we will assume to be six. Then, since the sum of the angles of the six flutes or spaces is 360 degrees greater than the sum of the angles of the six teeth, each flute will be $360 \div 6 = 60$ degrees greater than the adjacent tooth, and as we want to cut a tooth of 30 degrees we must use a cutter of $30 + 60 = 90$ degrees. This, expressed in a formula, would be:

A = angle of space, or of cutter to be used,
B = number of teeth in reamer,
C = desired angle of tooth.

Then,

$$A = \frac{360}{B} + C$$

Substituting for the symbols the actual figures for a one-inch reamer, 8 teeth, 35-degree tooth, we have:

$$\frac{360}{8} + 35 = 80 \text{ degree cutter to be used for fluting.}$$

It was just stated that an angle of from 30 to 35 degrees is a suitable angle for reamer teeth; this should not be understood as applying at all times and for all sizes. If we were to cut a ¾-inch reamer, 6 teeth 30 degree tooth, we would, according to the formula, use a 90-degree cutter, but if we should use this same cutter for a ½-inch reamer, the flutes would be rather shallow, and they would be still more so in the ⅜-inch size. Cutters of 87½- and 85-degree angles are better adapted for these sizes, which would give a tooth of 27½ and 25 degrees, respectively. Very often a 40-degree tooth is the one most suitable for the larger sizes. This does not mean, however, that we can say off-hand what the tooth-angle shall be, and then proceed to cut any number of teeth on a certain size reamer, for the number of teeth has a great deal to do with the angle of the teeth. In addition, the general appearance of the flute and the tooth depends largely on the rounded corners of the cutter used for fluting, as may be seen by a comparison of Figs. 2 and 3.

Taper Reamers

What has been said about solid chucking reamers in regard to teeth, holds good, largely, for taper reamers, except that we may cut an odd number of teeth in them if we have a shell-gage to which to grind them. It is claimed that reamers with an odd number of teeth chatter less than those with an even number; this the writer can neither confirm nor deny, since they seem to work alike with him. Stepped taper roughing reamers are generally made with four flutes, and if so made, the tooth should be similar to the tooth in a four-lipped drill.

Spiral Reamers

A right-hand reamer used in an automatic screw machine should have the teeth cut on a right-hand spiral, as this form is better adapted to allow the chips to pass out freely. For deep reaming, an oil-reamer is sometimes used for getting rid of the chips. Such a reamer has a hole drilled through the center and is used like an oil-drill. Left-hand spirals on right-hand reamers are more apt to force the chips ahead, which is a good feature when reaming holes passing clear through, in a vertical machine such as a drill press.

* * *

RECENT TESTS OF MACHINERY BRAKE LININGS

Prof. C. L. Norton, of the Massachusetts Institute of Technology, recently made some tests of materials used as machinery brake linings, which show that asbestos is a superior material for this important part of certain classes of machinery. The manner in which these tests were made was quite simple, yet the results obtained were accurate. The different materials used in brake bands were applied one by one to the surface of a steel drum which was revolving under approximately the identical speed conditions of the ordinary machinery brake drum. The normal coutact pressure and the tractive force were carefully measured, and the arc of contact and the pressure per unit of area were varied over wide limits. Each specimen was tested when new and after several days' running. In the case of the asbestos lining, the coefficient of friction did not vary sensibly with the pressure per unit of area or the length of the arc of contact. The final results showed that the two specimens of the asbestos lining, called respectively "J. M. Non-Burn A" and "C", showed a coefficient of friction of 0.37. The relative value of asbestos linings to other linings may be found by comparing this figure with the figures given as follows:

Material	Coefficient in Motion Dry	Wet	Oily
Asbestos to metal......	0.37	....	0.20 to 0.25
Metals on metal.......	0.15 to 0.24	0.31	0.20 to 0.06
Wood on metal........	0.20 to 0.62	0.24	0.20 to 0.06

Oil was applied to these asbestos brake linings without much effect. While it was possible by means of a forced test of oil between the asbestos lining and the metal drum to bring the coefficient of friction down as low as 0.20, it was found that a good value for the coefficient of friction of the asbestos brake linings after they had been soaked in oil or exposed to splashing from oil was from 0.20 to 0.25. Values as high as 0.30 are not infrequent for an oily lining used under high pressure. Even when the asbestos brake lining was thoroughly saturated with oil the coefficient of friction, although it went down materially upon the first application of the brake, was not afterward greatly affected. It is to be noted that under the heat of the friction when the brake was again applied to the drum, the oil was quickly volatilized and the coefficient of friction was rapidly raised toward the maximum when dry. An asbestos brake block tested under similar conditions proved to have a more variable coefficient, depending upon the nature of its contact surface. The limits observed were 0.32 and 0.39. While the tests were indeterminate as to wear, they indicated that the material is very durable. An asbestos lining absorbing 15 horsepower for ten hours lost only a few grains in weight.

* * *

In a recent issue of the *Practical Engineer*, a brief description is given of the difficulties incident to transporting two big castings intended for two large British dreadnaughts. These castings, each weighing about forty tons, were to be conveyed from Sheffield to the docks at Liverpool. They each measured 12 feet, 4 inches in width, when loaded on a car, with a maximum height above the rail level of 10 feet, 7½ inches. This would be difficult enough to handle with American clearance limits, but with the 9-foot loading limit on the English railways, still greater difficulties were encountered. The transportation was satisfactorily accomplished by stopping all traffic on opposite lines of rail between Sheffield and Liverpool while the castings were being moved.

* * *

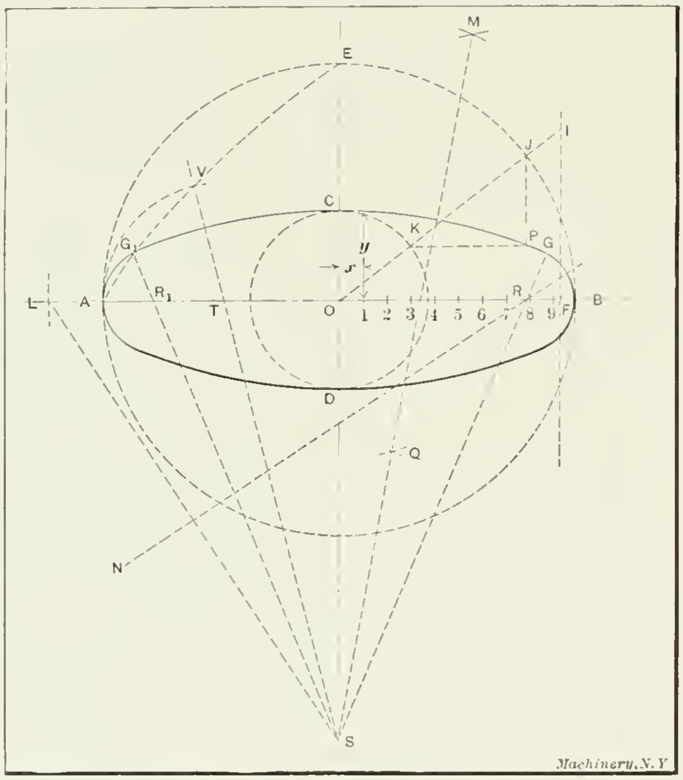
A dirty machine may be a sign of such busy times that the operator has no leisure to clean it up, but it is more likely to be a sign of slovenliness.

CONSTRUCTING AN APPROXIMATE ELLIPSE WITH TWO RADII

By J. J. CLARK*

In MACHINERY for March, 1911, engineering edition, Mr. H. A. S. Howarth describes a method for drawing an approximate ellipse with two radii and four centers. The method is chiefly defective because the second arc does not pass through the end of the major axis. As it is a very easy matter to locate geometrically the center for the second arc so that it will pass through the point B and be tangent to the first arc, one wonders why Mr. Howarth did not give the construction instead of devoting more than one-half of his article to discussing errors which ought not to have occurred. The writer has devised the following method of constructing an ellipse with two radii, which he believes to be as simple as that of Mr. Howarth's, and thinks that the resulting curve has a better appearance for flat ellipses; *i. e.*, when the ratio of the axes is 3:1 or greater. In so far as was practical the accompanying illustration has been lettered in the same manner as Figs. 1 and 2 of Mr. Howarth's article.

Construction.—Draw $A B$ and $E S$ at right angles to each other, and, with the point of intersection O as a center,



Method of Constructing an Approximate Ellipse with Two Radii

describe two circles with the semi-axes $O A$ and $O C$ as radii. Locate a focus F by taking C as a center, $O A$ as a radius, and striking a short arc intersecting $O B$ at F. Through F draw a perpendicular to $A B$ and lay off $F I$ equal to $C D$, equal to the minor axis. Draw $O I$, cutting the large circle at J and the small circle at K. Draw $J P$ and $K P$, perpendicular and parallel respectively to $A B$; they intersect at P, a point on the true ellipse. With P and C as centers and any convenient radius greater than one-half $C P$, describe short arcs intersecting at M and Q. Draw $M Q$ intersecting $E S$ at S, the center for the arc passing through C. Describe the arc $G_1 C G$, extending it beyond P. On $A B$ lay off $B L$ equal to $C S$, equal to $G S$, and bisect $L S$ by a perpendicular $N R$, intersecting $A B$ at R. Draw $S R$ intersecting arc $C P G$ at G. Then R is the center for the second arc, G is the point of tangency for the two arcs, and $R G$, which is equal to $R B$, is the radius.

For very flat ellipses, it may be inconvenient to lay off $B L$ equal to $C S$; if such is the case the center R and point of tangency may be located as follows, referring to the left-hand half of the figure: With a point T, about midway between O and A, as a center and $T A$ as a radius, describe arc $A V$; draw $S T$, intersecting this arc at V. Pass an arc of a circle through the three points A, V, and E, by the usual geometric construction; this arc intersects the arc $G_1 C G$ at G_1. Draw $S G_1$, intersecting $A B$ at R_1. Then R_1 is the center for the second arc, G_1 is the point of tangency of the two arcs, and $R_1 G_1$, which is equal to $R_1 A$, is the radius.

It may here be stated that in the case of flat ellipses it is not possible to obtain a very close approach to the true curve with only two radii. The curve so obtained will either be too flat or else it will be too round at the ends. The writer

TABLE I. COMPARISON OF THE TWO METHODS WITH SEMI-AXES 10 AND 2

Semi-axes 10 and 2	True Ellipse	Approximate Ellipse (Howarth)	Approximate Ellipse (Clark)	Semi-axes 10 and 2	True Ellipse	Approximate Ellipse (Howarth)	Approximate Ellipse (Clark)
x	y	y	y	x	y	y	y
1	1.990	1.985	1.986	9	0.827	0.772	0.839
2	1.960	1.940	1.944	9.2	0.784	0.716	0.786
3	1.910	1.867	1.873	9.4	0.682	0.658	0.732
4	1.840	1.761	1.774	9.6	0.560	0.596	0.677
5	1.749	1.626	1.646	9.7	0.509	0.544	0.619
6	1.687	1.460	1.489	9.8	0.439	0.466	0.519
7	1.458	1.263	1.302	9.9	0.326	0.345	0.380
8	1.190	1.034	1.086	10	0	0	0

believes that a flat curve drawn as described has a better appearance than the curve described by Mr. Howarth. Table I was calculated for semi-axes of 10 and 2. The first column contains distances from O measured along OB. The second, third, and fourth columns contain ordinates for the corresponding distances in the first column. As it was not worth while to use Mr. Howarth's construction for the second arc, it has been assumed that the center R was found by one of the methods previously described.

Calling Mr. Howarth's curve as thus modified No. 2 and the curve in the fourth column of Table I, No. 3, that of the true ellipse in the second column being No. 1, it will be noted that the arc $C G$ of No. 3 approaches the same arc of No. 1 more closely than the corresponding arc of No. 2; but the arc $G B$ of No. 2 approaches No. 1 more closely than No. 3.

When the ratio of the axes is less than 3:1, Mr. Howarth's construction (when the center R is found as previously described) is much to be preferred. As a general method for drawing an approximate ellipse with only two radii, it is the best method that the writer has seen. To gratify his curiosity, the writer calculated Table II for a true and an approximate ellipse with semi-axes of 10 and 5. The approximate ellipse

TABLE II. TRUE AND APPROXIMATE ELLIPSES WITH SEMI-AXES 10 AND 5

Semi-axes 10 and 5	True Ellipse	Approx. Ellipse	Semi-axes 10 and 5	True Ellipse	Approx. Ellipse	Semi-axes 10 and 5	True Ellipse	Approx. Ellipse
x	y	y	x	y	y	x	y	y
1	4.975	4.979	6	4	3.852	9.4	1.706	1.8
2	4.899	4.876	7	3.571	3.415	9.6	1.4	1.497
3	4.770	4.721	8	3	2.892	9.7	1.216	1.308
4	4.583	4.5	9	2.179	2.449	9.8	0.995	1.077
5	4.330	4.212	9.2	1.960	2.040	9.9	0.705	0.768

is constructed by Mr. Howarth's method, as modified. On the whole it will be noted that the deviation from the true ellipse is greater than in the preceding case, when the axes were 10 and 2.

* * *

A large manufacturer of air-cooled stationary gas engines machines the cylinders on Gisholt turret lathes. The bore is finished by reaming, and round, parallel and smooth surfaces are thus cheaply produced. The pistons are finished by grinding, not because a ground surface is wanted, but because grinding is the simplest, cheapest and most accurate way to size them.

* * *

The man who does his work just as well when he knows the boss's eye is not on him as when it is, is the one who does not need watching.

* Address: Manager Textbook Department, International Correspondence Schools, Scranton, Pa.

WORK OF THE GARDNER PATTERN-MAKER'S DISK GRINDER

During a recent editorial visit to the fine new plant of the Gardner Machine Co., Beloit, Wis., we were shown some of the remarkable work done in patternmaking with the Gardner patternmaker's disk grinder that was illustrated and described in the May, 1910, number. This machine, with very simple appliances, is made a most efficient and economical woodworking tool, as is shown by the fact that it and a band saw are the principal machines used in the company's own patternshop. Not only will it quickly shape most of the circular pieces in core work ordinarily turned up in the lathe, but a grade of lumber can be used that would be worthless if the attempt was made to work it with ordinary tools.

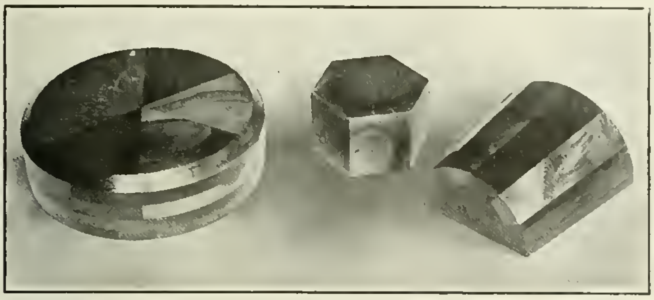


Fig. 1. Patterns made on the Disk Grinder—Note Different Kinds of Wood used

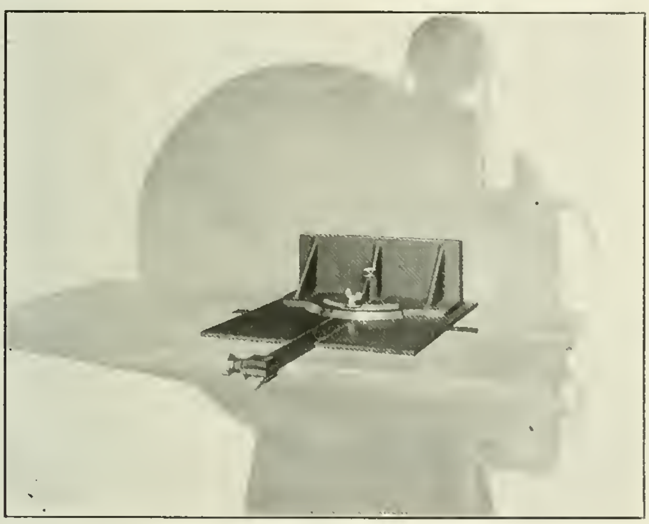


Fig. 2. Universal Duplicating Gage for Grinding Sectors, etc.

Fig. 1 shows three sample patterns made from several kinds of lumber to illustrate the possibilities of the machine for close and accurate jointing of angular parts, use of poor lumber, etc. Some of the lumber would be considered good only for firewood in most patternshops. Imagine for instance the prospect of making the hexagon nut pattern, shown in the center, from a piece of pine containing a large hard knot, without breaking a few tools and the third commandment. Again, note the soft pine sector containing a large hard knot in the top of the larger pattern at the left. Not only is this piece worked smoothly, but the joints are as close as the most discriminating cabinet maker could require. The other sectors in the tops of this pattern are oak, walnut, cherry, birdseye maple, and birch, all of which were jointed and finished on the disk grinder. After being glued up, the top was smoothed off with the same machine. The third piece at the right illustrates the fitting of taper staves in a conical drum pattern.

In fitting such parts, they are roughly sawed out on the band-saw and then ground to shape. The universal duplicating gage used for grinding tapering parts, such as sectors, etc., is shown in Figs. 2 and 5. This gage is graduated from zero to 45 degrees in either direction from the parallel position, and it has an adjustable stop-screw that regulates the amount of stock removed. Instead of sizing each piece by grinding to a scratch line, this gage with its stop enables any number of duplicate pieces to be made.

Another useful attachment is shown in Figs. 3 and 4. This is known as a "circular core-print gage," and it is used for producing round or curved surfaces. Core-prints are built up from roughly sawed circular pieces, and then ground to an accurate circle in a jiffy with this attachment. The work is pivoted on a pin or center located at the required radius from the disk. Three of these pins and the holes in which they fit are shown in Fig. 3. Circles of different radii can be ground and the gage has an adjustable stop-screw that regulates the amount of stock removed and enables the production of duplicate work. To grind a piece tapering, it is simply necessary to tilt the main work-table to the required angle. With this simple attachment a rough circular piece, say six inches in diameter, can be ground smooth and true on the edge in less time than it takes to describe the operation.

* * *

In a manufacturing plant where there are a large number of castings passing through the shop, it is sometimes a difficult matter to distinguish between the fixtures used for holding these castings during the various machining operations and the castings themselves, especially when the fixtures resemble the castings. Gould & Eberhardt, Newark, N. J., manufacturers of shapers, automatic gear and rack cutting machinery, paint all their jigs and fixtures with red paint, which is an effective means of distinguishing them from the castings. The jigs and fixtures are taken out from the store-room by the check system, and the man who takes them out is held responsible for their return. Supposing a fixture has been laid down at the side of the machine, it does not require a close search to find it when it is to be returned, and the fixture is not likely to be transferred with the castings from one machine to the other.

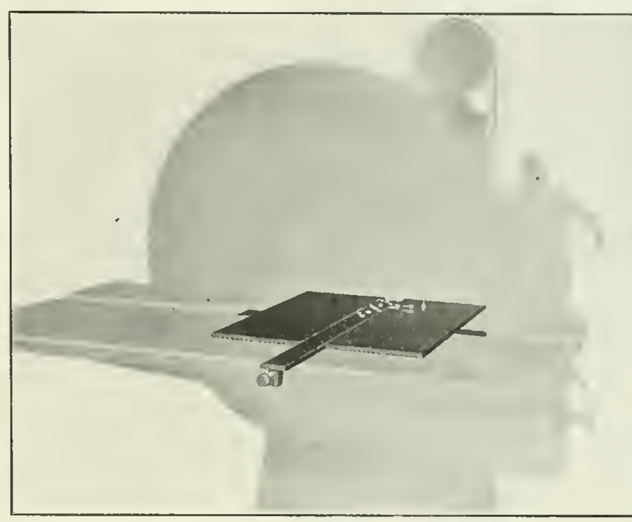
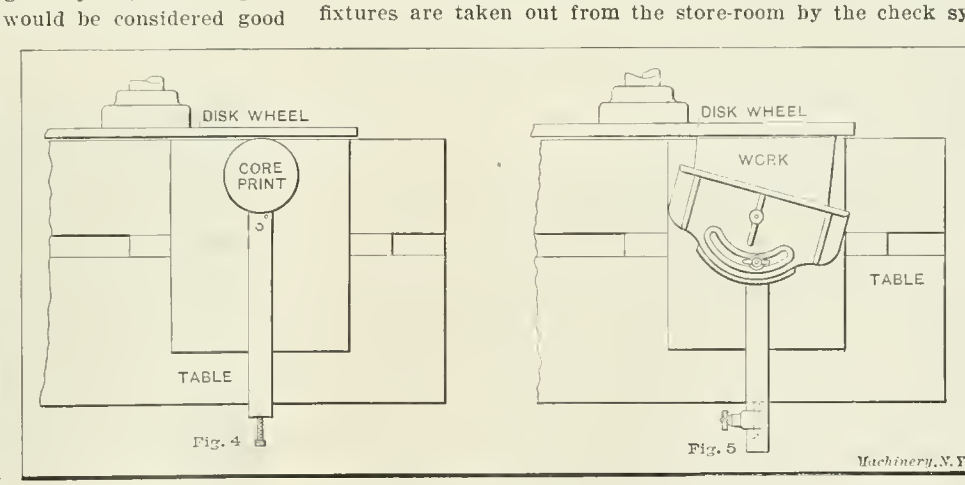


Fig. 3. Circular Core-print Gage



Figs. 4 and 5. Plan Views illustrating Use of Core-print Gage and Universal Duplicating Gage

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

IMPROVEMENTS IN CENTERING MACHINE

In a shop where the writer was once employed, a commercial centering machine of the type shown in the accompanying halftone, Fig. 1, is used for centering small pieces cut off from cold rolled bar stock. The principle of the action of the machine is as follows: The center drill is held in the tailstock spindle, and clamped by set screw *A*. The work to be

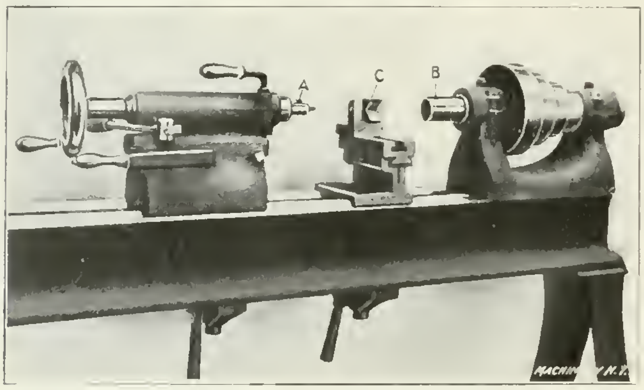
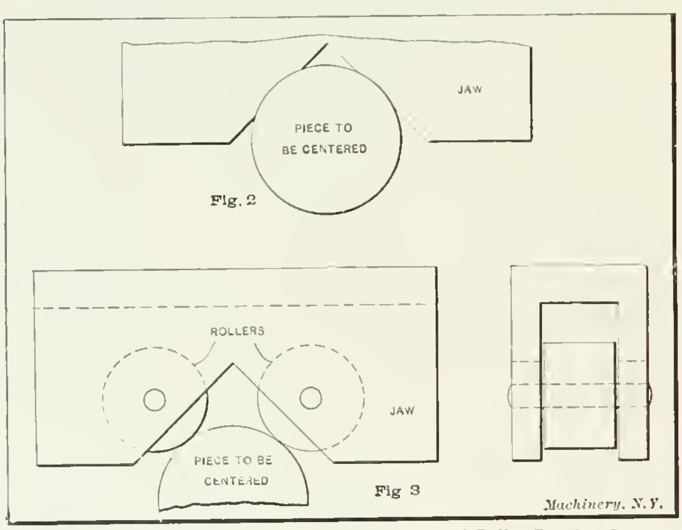


Fig. 1. Centering Machine on which Improvements were made

centered is driven by means of a tapered hole in the end of spindle *B*. This tapered hole is knurled on the inside, so that it will easily take hold of the corners of the stock to be centered. The large end of the hole is 2 inches in diameter and the small end ¼ inch, so that the machine has a range for stock of from about 5/16 to 1⅞ inch diameter. The work to be centered is pressed by the hand of the operator into the V-block *C*, which latter is adjusted forward or backward on the cross-slide shown, so that the proper center can be obtained for different sizes of stock. When the V-block has been



Figs. 2 and 3. V-jaw originally on Machine and Roller Bearing Jaw substituted

properly adjusted, the operator can center the pieces at a very rapid rate, as the machine is never stopped, and all he has to do is to put one end of the piece into the hole in the spindle, press the cylindrical part of the piece into the V-jaw, and feed the drill into the end to be centered.

Some improvements on this machine were, however, found desirable. It is the object of this article to describe these improvements. When several thousand pieces were to be centered, and it was expected that all should run true within 0.001 inch, it was found that small grooves would wear in the sides of the V-jaw, as indicated in an exaggerated manner in Fig. 2. Evidently this made the center at the end come out of true, the operator always pressing the piece to be centered against the V-jaw, and hence into the grooves, and unless the operator watched out for this difficulty and re-adjusted the position of the V-block, he would be likely to get several hundred or even thousand pieces out of center, the error being greater as the stock to be centered wore into the V-jaw. To remedy this defect, hardened rollers were provided, mounted on hardened studs, as shown in Fig. 3, and as the friction between the rollers and the piece to be centered is almost imperceptible, there is practically no wear whatever on the rollers, and the only possible cause for the pieces being "out of center" is the variation in the diameter of the stock, which, however, is not over 0.001 inch.

Another difficulty met with was that if the body of the center drill did not fit the hole in the tailstock spindle exactly, the binding set-screw *A*, Fig. 1, would press it down to the bottom of the hole in the spindle, and the point of the drill would not be exactly in line with the headstock spindle or the center line of the work, thus not only centering the stock out of true, but in many cases breaking the drill part of the center reamer. In order to make it possible to hold the center drill true at all times, a universal chuck was mounted at the end of the tailstock, as shown in Fig. 4. At the front end of the chuck a stop *D* was also provided, in the form of a bushing

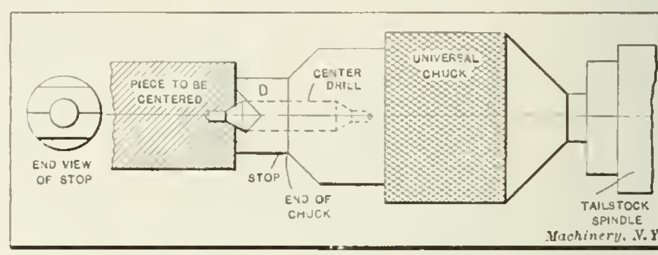


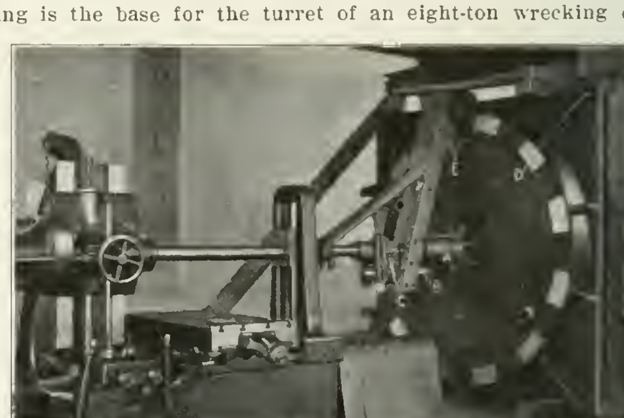
Fig 4 Universal Chuck for Holding Center Drill, and Stop for Drill Feed

placed over the center drill, and with part of the outside end-surface cut away as shown, in order to reduce the friction against the end of the piece to be centered when brought up against this stop. By means of this stop it is possible to obtain exactly the same size of center in all the pieces, even if the pieces to be centered should vary in length, in which case a positive stop, as provided with the machine, is useless. These improvements greatly increased the usefulness and accuracy of the machine, and were comparatively inexpensive.

CORRESPONDENT

THE MACHINING OF A LARGE STEEL CASTING

The accompanying illustration shows the method employed in the shops of the Twin City Rapid Transit Co., St. Paul, Minn., for machining a large steel casting. This method was originated by the shop foreman, Mr. John Hallberg. The casting is the base for the turret of an eight-ton wrecking car.



Method of Setting up and Machining the Base of a Derrick for an Eight-ton Wrecking Car

The base and the turret which carries the derrick were both machined in the same manner. The dimensions of the casting shown in the illustration are as follows: The base is 8 feet square; length of hub plus thickness of casting, 2 feet; diam-

eter of hole through hub, 6 inches; outside diameter of hub, 9 inches; and the length of the hub projecting from the casting, 14 inches.

This difficult piece of machining was accomplished with a No. 32 Lucas precision boring machine. The capacity of this machine is 2 feet swing over the carriage, with the boring-bar at its highest position. To machine, the casting was placed at the end of the machine against a pillar of the building, and supported by wooden framework. An extension bar was connected to the boring-bar, passed through the hole in the casting, and supported at the rear end by a rigid bearing.

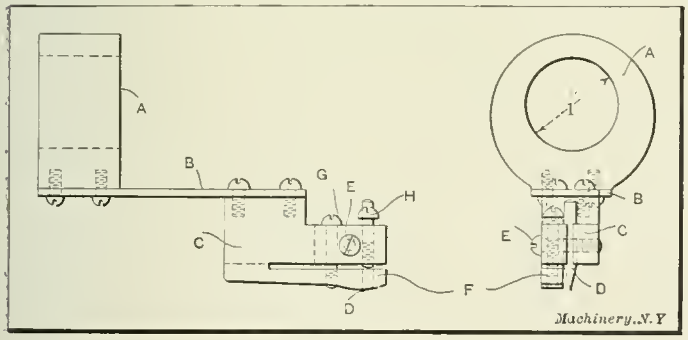
The outside diameter of the hub *A* was turned with a tool held in the short bar *B*, this bar being held in a bracket *C* connected to the extension shaft. The babbitted bosses *D* were faced by a tool held in tool-slide *E*, actuated by a star feed.

St. Paul, Minn. FRANK L. ZAHLER

A GRADUATING TOOL FOR FINE LINES

The writer at one time had a 14-inch vernier to graduate when he was employed with the United States Cartridge Co. This scale was to be used on their chronograph, an instrument which is used for calculating the velocity of bullets fired from cartridges loaded with various powders and charges. The graduating was accomplished in a milling machine by locking the spindle in its bearings, and holding the device shown in the accompanying illustration on a cutter arbor by the eccentric collar *A*. The work was held lengthwise on the table, and the table was moved forward for each graduation by using the micrometer dial.

The stops on the cross-slide for the in-and-out movement of the table were set for the length of the longest line, and parallel strips of different thicknesses were inserted between the stops, so as to make provision for the variation in the length of the lines. The lines were cut by means of a tool *D* of drill rod, which was made with a sharp V-point, hardened and tempered. This tool *D* is held in the block *C* by the



A Graduating Tool of Simple Design

screw *E*, the block *C* being split as shown. The lower portion of the block *C* which forms a sort of shoe at *F*, is adjusted by the screws *G* and *H*, and rests upon the surface of the work to be graduated, only allowing the cutting tool to project in to the required depth.

When raising the work by means of the elevating screw to take a cut, instead of stopping when the shoe *F* touches the work the table is raised slightly higher, say 0.010 inch, so that sufficient pressure is brought to bear upon the broad flat spring *B* to overcome the resistance of the cut and insure that the shoe is always in contact with the work, even if the surface is slightly bent.

This tool was not expensive, and was comparatively easy to make. In making the device, the precaution was taken to avoid using any pivoted joint, plunger and spring, or any working fits whatever, which would have a tendency to make it inaccurate. S. J. PUTNAM

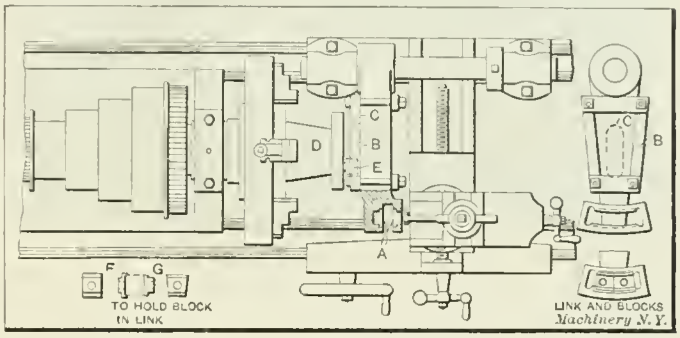
Bentley Manor, N. Y.

A LINK AND LINK-BLOCK JOB

Sometimes a job will occur in machine shop practice that is different from anything that has previously been done. Such special jobs are somewhat expensive, but this is of minor importance when the piece required is a necessity and when a good job is demanded.

In the accompanying illustration the view to the right shows the piece—a rocker arm—quite clearly; the other view shows it in position in the lathe. This rocker arm or lever is a steel forging having a circular slot machined concentric with the bored hole in the end; the end was also slotted radially, as indicated at *A*. This divides the circular slot into two portions, these two portions being cut down on the inside, forming a T-shaped cross-section of each part, which fits the flange of the corresponding link-block.

It was possible to do the work on either the planer, slotter, shaper or lathe, but the latter appeared to be the most suit-



Lathe set up for Machining Link and Link Block—Pieces for Holding Latter in Lower Left-hand Corner

able; the illustration shows how the work was done, after all the stock except enough for finishing had been drilled and chipped out. The piece was secured on a shaft which was mounted in bearings on the lathe carriage, these bearings being approximately level with the center line of the lathe. Adjustment was made to bring them exactly so, when the shaft was babbitted in the bearings in its position. A plate *B* with an elongated slot *C* in it was bolted to the back of the link, a cast-iron nipple *D* secured in the lathe chuck was fitted with the small roller *E* which engaged with the before-mentioned slot *C*, so that as the chuck revolved, an oscillating motion was given to the link. The amount of this oscillation could be adjusted by changing the throw of the roller *E* through the nipple *D*, which is merely held by the lathe jaws and is, therefore, adjustable. During the operation of machining, the carriage remained in a fixed position; the cross feed and compound rest, the latter turned at right-angles to the work, provided the necessary means for machining.

To finish the blocks, pieces *F*, such as shown in the lower part of the illustration, were made to hold them. One side fitted the circular slot while the other received the roughed-out block *G*, as indicated by dotted lines between *F* and *G*, a hole through each allowing them to be bolted to the face of the work, all as shown in the lower right-hand corner; thus the blocks could be finished while the main piece was still in the lathe. By this means a very satisfactory piece of work was obtained. C. L. NEWTON

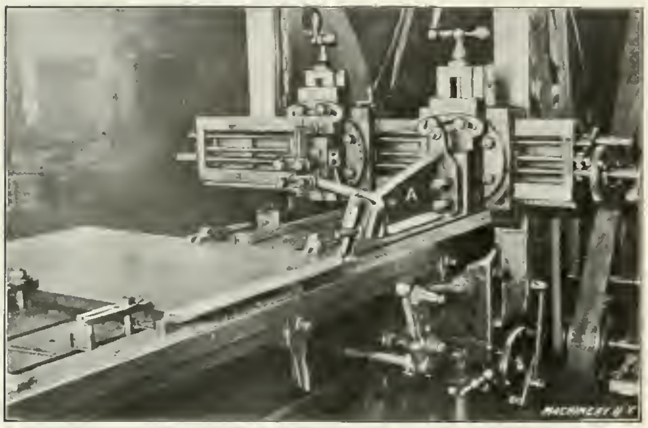
Pueblo, Colo.

EXTENSION TOOL-HOLDER FOR THE PLANER

In nearly every shop can be found some form of extension head for holding the tool when planing work which is longer than the distance between the housings. Some of these devices are provided with down feeds and are bolted to the saddle, while others have a swivel clapper box on the work end. The majority, however, consist only of a cast-iron bracket, which is slipped over the bolts of the clapper box, and in which the tool is held by a set-screw. With this latter construction the tool is subjected to harsh treatment on the return stroke, as the extension block allows the tool to drag, thus soon destroying the sharp cutting edge. Another objection to the extension head is its tendency to spring sideways when a good cut is being taken, and also to spring out of the vertical line when a facing cut is being taken.

We had considerable work that would not pass through the

housing of the planer and, after having tried a number of different extension holders, we struck on the one shown in the accompanying illustration. This consists mainly of a casting A, held to the main tool-holder by the bolts in the clapper box. On the forward end of the arm A is a block carrying a toolpost. This block can be swiveled through a short arc, and is



Extension Tool-holder of Rigid Construction

held to the arm by two nuts on the rear face of the front end of the bracket. The bracket is also additionally supported by means of the arm B, which is fastened to the casting A, and also to the other tool-head, as shown. This arm is made from pipe section. When using this device for facing, both toolheads are set to feed downward together. This makes a combination sufficiently rigid to enable a cut to be taken well within the capacity of the tool held in the tool-holder.

Middletown, N. Y. DONALD A. HAMPSON

CUTTING AN OCTUPLE THREAD

The piece of work shown in Fig. 1 is part of the focussing mechanism of a certain make of prism binocular, and was originally made of aluminum, apparently alloyed with zinc; this is a rather poor material from which to make narrow faced gears, particularly when they are to be used by people

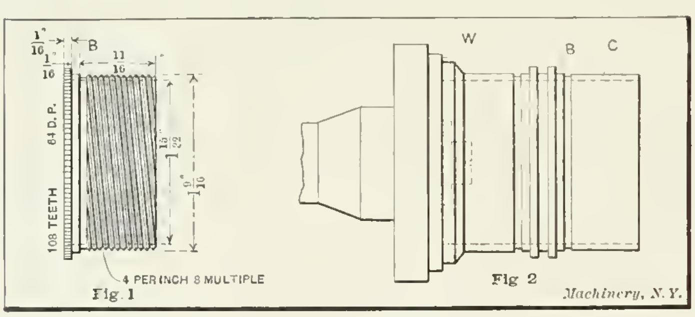


Fig. 1. Piece of Work to be repaired

Fig. 2. Method of Chucking Stock for a New Piece by Soldering to a Faceplate

who are not mechanics. Both gears in this instrument had many of their teeth stripped off, and had to be made new, out of brass. The threaded parts were in good condition, but there did not seem to be any good means of fastening a brass gear to the aluminum threaded tube. If the large hole through the piece had not been in use up to its full diameter, then a brass gear could have been made with a slight hub to go inside the aluminum tube, and six small rivets could have held them together, but in that case the rivets would have had to be put in the threaded part or in the bearing strip B. Either of these methods would have been objectionable, as the nut in which this tube moved, was at times screwed clear up to the shoulder, and the nut could not be made shorter, as it was only 3/16 inch long. Solders adapted to aluminum would be uncertain in their hold where the surfaces in contact were as small as in the piece of work under consideration. All things considered, it was decided that the best way out of the difficulty was to make the entire part new in one piece.

A piece of tubular composition casting was cut off a little longer than necessary to make the two pieces, and this was soldered onto a brass washer W which was fastened to a small faceplate in the bench lathe, all as shown in Fig. 2. In this position the hole was first bored to size through the full length of the casting. The places for the two gear blanks were then turned to size and the teeth cut, after which the bearing B on the outer piece was turned to size, and part C was turned and threaded; the parting tool was then run in between the two gears. The outer piece was next placed on an expanding chuck and the back surface of the gear finished off true and flat. Having the first gear out of the way, the end of the second gear was turned true and then unsoldered from its washer, turned end for end and placed on an expanding chuck, the operations as on the first piece being repeated.

As shown in Fig. 1, the thread is four turns per inch, but there are eight threads; that is, it looks like a thread of 32 per inch, but with a greater lead. The tools used in cutting this thread are shown in Figs. 3, 4, 5, 6, and 7. The steel screw and solid brass nut shown in Fig. 7 were the only tools made specially for the job in hand, the others being part of the regular shop equipment. Fig. 3 shows two views of an iron casting fitted to the slide rest, and ordinarily used as a boring-tool holder, the ½-inch hole through it being at the height of the lathe centers. It will take a ½-inch round bar, or smaller sizes by means of split bushings like Fig. 5. Fig. 4 is a threading tool for either inside or outside chuck work,

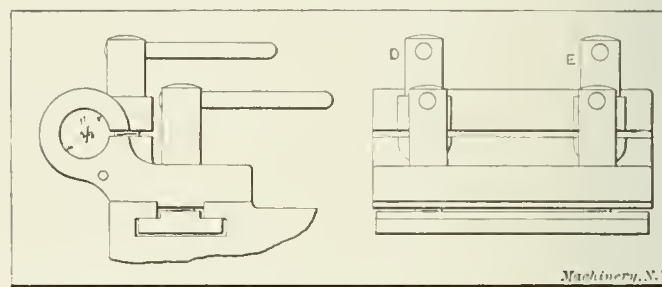
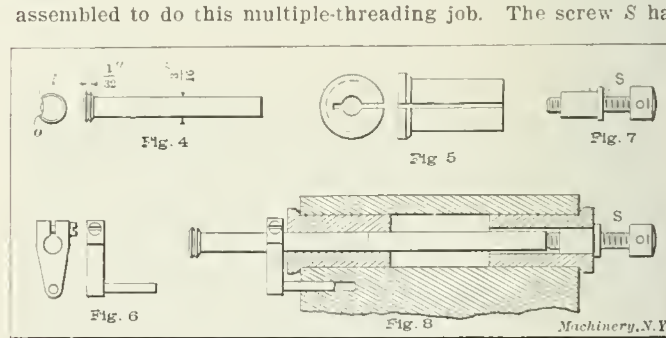


Fig. 3. Boring-tool Holder utilized in Cutting the Octuple Thread

and is held in the boring-tool holder by one of the split bushings, the cutting lip i being used for internal threading, and the lip o for outside work. As the shank or stem of this tool is at the same height as the lathe centers, it has to be set with its cutting lip below the center to give the necessary clearance, and this somewhat distorts the shape of the thread from its 60-degree form, but not enough to be injurious.

Fig. 6 was made to be clamped on a threading tool like Fig. 4 for boring and threading alternately, so as to avoid adjusting the thread tool for height each time it was placed in its holder; it proved very useful on the present job, as it enabled the thread tool to be fed out of its holder without rotating.

Fig. 8 is a sectional view through the boring-tool holder as assembled to do this multiple-threading job. The screw S has



Figs. 4 to 7. Component Parts of Threading Device. Fig. 8. Assembled View of Threading Device

32 threads per inch, and was cut with a single-point tool in order to get a more accurate lead than if cut with a die, although a die was used to bring it to size. Its head has a single hole drilled crosswise, and one side of the head is marked with a file nick, as shown in Figs. 7 and 8. As the lathe was geared to cut four threads per inch, the tool would cut two of the threads, and after these were cut to depth, the clamping screw D, Fig. 3, was slightly loosened, the screw

S given two complete turns, which pushed the tool 1/16 inch further out of the holder. The screw *D* was then tightened, and two more threads were cut. By repeating this operation, all the eight threads could be cut.

It was originally intended to use this method, but when the job was actually under way it was decided to move the tool out 1/32 inch each time, as it would then leave the work in a little smoother condition. If fed out 1/16 inch each time, every other thread would have a burr left on it.

The method of giving *S* one exact turn was to put a wire through the hole in its head and use this as a lever by which to turn it until the wire came in contact with the edge of the top slide dovetail of the slide rest, the file nick in the screw head being a check against giving it ½ or 1½ turn. Thanks are due to Mr. Donald Walters for suggesting the edge of the slide rest itself as a stop for the lever used to turn the screw; the original plan was to fasten a straightedge to the top of the boring-tool holder and let it project over the right-hand end of the holder. WALTER GRIBBEN

Brooklyn, N. Y

COMPOUND BENDING DIE

The illustrations Figs. 2 and 3 show plan, end and side elevations of a die for making the two bends in the piece

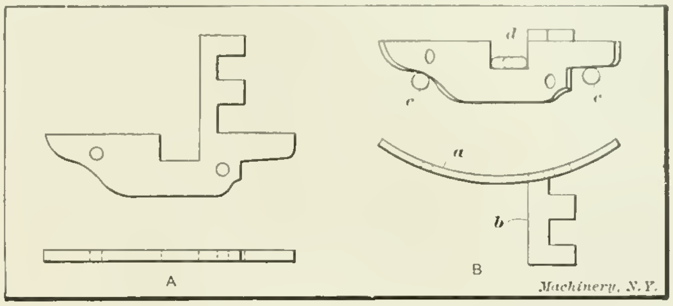


Fig. 1. Blank before and after the Bending Operation

shown at *B*, Fig. 1, the shape of the blank previous to bending being shown at *A*. The die-bolster *A* (Figs. 2 and 3), made

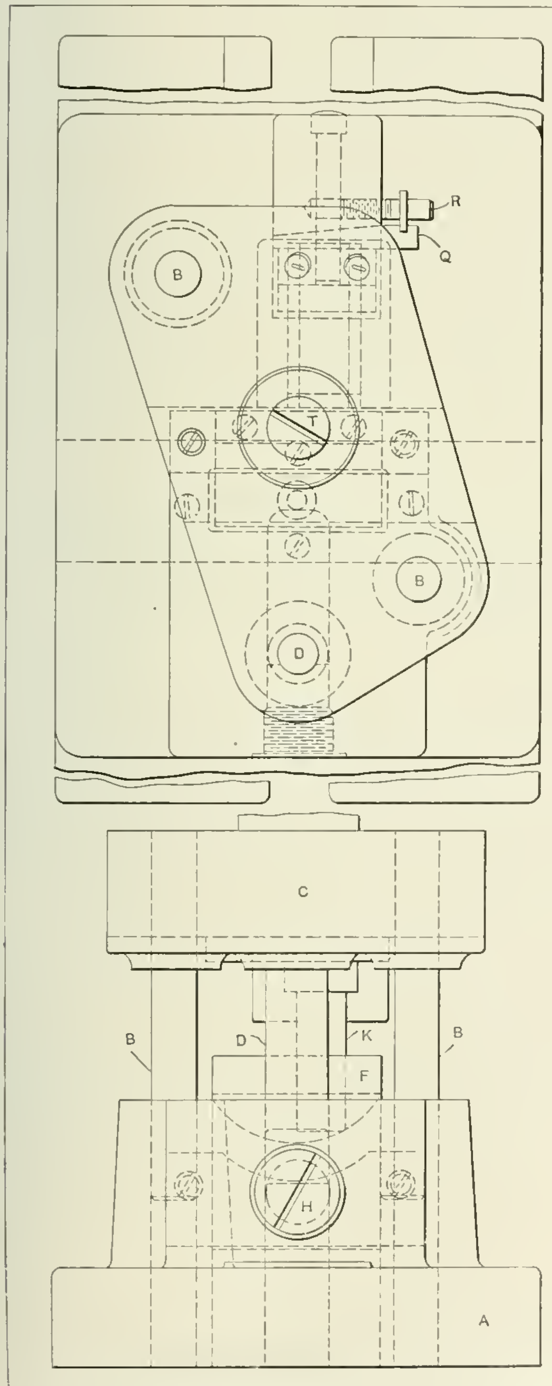


Fig. 2. Plan View and Elevation of Compound Forming Die

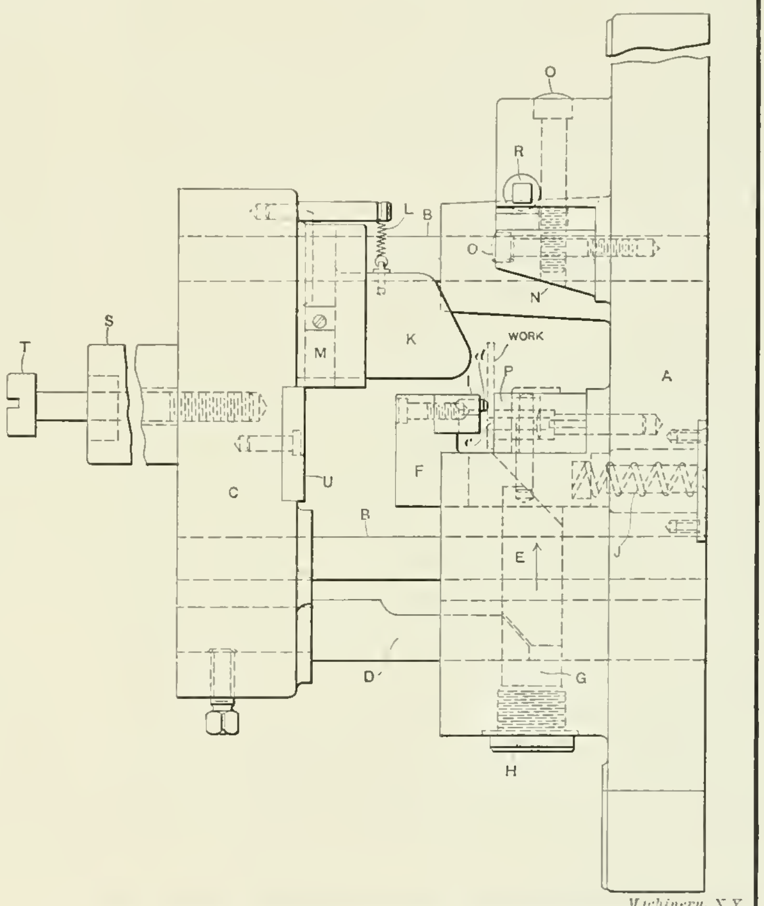


Fig. 3. Side View showing how the Work is located and formed

of cast iron, is bored out to receive the two guide-rods *B*, which are made a sliding fit in the die-holder *A*. It will be noticed that the bosses on the die-holder *A* are made large, sufficient material having been left so that they could be bored for bushings. However, in this case the bushings are not required, and the writer has found that in the majority of cases it is not necessary to bush the die-holder, especially when the dies are not in constant use.

The stud or cam *D* held in the punch-holder presses on a block *E*, which, in turn, operates the bending-die holder *F*. A hardened block *G*, of the same size as *E*, is held by a screw *H*, in the die-bolster to take the thrust of the stud *D*. The stud *D* is made with a 45-degree angle; all of these parts are made of machine steel and casehardened. The movable member *F* or die-holder, carries the die *I*, which, after the bending operations are completed, is returned to its normal position by the spring *J*, held in the bolster. The bend *a*, Fig. 1, is performed with the die *I*, while the bend *b* is made with the punch *K*, which is held to the upper member. This punch *K*

slides in a slot cut in the upper member, and is retained by a spring L against the stop M, when in its normal position.

In operation, the piece to be bent is located in the lower die P in the manner shown at B in Fig. 1, being placed against two pins c, held in the lower die. The blank is also additionally supported when the dies come together, by a pin d held in the die I. This pin is so shaped that it fits the slot and locates the blank properly. When the blank is located in the die P, the punch-holder descends, and the die I makes the circular bend a, which is accomplished by the stud D forcing the block E in the direction indicated, thus drawing down the member F, holding the bending die I. When the stud D has descended 7/16 inch, the holder F comes to rest, so that the blank is held firmly when the punch K acts on it. The punch K then comes in contact with the blank and the adjustable block N. The block N is tapered as shown, and deflects the punch K inward, so that it slides in the punch-holder, and in its descent bends the blank at right angles. The block N is held to the die-bolster A by means of three screws O, and is adjusted inward by a tapered gib Q operated on by a screw R. Having the block N adjustable in this manner makes provision for the blank to be bent to such shape that after the punch retreats it will spring back to the angle desired. The shank S is held to the punch-holder C by a screw T. A hardened block U held to the punch-holder C comes in contact with the holder F, and gives the final blow to the blank.

B. P. Fortin

Hartford, Conn.

THE USE AND ABUSE OF GRINDING MACHINES

At the present time when makers of grinding machines and of grinding wheels are trying to show to the world what work can be done by them, it may be interesting to some to know the treatment that the machines get. The following is an incident of how a machine, called by its makers a "No. 1 universal grinder," was abused. When the machine arrived at the works to be erected, the foreman who was to have charge of erecting it, as soon as the case was opened took out the blueprint showing how to set up the machine and also the book of instructions. The machine was then unpacked and the place where it should be erected was decided on. The foreman got a man to erect the machine and countershaft, but did not give him either the blueprint or the book of instructions. However, the man got the belts on and the machine ready to start.

Some time after it was set up, a foreman from another room, in passing, started the machine, and was delighted with the speed at which the grinder was running. It was not long before he had a chuck made, and a boy was set to work polishing disks on it, which could easily have been done on a polishing or buffing wheel.

After two months of this work, another man came along and thought he would use the machine for what the makers had intended it, *viz.*, the grinding of hardened steel pivots and a mild steel mandrel, with the wheel that had been sent with the machine. He was not satisfied with the results, and wrote to the makers stating what he was doing, and asked for their advice. A courteous reply was received, stating what wheels were best to use for certain classes of work, and also a copy of their book of instructions. They also stated that they had put a copy of the book of instructions in the case with the machine. This man then asked the foreman why he had kept the book and not placed it with the machine, when he was very bluntly told that nobody wanted to see it, and the best way to use the machine was to find out. This man then thought that he would ask the firm's works manager to get him the wheels which the makers had recommended, and here again he was put off with a blunt answer, and was quickly asked what he knew about grinding wheels, and where he obtained his information; he was also reminded that he had better leave such matters to the office, and use the wheels provided.

Among the work tried out on this machine and said to be a failure were piston rods for air pumps. These rods varied in length from about 8 to 14 inches and ¾ to 1½ inch in diameter. When these were tried out, no steady-rests of any kind were put on the machine, and no water was used, so it is evident that they would spring from the center, and, of course, not be parallel. Another job for the machine was some hardened steel cones. Now the taper on these cones could not be obtained by the swivel table, and it never occurred to the operator to set over the wheel-bed, so he drilled more holes in the table, and set the swiveling table over. This is how the cones were ground—with the swivel table hanging half off.

This machine has now been set up for over ten years, and in that time the belt from the countershaft to the wheel spindle has been broken a number of times, and to-day there are upwards of eight belt fasteners in it, whereas for good work one is sufficient. One day a man was sent to the machine who had never seen it before; he ran the table into the wheel when it was going at full speed and the way that wheel flew to pieces was marvelous. One of the pieces left its imprint in a wall eight yards away.

The other machine which the writer saw abused was a No. 2 surface grinder, manufactured by the same company. This machine is not as old as the other, but has had a lively life of it. The countershaft is set at right angles to the main shaft, and its belt is forever breaking, coming off the pulleys and giving an endless amount of trouble. After the machine was set up, a magnetic chuck was obtained for it, and as the other machine had a water tank and pump on it that was never used, it was removed and placed on the surface grinder. The base of the machine after the water tank was applied was flooded with water, and sawdust was used to dry it, which gave the machine the appearance of having been used in a sawmill. After the magnetic chuck had been flooded a number of times, one of the coils burned out, so it was removed and it is now only a matter of time before the whole chuck will be put out of business.

The writer once asked to have charge of these machines, but was told that the work he was doing paid them better than if he did the grinding, and that they were going to keep someone on the machine when they got plenty of work to do. That was over eight years ago, but nothing has been done since, so we simply go on in the old sweet way.

England

BENDING COPPER EYES FOR WIRE SLINGS

Fig. 1 shows a neat bending device for making the copper eye shown in Fig. 2. Fig. 3 shows the tube of special design used for its production. The eye as shown in Fig. 2 is ready to be applied to the sling. These slings are made of fine brass wire, a loop being left in each end for the copper eye.

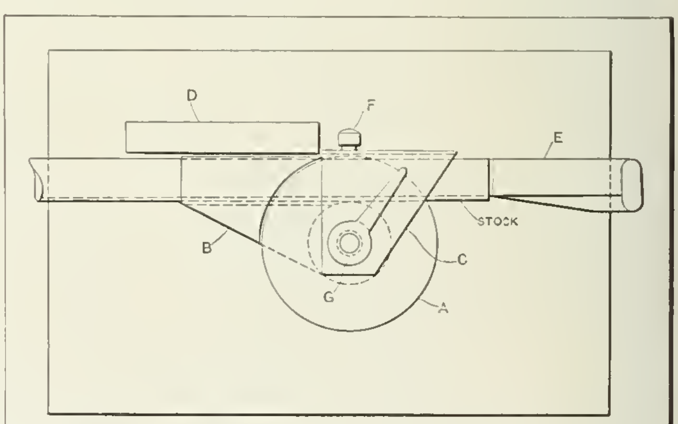


Fig. 1. Device for Bending Copper Eyes for Wire Slings

Fig. 4 shows the various details that enter into the making of this jig; the lettering throughout all these figures is the same. A sheaf A, split in the plane of rotation as indicated, has a grooved diameter equal to the inside diameter of the

eye, the groove being of the same section. This sheaf is attached to a table. A piece *B*, made of the form shown, has the angle of taper *b*, the shape of the enclosed triangle corresponding to the inside section of the eye. *C* is a piece of angle-iron with a ⅜-inch web arranged in the piece as shown in Fig. 1. A stop *D* is so arranged as to just allow clearance for the eye stock to pass between it and the sheaf. When equidistantly located each side of the center line, the chain or mandrel *E*, which is inserted inside the eye stock, is tightened down by the set-screw *F* in the angle-iron piece *C*, before mentioned. By twisting the flexible mandrel *E* around until it comes in line with the other side of the part *B*, the eye will be formed, the eye stock being twisted symmetrically about

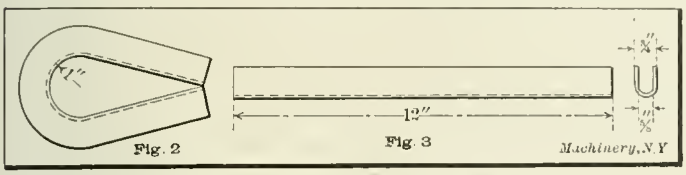


Fig. 2. Finished Copper Eye Fig. 3. Copper-Eye Stock

the sheaf, as it is secured by the set-screw *F*. By loosening set-screw *E* and removing the nut *G*, the upper half of the sheaf may be taken off permitting the removal of the copper eye.

The method of making this flexible mandrel *E* is important, as it is principally because of its construction that this method of producing the eye is possible. The manner in which the parts are made is indicated at *H* in Fig. 4. Pieces such as are shown by the heavy lines are blanked out, their size being such that when arranged in a circle as shown and bored out, they will reduce in inside diameter to the diameter at the bottom of the sheaf indicated by the light lines. In order that they may be turned in this position, two circular layers of

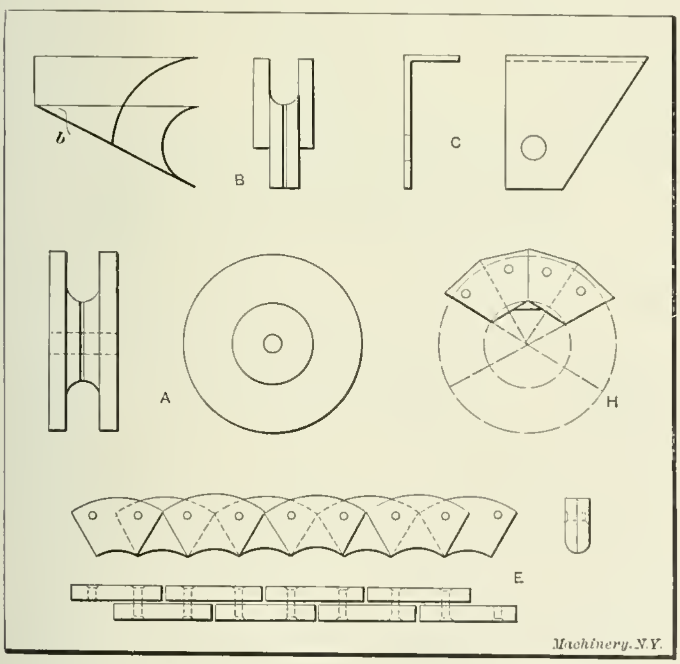


Fig. 4. Details of Bending Device and Method of Construction

these lengths are arranged as indicated and are soldered together in that position; they are then placed in the lathe and turned down as desired, forming a cross-section of ring, as indicated to the right at *E*, Fig. 4. The ring may then be removed, heated and the solder scraped off after which the joint-holes may be drilled. These joint-holes are located near the outside of the chain in order to allow free action with no binding at the corners.

Before this tool was designed the making of these copper eyes was an expensive proposition. Many unsuccessful attempts were made to produce a tool that would do the job, but none of them gave satisfactory results until this one was tried out. As will be seen from the foregoing description it is very simple and requires no skill on the part of the operator.

J. A. Whitcomb

Kenosha, Wis.

THE FIELD FOR GRINDING—A COMMENT

Having read with much interest the article entitled, "The Field for Grinding," by Mr. C. H. Norton, in the January number of Machinery, engineering edition, and "Rough Turning vs. Rough Grinding of Crankshaft Pins," by Mr. H. C. Pierle, in the March number, engineering edition, the writer feels that a few words on the points brought out by these enthusiasts in their different lines may be of interest at this time when coming from a layman and not a manufacturer.

Mr. Norton is well known as a pioneer in his field, and if it were not for the optimism displayed by men of his type the manufacture of machine parts by modern methods would never have made the great strides that it has during the past few years. The writer's experience in the machinery field leads him to believe that the results claimed by such enthusiasts have been actually obtained, although doubtless many will not agree with this statement. However, practical experience would seem to prove that the results must have been obtained under ideal conditions and not under those found in the every-day routine work of commercial manufacturing.

It is only necessary to look at other branches of the trade to see that this fact holds true. One of the best examples, and one with which even the smallest shops are acquainted, is the great result claimed by the makers of certain grades of high-speed steel. But how many can get the results claimed day after day? Very few. In several places in which the writer has worked it has been the same story: "Well, so-and-so gets certain results; why can't we?"

This same trouble obtains in other branches of the trade, and not long ago an instance came under observation which will serve as a good illustration. A salesman was trying to sell a certain well-known make of turret lathe, and from the argument, figures and estimates presented, he seemed to make a good impression upon the superintendent of the factory, who answered, "Yes, I know what you claim can be done, for we have one of your machines on which we accomplished wonderful things, but with only one man who is not with us now. If you will obtain an operator who can produce the results claimed I will be in a position to place an order for the second machine before the manager." Not having seen the second machine it must be taken for granted that the salesman was unable to find the operator.

Mr. Norton's claims for rough grinding of crankshafts cannot be looked upon as impossibilities, for in his own factory where he has every facility for doing this special class of work, and men properly trained to produce great results, it is possible to accomplish what would seem incredible to a skeptic. The same operator, however, who in Mr. Norton's factory produced the seemingly impossible results, if put in another factory and required to keep up this rate week after week, would soon tire of the job, as in most cases he is only required to obtain such results before a prospective customer or visitor.

Mr. Pierle's article appeals to the writer as being nearer the methods of manufacturing that should be employed in the commercial manufacture of crankshafts. He fully enumerates the disadvantages of grinding a drop-forging, and agrees with Mr. Norton as regards rough turning. There is a point here that should be mentioned: the average lathe-hand seems to think that because he is only roughing out, there is never going to be a finish, and a carelessness develops amongst them exemplified by the deep gouges often produced in their work, which afterward cannot be removed by the grinders. A careful supervision therefore, is still required in the lathe department, even though it is only rough turning that is being done.

Labor cost on grinders is an item in which there is a great deal of variance among shops. In small shops where there are only one or two grinders, wages are, as a rule, high on this class of work; but in larger factories where there are dozens of these machines, they will be found to be operated very efficiently by apprentices. The General Electric Co. in Lynn employs upon the finest grade of work apprentices at a low

rate per hour, which proves that it is the supervision given the department and not the high wages paid that makes for results. Grinders are often put in charge of men who are lathe specialists and depend on high-priced help for results, whereas if they had the proper training they would be in a position to train good handy men to produce the required results. This type of man is found in nearly every shop and takes pride in his work, in most cases staying with a firm longer than will a machinist. JOHN F. WINCHESTER

Brooklyn, N. Y.

COMPOUND TRIMMING DIE FOR DROP FORGINGS

A compound trimming die which has been found useful for trimming the flash from drop forgings, and also for piercing holes in them, is shown in the accompanying illustration. This die is used for trimming the piece shown, and also punching the hole *a*, and shearing the parts *b* shown by the dotted lines. Previous to the adoption of this type of trimming die, the ordinary trimming die was used, in which the flash only was trimmed off, so that if the forging required to have a hole pierced in it, this operation had to be done in another die. This, as can be seen, would increase the cost of the product considerably.

In using the die shown in the illustration, it is customary when holes are to be pierced in the blank to make the drop-forging die of such shape that the hole in the part will be partly formed, leaving only a small internal web to punch out. The perspective view, Fig. 1, shows the general construction of this die, while the cross-sectional view, Fig. 2, shows more clearly the method of applying the stripper-

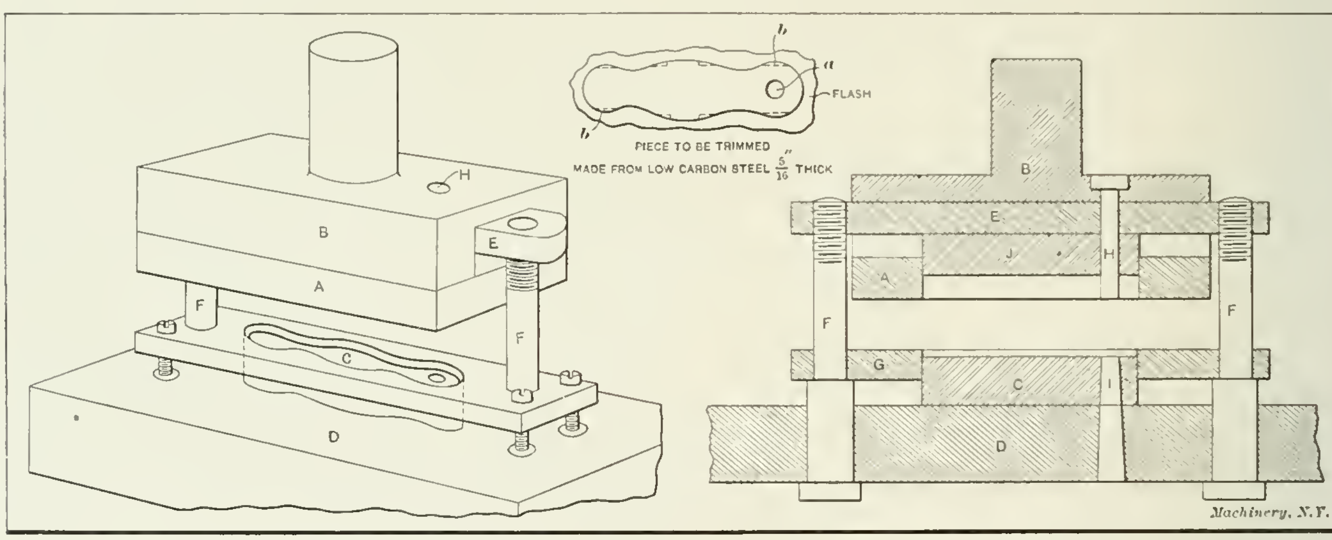


Fig. 1. Perspective of the Compound Trimming Punch and Die

Fig. 2. Sectional View showing Method of Applying Stripper-plates to the Punch and Die

plates to the punch and die, and also the piercing punch and guide pins. The die *A* is fastened to the punch-holder *B*, while the punch *C* is fastened to the die-holster *D*. The member *B* which holds the die is grooved for the reception of a strip *E* into which are screwed the bolts *F*. These bolts, as shown, pass through the die-block *D* and operate the strap *E* to which the stripper *J* is held.

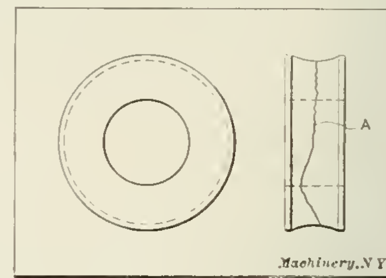
In operation, the blank is placed on the plate *G* which acts as a stripper for the punch *C*. Then as the ram of the press descends the stripper *G* descends out of the way, while the punch *C* forces the piece up into the die *A*, removing the flash. At the same time the punch *H* pierces the hole *a* in the piece. A hole *I* is provided in the punch *C* to allow the trimmings to fall through the die-bolster. When the ram of the press ascends the bolts *F* lift the stripper *G*, and pull down the stripper *J*, which clears the die. This die is set in an inclined press, so that the work and scrap drop out as soon as the ram ascends. C. H. WILCOX

Springfield, Mass.

AN ODD EXPERIENCE IN HARDENING ROLLERS

Many stories have been told of strange things happening in the "oil country;" but perhaps the following account of Vernie's experience in hardening rollers will convince the skeptical that not all the mysteries are confined to that section of the country.

Vernie was getting his first experience in hardening, and indeed was having such marked success that he began to believe himself to be nearing the point where he would be considered a professional hardener, until he tackled the job of hardening a set of rollers, such as that shown in the illustration. Now really, these rollers were very innocent-looking specimens, and no trouble was looked for in hardening; but alas! the unexpected happened, which crushed Vernie's hopes very nearly to the ground. The sad and doleful rehearsal of the facts are as follows:



Rolls subject to Mysterious Cracking

The first pair of rollers was heated and immersed in the bath, but upon removing the second one a crack was noticed as shown at *A*. A little encouragement lifted the drooping spirits of the hardener sufficiently to induce him to harden a third roller, made to replace the broken one, which after hardening, was delivered to the diemaker's bench. Not having occasion to use the roller immediately it was not examined until the following day, when it was found to have a crack similar to the former one. When this was brought to Vernie's attention, he declared the roller to have been free from cracks when it was placed upon the bench, and to determine the truth about the matter the whole tool-room force was called together in a council of war, and after thorough investigation, the following facts and conclusions were settled upon.

1. The roller was sound when delivered;
2. It had lain on the bench nearly 24 hours without being touched;
3. The sun had been shining and cast its direct rays on the bench where the roller lay for a considerable part of the afternoon; and
4. The roller now had a crack.

Conclusion: The heat of the sun must have warped the roller, causing it to crack.

Everyone being satisfied with the conclusion, another roller was made and Vernie was carefully instructed not to allow it to lie around in the sunshine after hardening.

With much fear and trembling this roller was hardened and upon examination it appeared to be perfectly sound,

though caution decreed that a further examination should take place after several hours had elapsed. But mischief was loose, for as soon as the unfortunate hardener turned his back, the sound roller was replaced by the cracked one. Several hours afterward when Vernie came back to inspect the roller —horror of horrors—cracked again; he could hardly believe his eyes; surely the sun had not shown upon this roller. With pallid face, shaking knees, and quivering hand, the humiliated Vernie presented the difficulty to the foreman.

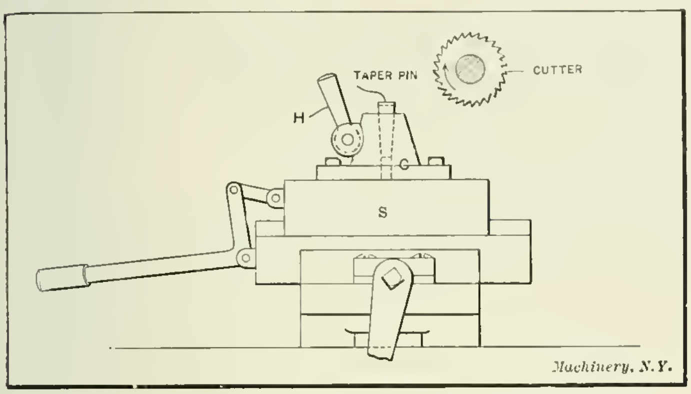
When Vernie confidentially told the diemaker that this "doggoned" roller was cracked again, it was suggested that possibly he had picked up the wrong roller, and the evident amusement in the eyes of the "boys" suggested the secret. To report to the foreman that he had been made the victim of a joke, though offering a measure of relief to his troubled spirit, was Vernie's second humiliation.

Let it be said in fairness to Vernie, that since this experience he has had no difficulty in hardening rollers.

E. J. P.

A MAKESHIFT SLOTTING JIG FOR THE MILLER

At one time we had an order for 600 No. 7 taper pins, which were required to have a slot ⅛ inch deep by ⅛ inch wide, cut through the large end. These pins were waiting



Makeshift Device used for Slotting Taper Pins

their turn to be slotted in a screw slotter, when a call came in to have them done at once. It was therefore evident that something had to be done. The work in the screw slotter could not be stopped, so it was up to the writer to devise a makeshift; the device is shown in the accompanying illustration.

This fixture consisted of a casting *C* which was faced top and bottom and reamed to fit the taper pins. It was slotted, drilled, and tapped, and fitted with a binding screw actuated by the lever *H*. An ordinary vise was then clamped to the platen of the milling machine, and the jaws opened to receive the tool-slide *S* of a hand-lathe. With this simple device it was a very easy matter to slot the pins, and before night the order was finished.

It might appear to some that this fixture *C* would have worked better if clamped directly to the platen, instead of being fastened to the tool-slide *S*; but this was not the case, as the quick-acting slide had a distinct advantage over the more laborious screw feed of the miller.

Middletown, N. Y. DONALD A. HAMPSON

SOLUTION FOR CLEARING BLUEPRINTS

The color of a blueprint can be greatly improved by adding a small amount of bichromate of soda to the water in which it is washed; about one-half teaspoonful to one quart of water is sufficient. When blueprints are rinsed in this solution the high lights come out much whiter and the background much darker, thus making a sharper and clearer print. This adds greatly to the value of the print, as one of the chief defects of a blueprint is that it is generally "mealy-looking," lacking contrast.

Pittsburg, Pa. HOWARD M. NICHOLS

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

BABBITTING BOXES—SPLIT PULLEY HUBS

J. P.—Will some one of MACHINERY'S readers give a quick method of babbitting common boxes, pillow blocks, chain and ring oiling boxes? I would like to know what kinds of jigs the leading makers of these boxes use.

J. P.—Where can I get the proper proportions for split pulley hubs? I notice that some pulley manufacturers make split hubs lighter than the solid hubs for the same size of pulley and shafts.

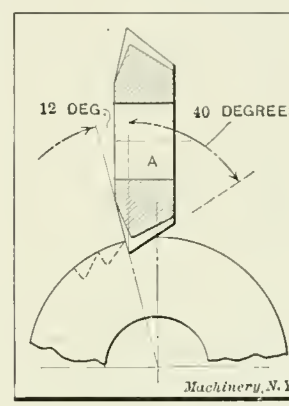
RELIEVING A WORM-GEAR HOB

R. H.—How should a worm-gear hob be relieved?

A.—The common method of relieving a hob for cutting the teeth in a worm-gear is by means of a relieving attachment in a lathe. The relief is obtained in the same manner as for a formed tooth milling cutter, but it is, of course, necessary to relieve the bottom and sides of the teeth by the regular worm-thread cutting tool, and then the top of the thread of the worm by another flat-nosed tool. Detailed instructions for making hobs for worm-gears are given in MACHINERY'S Reference Book No. 1, Chapter II.

FLUTING SPIRAL MILLS

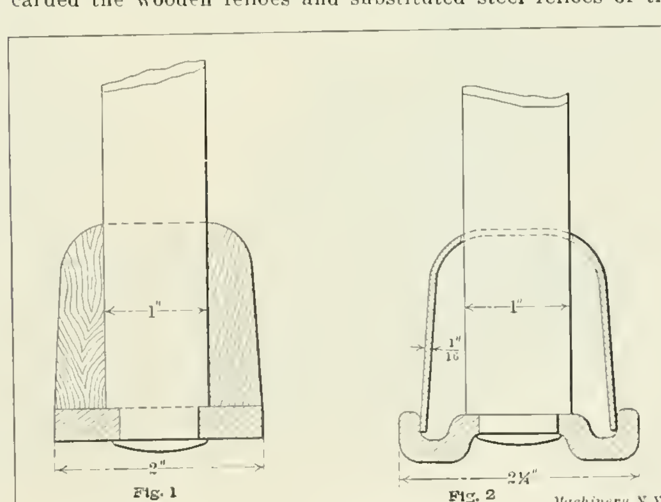
R. H.—What is the quickest and simplest method for setting a milling cutter for cutting the teeth in a spirally fluted milling cutter? The fluting cutter used is of the ordinary double-angle type, with a 12-degree angle on that side which cuts the radial face of the tooth in the cutter to be fluted, as shown in the accompanying line engraving, where *A* is the double-angle fluting cutter having an angle of 12 degrees on one side and 40 degrees on the other, this being the standard form.



A.—Submitted to the readers.

ROLLING RIMS AND FELLOES OF WHEELS

J. G. & Co.—We are about to undertake the manufacture of an all-steel wheel for agricultural machines in Russia and wish to obtain machinery suitable for rolling the felloe and tire shown in Fig. 2. Fig. 1 shows the original wheel made with steel spokes and steel tires but wooden felloes. We have discarded the wooden felloes and substituted steel felloes of the



same shape. Any suggestions that you can make regarding the machinery and methods to be followed in rolling and assembling this wheel will be much appreciated.

A.—The problem is submitted to the readers. A first-class contribution on the making of all-steel wheels of this or similar shape would be acceptable.

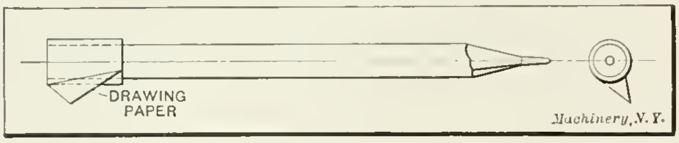
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO KEEP PENCILS FROM ROLLING

To keep pencils from rolling off the board the method indicated in the accompanying illustration has proved very satisfactory. This consists in wrapping a piece of pasted drawing

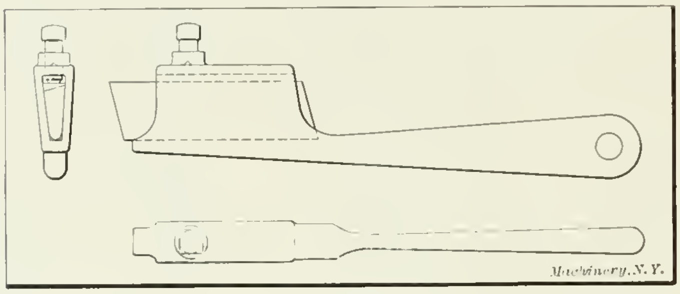


paper around the end, bending up one corner so that it forms a fin. The fin acts as a stop and keeps the pencil from rolling. BENJ. BROWNSTEIN

Ellwood City, Pa.

TOOL-HOLDER FOR GRINDING SHORT TOOLS

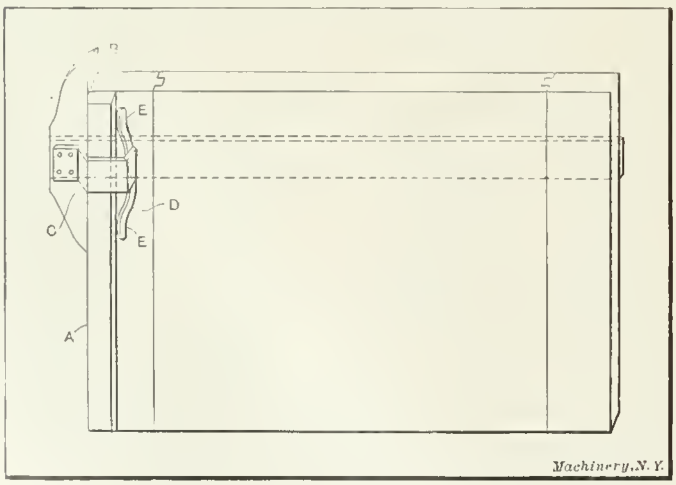
In the town where the writer is located, V-section tools are used to a considerable extent for lathe, planer and slotting tools, in specially designed holders. These V-section tools vary in length from 4 to 6 inches, according to the strength of the section, and it is obvious that unless some means of holding these tools when grinding is provided, the full value or use-



fulness of the tool cannot be obtained each time it is ground. The tool becomes shorter after each grinding, and therefore more awkward to hold by the hand. The accompanying illustration shows a holder that was found very satisfactory for the purpose; it is made of cast steel with a slot cored through to receive the tools which are held in position by the set-screw on top of the holder as shown. P. H.

ATTACHMENT FOR THE T-SQUARE

A device that can be attached to a T-square and that will keep the head up against the drawing-board at all times, is shown in the accompanying engraving. *A* is a piece of wood which is screwed on the under side of the board parallel to

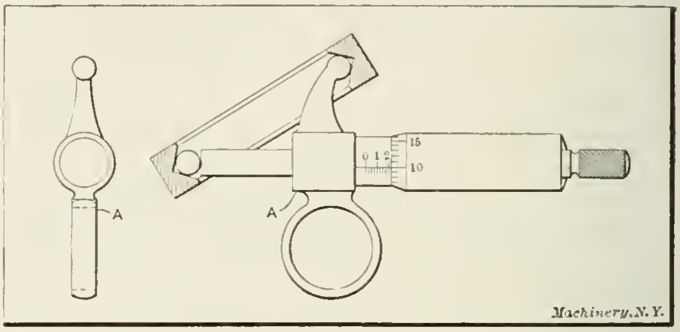


the edge *B*. A piece of sheet metal, bent to the shape *C* with a spring *D* secured to it as shown, is screwed to the under side of the T-square. It is then ready for use.

In operation, the two feet, which are curved at *E* so as not to cut into the wood, bear on the right side of the guide *A*, and the spring keeps the T-square head tight against the left side of the board and relieves the draftsman of the necessity of keeping his left hand on the T-square. This attachment has the additional advantage of preventing the T-square from being knocked to the floor and damaged. F. M.

BALL-RACE GAGE

The accompanying illustration shows a ball-race gage which the readers of MACHINERY will probably find of interest. The main feature is the addition of the machine-steel piece *A* to the ordinary micrometer head. It is made a tight fit, and forced over the micrometer barrel. On the tip of the projecting arm of piece *A*, and of the micrometer stem, ¼-inch steel balls are soft-soldered, as indicated. In use, the posi-

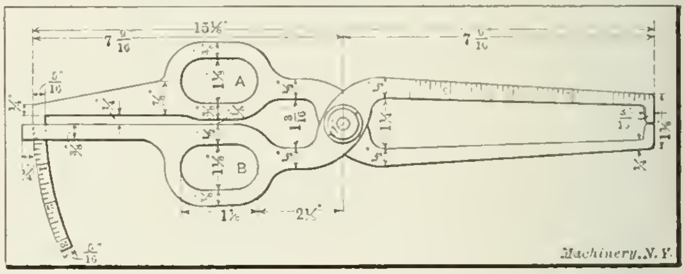


tion of the balls is set by adjusting to an outside micrometer. The reading on the barrel of the gage in this position is noted, and the ball races machined to conform to this reading. The finger-ring on the attachment furnishes a convenient means for holding the micrometer. DAVID MELVILLE

Detroit, Mich.

A COMBINATION CALIPER

The accompanying illustration shows a combination caliper for measuring the interior and exterior of small cored castings, thus enabling one to determine the thickness of the metal and the depth of the core, and also the amount of its eccentricity, if this be necessary. The main feature of this caliper is that it

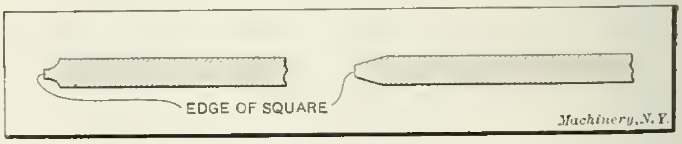


can be seen at a glance by referring to the caliper graduations what the measurements are, thus obviating the necessity of using a scale in connection with the calipers to obtain the desired measurement. This caliper is so constructed that the operator can hold it with one hand by placing his fingers in the holes *A* and *B* in each of the legs, and can hold the casting with the other, which in some cases is a material advantage.

Bordentown, N. J. EDWARD C. CONLIN

ELIMINATION OF DUST FROM SET-SQUARE EDGES

The method of fixing the edges of a set-square, indicated in the engraving, has been found to be very effective in eliminat-



ing the dirt nuisance on drawings. This treatment of the edges raises the ruling edge against which the pen works, from the tracing, so that the dust on the tracing does not come in contact with it, and hence no blots or ragged lines are formed. BENJ. BROWNSTEIN

Ellwood City, Pa.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

ROCKFORD HORIZONTAL BORING MACHINES

The Rockford Drilling Machine Co., Rockford, Ill., has added to its line of drilling and boring machinery the No. 2 horizontal boring machine illustrated in Fig. 1. The boring-bar and saddle of this machine are vertically adjustable on the column, and the latter has a transverse adjustment on the dovetailed ways of the bed, as shown. Instead of having a rack and pinion to traverse the column, a screw and hand-wheel is employed as the illustration shows. The screw is double-threaded, giving a quick movement to the column, and its application in place of a rack and pinion makes it possible to easily apply power feed for the transverse movement, if necessary.

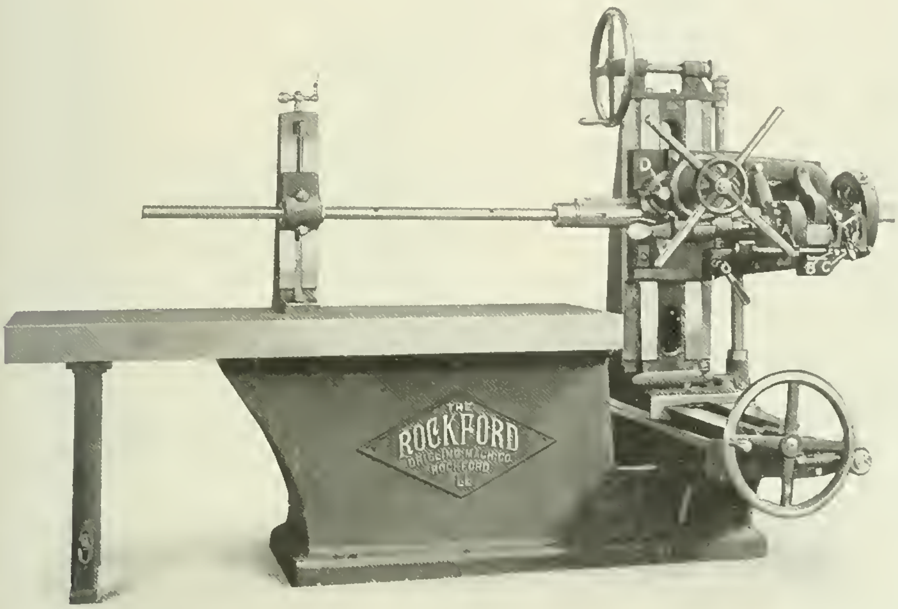


Fig. 1. Rockford No. 2 Horizontal Boring Machine

The table of this machine is solidly supported by the bed, and the projecting end is provided with a bracket to prevent any possibility of springing. This machine is driven by a belt, operating on a four-step back-geared cone, giving eight speed changes. The power is transmitted through bevel gears to a vertical shaft, which connects by bevel gears with an intermediate shaft carrying a pinion that meshes with the large spur gear seen near the end of the boring-bar.

A positive geared feed is used, similar in principle to the feeding mechanism illustrated in the June number, applied to a Rockford 26-inch upright drill, but the construction is somewhat different. The feeding movement is taken from the spindle and it is transmitted to the worm-gearing shown through a gear-box located at the right of the saddle. This box contains a cone of four gears and a tumbler gear mechanism operated by lever *C*. When a change of feed is desired, lever *C* is lowered and the cone of gears is shifted axially by handle *B*, which also moves the tumbler lever index-plate. Lever *C* is then raised and latched, thus bringing the tumbler gears into proper mesh. In this way four feed changes are obtained and this number is doubled by two sliding gears at the left which make connection with the worm driving shaft and are shifted by knob *A*. The amount of feed in thousandths of an inch per revolution of the spindle is shown for different positions of the feed change gears by a pointer and suitable figures. The large star handle is used for traversing the spindle rapidly in or out.

The feeding mechanism has a simple but effective automatic tripping device at *D* for disengaging the feed at any predetermined point. On the threaded hub of the spur gear shown, which is mounted on the pinion feeding shaft, there is a stop-nut which advances toward the face of the gear when the spindle is feeding. Passing through this stop-nut there is an adjustable screw, and when this screw strikes the face of the gear, a lug on the lower part of the stop-nut disengages the trip handle and causes the feeding worm to drop down out of mesh. The principal feature of this stop is that while its range covers the full travel of the sleeve, it operates without the use of trip dogs on the sleeve.

A modification of the machine illustrated in Fig. 1 is shown in Fig. 2. This is a double-ended type that is particularly adapted for boring the crankshaft bearings of gasoline engines of the type now used extensively on farms or for domestic power purposes. The illustration shows a small gas engine cylinder and bed in position for boring the crankshaft bearings. The two boring-heads or columns of this machine are rigidly held together by a tie-bar extending across the top from one to the other. The heads are not adjustable on the bed, as with the single-ended type, there being simply a vertical adjustment for the saddle. The boring-bars are

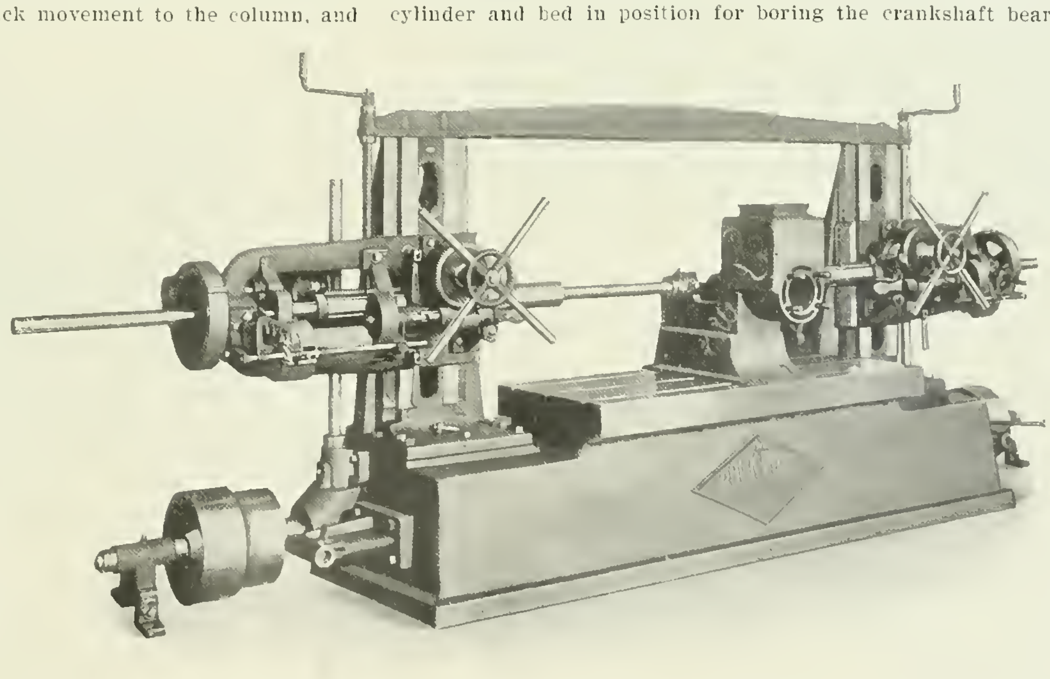


Fig. 2. Double-ended Rockford Boring Machine

accurately located vertically for boring the bearings of different sized engines, by special index-plates that are attached to the saddles. These plates, one of which is shown to the right, contain a number of holes and there is a second series of holes in the column so that the saddles can be positively located by the insertion of accurately fitted plugs.

Some engine cylinders require tapping operations on the upper part of the casting, and for work of this kind a regular sliding-head drill press, with the arm and the table omitted, is placed at the rear of the machine, as shown in Fig. 3. The base of the drill press projects beneath the base of the horizontal machine, and a rotary table can be placed upon the table of the horizontal machine for holding the jig containing the gas engine casting. The spindle of the drill press is equipped with a geared tapper, as the illustration shows. In some cases instead of placing an upright drill press at the rear of the horizontal machine, a regular gang drill head of suitable size is mounted on a sub-base which forms a part of the base of the horizontal machine.

The saddles and feeding mechanism of these double-ended machines are similar to the single-ended type. The drive, however, is slightly changed, there being a two-step back-geared cone with a six-inch belt width, instead of a four-step cone, to obtain the extra power required for gas engine work. With this arrangement, eight driving speeds are obtained by the use of a two-speed countershaft. The table of the machines illustrated is 72 inches long by 24 inches wide, but these dimensions can be varied to suit individual requirements.

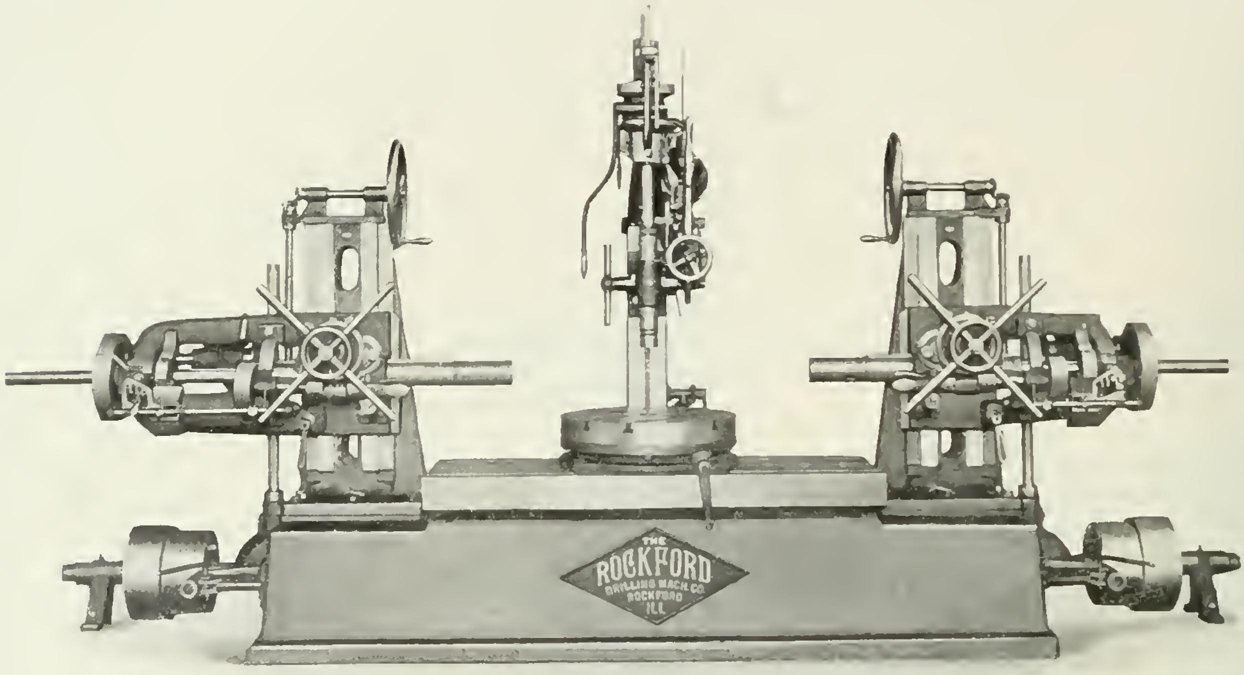


Fig. 3. Boring Machine with Drill Press for Drilling and Tapping Operations

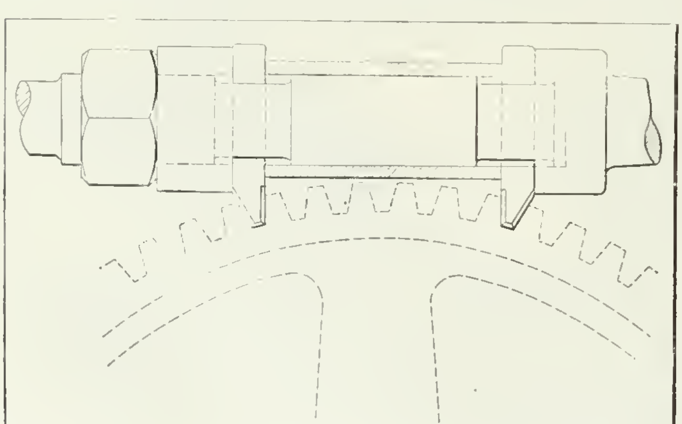


Fig. 1. Showing Double Fly-cutter used for Cutting Teeth in Hindley Worm-wheels on S. & S. Hobbing Machine

CUTTING HINDLEY WORM-GEARING ON S. & S. GEAR-HOBBING MACHINE

An interesting experiment has recently been performed on the Schuchardt & Schutte gear-hobbing machine to determine the adaptability of this machine for producing Hindley worm-gearing, and the results are said to be very satisfactory. As will be recalled by those familiar with this machine, the work-table is adjustable horizontally along the bed, and the slide carrying the hob moves vertically on the ways of an upright column. When turning a Hindley worm, the blank is fastened to the hob arbor in place of the hob ordinarily used for cutting spur, worm or spiral gears, and the threads of the worm are formed by a single-point form tool that is clamped on the rotating work-table. During this turning or threading operation, the table is slowly fed toward the worm blank just as it would be for hobbing ordinary worm-gears.

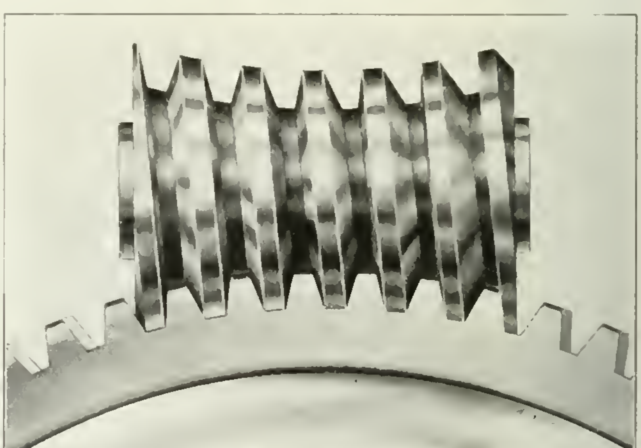


Fig. 2. Typical Hindley Worm and Worm-wheel cut on S. & S. Hobbing Machine

It will be seen that the tool is given a circular movement about a center which corresponds to that of the axis of the worm-wheel. The distance from the tool point to the center of the table is approximately equivalent to the radius of the worm-wheel, and the cutting edge of the tool lies in the same plane as the axis of the worm. The tool and worm blank are geared to rotate in the required ratio, the regular change gears of the machine being used. The tool is given a circular movement equal to the circular pitch of the wheel for each revolution of the worm blank. As the longitudinal curvature of a Hindley worm depends on the diameter of the

particular wheel for which it is intended, the distance from the tool point to the center of the work-table is varied according to the diameter of the wheel.

For cutting the worm-gear, the blank is mounted on the table by means of the supports regularly furnished with this machine, and a special arbor having two cutters, as shown in Fig. 1, are inserted in the cutter spindle. The gear is then finished by the ordinary method employed for hobbing worm-wheels; that is, by gradually feeding the table and work in until the proper depth of cut or tooth is obtained. During this operation, the work-table and cutter spindle are also connected through gearing in the same ratio as when turning the worm. In this case, however, the work is held on the table and the cutters are mounted on the cutter arbor, whereas this order was reversed for turning the worm. As the illustration shows, the cutters are placed in positions corresponding to the end threads of the worm, and as it is these end threads on a hob which give the teeth their final shape (see "The Hindley Worm and Gear," December, 1908) when the hobbing process is employed, these fly-cutters should give satisfactory results provided they are correctly formed and accurately set; in fact, the results obtained by employing the foregoing method in connection with a regular Schuchardt & Schutte gear-cutting machine, are said to be entirely satisfactory. This fact is of especial interest in view of the tests being made at the present time by automobile concerns in the use of Hindley worm-gearing for the driving mechanism, and the simplicity of the process, combined with the fact that very little special tool equipment is required, makes the experiments and their results of considerable value.

Fig. 2 shows a typical Hindley worm and gear that can be cut in the manner just described on the "S & S" hobbing machine sold by Schuchardt & Schutte, Cedar and West Sts., New York.

BARNES DRILL CO.'S TAPPING MACHINES

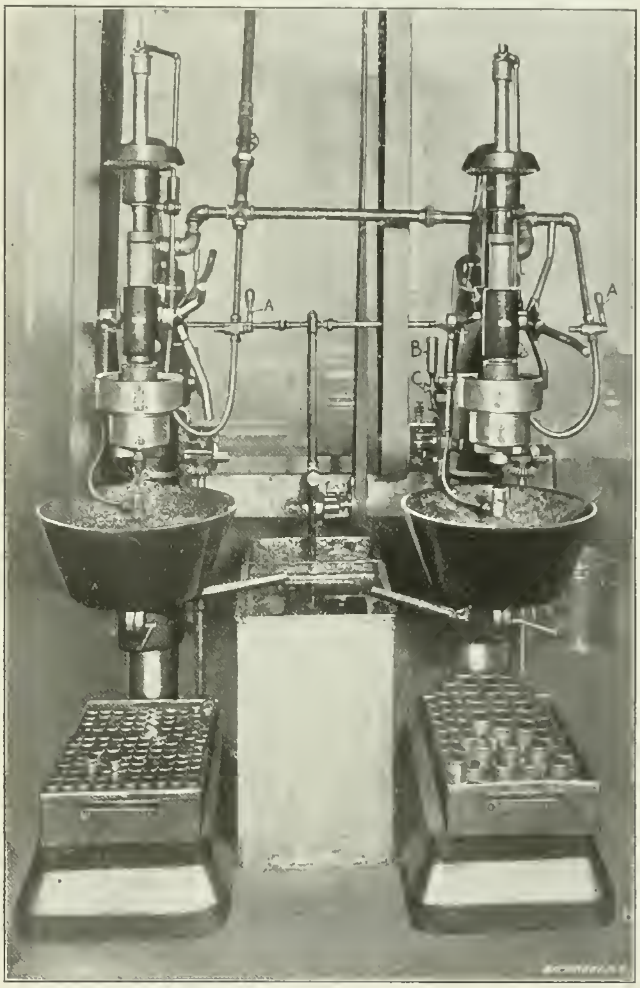
An interesting application of the all-geared tapping machine built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is shown in the accompanying illustration, which is a view of two 20-inch machines specially fitted up for tapping pressed steel grease-cup caps. The spindles of these machines are equipped with Garvin pneumatically operated chucks which grip and release the caps without stopping. The work is fed down on the tap which is held stationary in a special cup-type table that receives the chips and overflow oil. The oil is fed to the work through the center of the tap, as shown in the view of the machine to the left, so that the chips are forced out by the oil and by gravity as well. This has proved to be a very satisfactory method of tapping blind holes.

The compressed air for operating the pneumatic chucks is supplied through the piping shown. Connection is made to each spindle by a flexible metallic hose which permits the necessary vertical movement. This hose is attached to a small pipe leading to the top of the spindle where there is a stuffing-box to prevent the escape of air. From this point the air passes down through a small hole in the spindle to the chuck. The enlarged part of the chuck is an air cylinder containing a piston, the movement of which controls the operation of the chuck jaws.

In operating one of these machines, the work is held beneath the revolving chuck jaws which grip it when air is admitted by turning the hand-valve A. Then the work, as before stated, is fed down on the stationary tap until the automatic trip with which these machines are equipped, operates and reverses the motion of the spindle, thus backing the work off the tap at an increased speed. This automatic reverse movement can be set to trip and back out within a quarter-turn from the bottom. The lever B which controls the forward and reverse clutch, has a spring-stud C that is pulled out for work of this kind, thus allowing the lever to be thrown back instantly into the reversing position when the automatic trip is disengaged. If necessary, however, this lever can be stopped at a neutral position by stud C, thus stopping the spindle instead of reversing it. When another cap is inserted in the chuck, lever B is pulled forward and latched, thus giving the spindle the forward speed for another tapping operation.

In this particular installation, the lubricant is supplied to both machines from the large tank shown between them. A single pump forces the oil up through the center of each tap as explained. It then drains back to the tank where it is strained before again being used.

It will be noted that the reversing clutch gears are on the driving end of the machine and not on the spindle. As the machine is geared down in the ratio of 13 to 1 in front of the frictions, these clutch gears are located where they have the least to do, and in this way excessive wear is eliminated. These machines are similar in construction to the regular all-geared drill manufactured by the Barnes Drill Co., which has previously been described in MACHINERY (see descriptive articles published May, 1908, November, 1909, and July, 1910).



Two Barnes All-geared Tapping Machines equipped with pneumatically operated Chucks

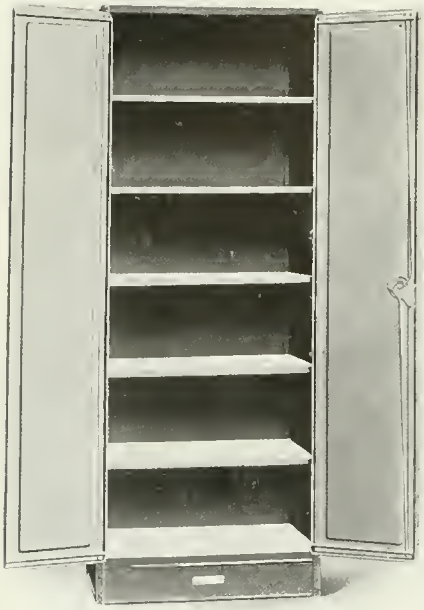
The transmission gears are located on diagonal shafts at the rear, and there are four changes of speed without back-gears, any one of which can be quickly obtained without stopping the machine, by operating conveniently located shifting levers. The star-wheel lever for hand feeding is so arranged as to give a powerful leverage and it also acts as a quick return lever. The movement is transmitted through a pinion running into an internal gear which is mounted on the cross spindle, thus making each handle of the star wheel equivalent to a lever four times its length. The spindles of these machines are made of best quality machinery steel and they are double splined and ground to size. The end thrust is taken by special ball thrust bearings and the nose of the spindle is extended to bring the drift hole below the sleeve.

TERRELL'S STEEL SHOP CUPBOARD

The use of steel cupboards in machine shops and other manufacturing establishments is strongly recommended by insurance underwriters, because they add greatly to the fire

protection of the building. It is especially important that articles of a very combustible nature be stored in receptacles made of fireproof material, as a building is not sufficiently protected when inflammable material is kept on exposed shelves.

A style of steel cupboard for shop use that is now being manufactured by Terrell's Equipment Co., North Grand Rapids, Mich., is shown herewith. The doors of this cupboard are fitted with a three-way locking device, which secures them at the top, bottom and center. If desired, the doors are provided with louver vents or round perforations. The body of the cupboard is made of No. 18 gage special furniture steel, and the doors are made of No. 16 gage steel of the same quality. The frames of both the bodies and doors are reinforced by special steel angles, thus insuring strength and rigidity.

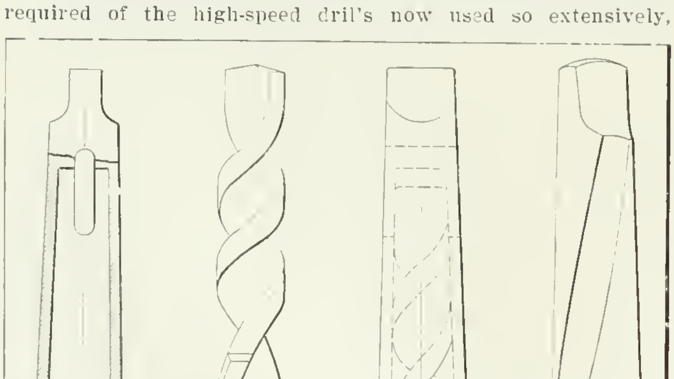


Steel Shop Cupboard, built by Terrell's Equipment Co.

These cupboards are made in the following standard sizes: 30 inches wide by 15 inches deep by 60 or 72 inches high; 30 inches wide by 18 inches deep by 60 or 72 inches high, and 30 inches wide by 24 inches deep by 60 or 72 inches high. The number of shelves can be varied according to requirements, and the cupboards are finished with baked enamel in either olive green, maroon or black. These cupboards will also prove useful for the storage of supplies which are liable to be damaged when stored on exposed shelves. As a building is not strictly fireproof unless the equipment is also made of fireproof material, the use of steel fixtures is certainly to be recommended.

PRATT & WHITNEY HIGH-POWER DRILL SOCKET

Before the introduction of high-speed steel, the service required of twist drills was such that the tang was strong enough to drive a drill in ordinary work, but the heavy duty required of the high-speed drills now used so extensively,



Pratt & Whitney Drill Socket and Shanks for which it is adapted

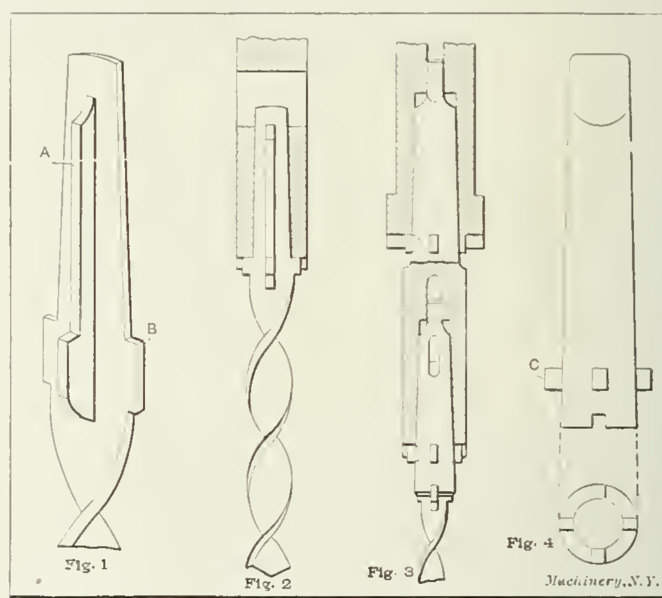
necessitates a stronger drive than that given by the tang, to secure the full efficiency of the drill. Any other method of driving drills should, however, as far as possible, not interfere with the simple collet system which is in universal use at the present time.

Fig. 1 of the accompanying illustration shows a socket brought out by the Pratt & Whitney Co., Hartford, Conn., that is provided with means for driving the "high-power" twisted drill, Fig. 2, or the solid-shank milled drill, Fig. 4, with equal efficiency, and it entirely eliminates the tang drive. This socket is enlarged at the lower end which contains a rounded projecting stud that engages the drill and gives a powerful drive at the base of the shank. The way the high-powered twisted drill is driven is indicated in Fig. 3, and a solid-shank drill having a spiral flute, as in Fig. 4, can also be used in this new socket as well as in one of the ordinary type. It will be seen that when the load is put upon the drill, the ball stud acts as a nut and the shank is thus seated firmly in the socket. The load is distributed between the friction and the stud and the drive is positive. Both types of drills can readily be removed from this socket by the use of center keys in the usual way. This company is prepared to furnish the high-power twisted drill or the high-speed milled drill for use in this new type of socket.

DRIVE FOR TWIST DRILLS

A method of driving twist drills, chucks, collets, etc., has been developed by J. L. Osgood, 121 Erie County Bank Building, Buffalo, N. Y. With this new system, a chuck or drill is driven by wings or projections located at the base or large end of the shank, thus giving a powerful drive.

The principle of the drive is clearly shown by the accompanying illustration. The drill used is formed from flat stock and the shank end is left straight. On this straight part there are strips *A*, Fig. 1, located centrally and on opposite sides to form the drill shank which is machined to a standard



Figs. 1 to 4. Method of driving Twist Drills, Collets, etc., by Wings or Projections at the Base of the Shank

taper. These side strips do not extend to the end of the shank, which forms a flat driving tang to supplement the drive at the large end. If desired, however, the end tang can be dispensed with and the driving projections used alone. These main projections, which are shown at *B*, fit into corresponding slots cut in the spindle, as indicated in Fig. 2.

When the use of sockets or sleeves is necessary, these are also provided with driving projections and cross slots at the ends, as shown in Fig. 3. Thus a drill can be held in either the spindle, a socket or a sleeve, depending on the size of the drill shank, and the same kind of interlocking drive is provided between the drill, sleeve, socket, and spindle. When sockets and sleeves are especially made for this new type of drive, the driving projections *C*, Fig. 4, are made integral, but when it is desired to use old sockets or sleeves, projections are formed by driving separate pieces into keyseats. These keyseats, as well as the slots in the ends of the spindles and sockets, can readily be milled at small cost.

The driving projections on the sleeves and sockets are preferable, but in case these are dispensed with, it would only be

necessary to mill slots for the reception of the drill itself. The side and end view, Fig. 4, of one of these sockets shows the driving projections and the end slots for receiving the sleeve or drill projections, as the case may be. By having the driving connection between the socket and drill at the base of the shank, as with this system, a very strong and reliable drive is insured.

QUEEN CITY BACK-GEARED SHAPER

The latest design of 16-inch back-geared crank shaper built by the Queen City Machine Tool Co., Cincinnati, O., is shown in Fig. 1. This machine is similar in many respects to designs formerly manufactured by this company, but it contains some interesting new features, among which may be mentioned the improvement in the radial bearings.

The bearings of a crank shaper that have to do with delivering the driving power to the ram, are, in the order of their importance, the crankpin, bull-wheel, driving and driven shaft bearings, the lower rocker-arm shaft bearing, and those that connect the link to the rocker-arm and ram. In this machine, these all have heat-treated and ground journals which run in cast iron. As the crankpin has the heaviest duty to perform, in proportion to its size, the body is a crucible steel casting with a heat-treated sleeve pressed over the pin which is ground to a running fit in the cast-iron crank-block. This block has an oil reservoir with channels cut in it to insure thorough distribution of the lubricant, which is lifted from the reservoir onto the crankpin by a chain. This oil flows back to the reservoir, thus having a continuous flow. Means are provided for drawing off the oil and replacing it when necessary.

The hub of the bull-wheel also has a hardened sleeve pressed over it which is afterward ground to size, and it is

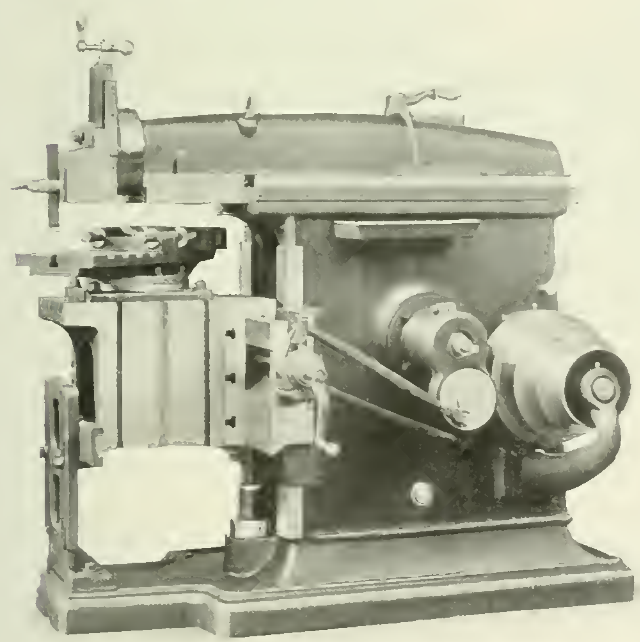


Fig. 1. Queen City 16-inch Back-geared Crank Shaper

oiled by the same method employed for the crankpin. The five journals of the driving and driven shafts are heat-treated and ground, and run in removable cast-iron bushings. These are kept flooded by means of ring oilers. Chains are used on the crankpin and bull-wheel hub and other revolving bearings in the feed, because a ring will not lift sufficient oil when the shaper is running at a slow speed. Fig. 2 illustrates the general construction of these bearings. The rocker-arm and link shafts are also provided with good lubricating facilities, although neither the ring nor the chain can be used, because the motion is not fully rotary, only about one-fourth of a circle being described. The cone-pulley shaft has a three-point bearing, thus eliminating the overhang at the drive.

There are twelve changes of feed on this machine and eight speed variations, which can be so combined as to insure efficient operation. The single-gear ratio of the drive is 4 to 1, and the back-gear ratio, 19 to 1. This combination gives the following cutting strokes to the ram: 7.98, 11.78, 17.15, 25.31, 37.9, 55.95, 81.46, and 120.24 feet per minute, which it will be noted are in geometrical progression.

The workmanship and rigidity of this shaper can be judged by the accuracy guaranteed. The makers agree to produce work within 0.0005 inch for the full 16-inch stroke, and the vise is square within this limit. The arch type of ram is an important factor in securing the rigidity necessary to produce such accurate results, and the table support, as well as the rigid construction of the column, rail, etc., enables the work to be held in a fixed position while being machined.

The shaper is designed very low to make its operation more convenient. The bearing in the column for the ram is long,

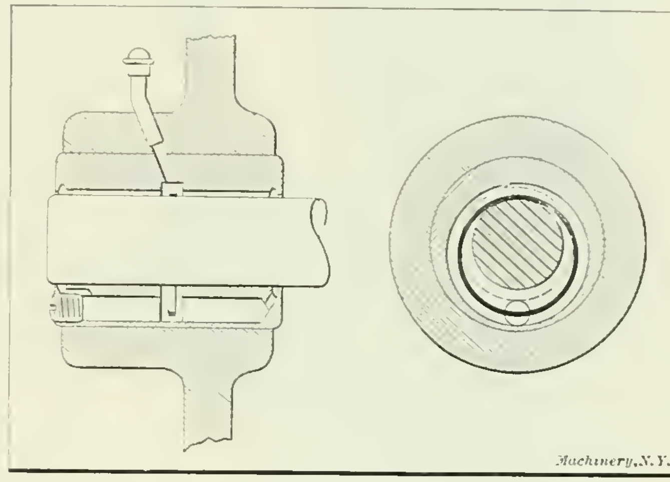
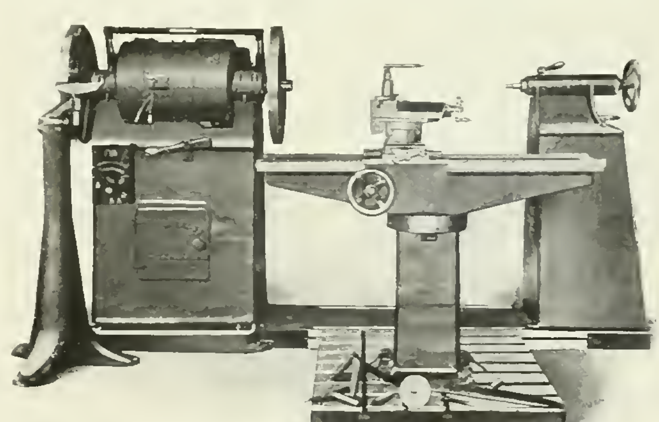


Fig. 2. Detail View showing General Construction of Bearings of Queen City Shaper

as is the ram itself. All flat bearing surfaces are of a large area and gibbed for taking up wear. The feed-screws have micrometer adjustment, and the swivels are graduated. The pinions are made from bar steel, and all gear teeth are generated. This shaper can also be furnished with an all-gear drive and with either a variable- or constant-speed motor drive, in addition to various special attachments.

FAY & SCOTT PATTERNMAKER'S LATHE

A special patternmakers' lathe is illustrated herewith, which has a swing of 100 inches over the baseplate. This lathe is driven by a four-horsepower, Reliance, variable-speed motor, and the headstock is double back-geared. The back-gears are thrown in or out of mesh by means of the handle shown over the motor, and the sliding back-gear is shifted by a conveniently located lever in front of the headstock. The motor



Fay & Scott 100-inch Patternmakers' Lathe

and all the gears are carefully guarded. The minimum and maximum spindle speeds are 22 and 1100 revolutions per minute, respectively. Practically all noise is eliminated in the drive by the use of rawhide pinions meshing with cast-iron gears. Work seven feet in length can be turned between the centers in this particular lathe, which has a 13-foot bed.

The tailstock is adjusted by means of a rack and pinion located at the rear. The absence of all vibration at high speeds is assured by the rigid construction and perfect balance of all rotating parts. This machine is the product of Fay & Scott, Dexter, Me.

GARVIN NO. 22 PLAIN MILLING MACHINE

The milling machine illustrated in Figs. 1 and 2 was designed by the Garvin Machine Co., Spring & Varick Sts., New York, primarily for manufacturing purposes. It is a powerful machine of large capacity having a minimum number of parts which are constructed to withstand hard and continuous work.

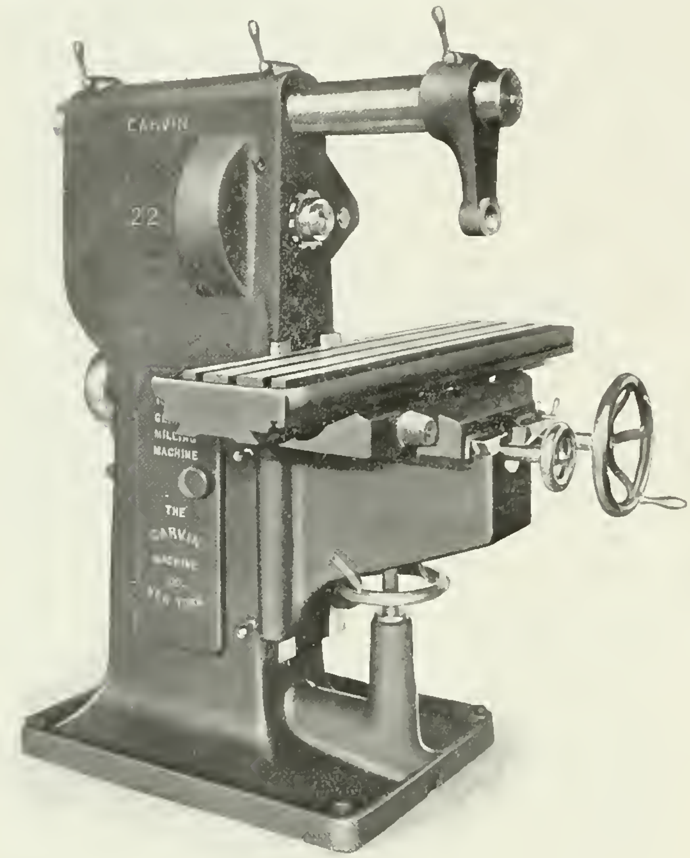


Fig. 1. No. 22 Plain Milling Machine, built by Garvin Machine Co.

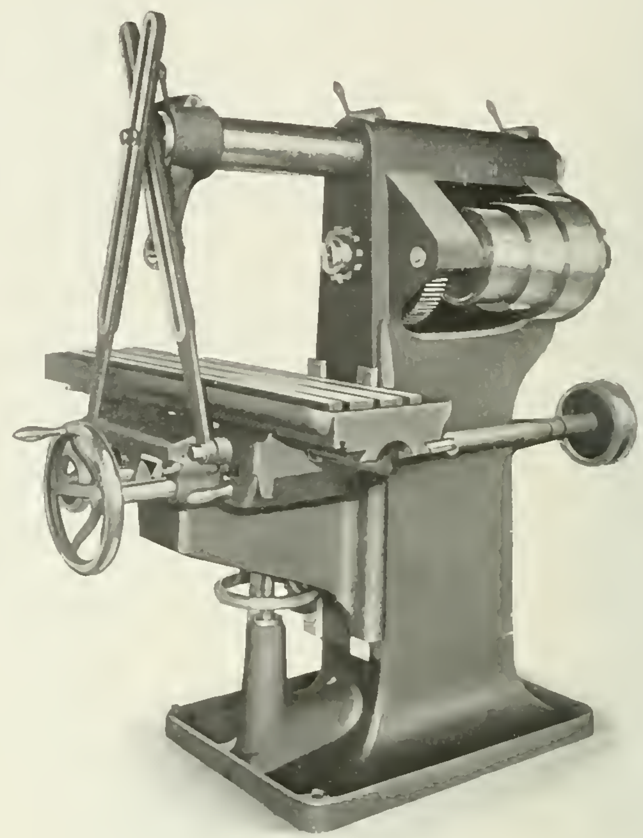
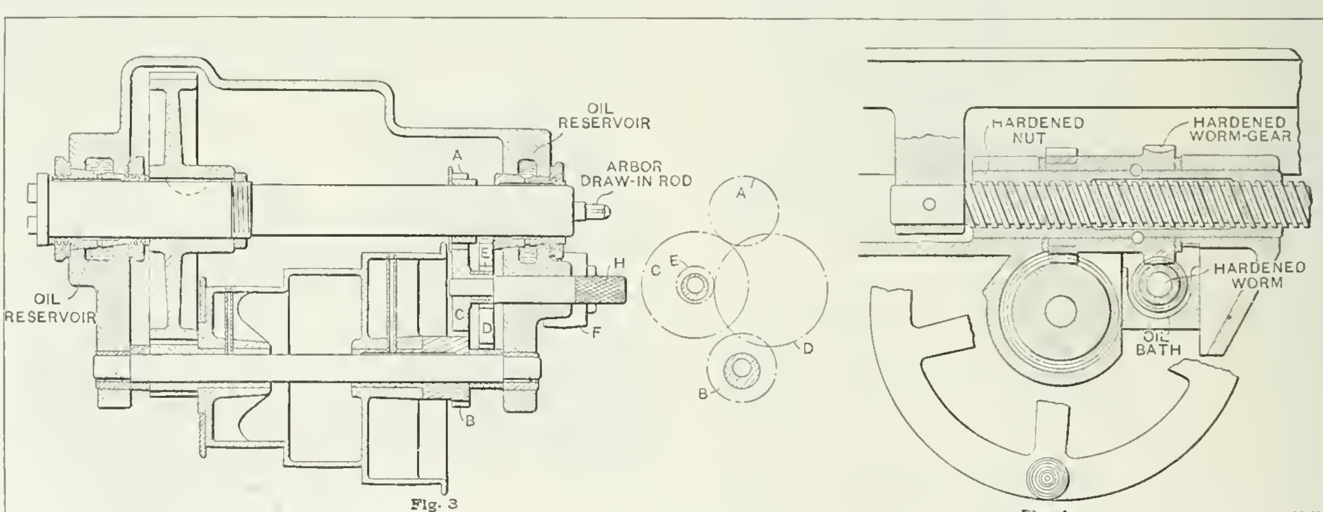


Fig. 2. View of Garvin Machine from Opposite Side

By referring to Fig. 1 it will be seen that one side of the machine is closed or solid, thus joining the arm and spindle bearings rigidly together and to the body of the machine. This construction insures great rigidity and freedom from vibration. The drive to the spindle is from a three-step cone-pulley at the side, which transmits the power through gearing having a ratio of 5¼ to 1. The general arrangement of the drive is shown in the sectional view, Fig. 3. The cone-pulley takes a four-inch belt and has a maximum diameter of twelve inches. The spindle has a No. 11 B. & S. taper hole with a driving slot, and it runs in adjustable bronze boxes as shown in the illustration.

The feed is driven either from the spindle or the cone-pulley shaft, the change being effected by operating handle *H*, which controls the position of gear *C* mounted eccentrically at its end. When gear *C* is in mesh with gear *A* of the spindle, a slow feed is obtained, and when it is thrown into mesh with gear *B*, which rotates at a higher speed, there is a corresponding increase in feed. The feeding movement is transmitted from either gear *A* or *B*, depending on which of these gears is in mesh, through *C* to the pinion *E*, which drives gear *D* and the belt pulley *F*. This pulley, in turn, is connected by a wide belt with the feed shaft at the side of the column, which extends forward to the table. The feeds vary from 1/200 to 1/4 inch per revolution of the spindle, change gears being provided to cover this range.



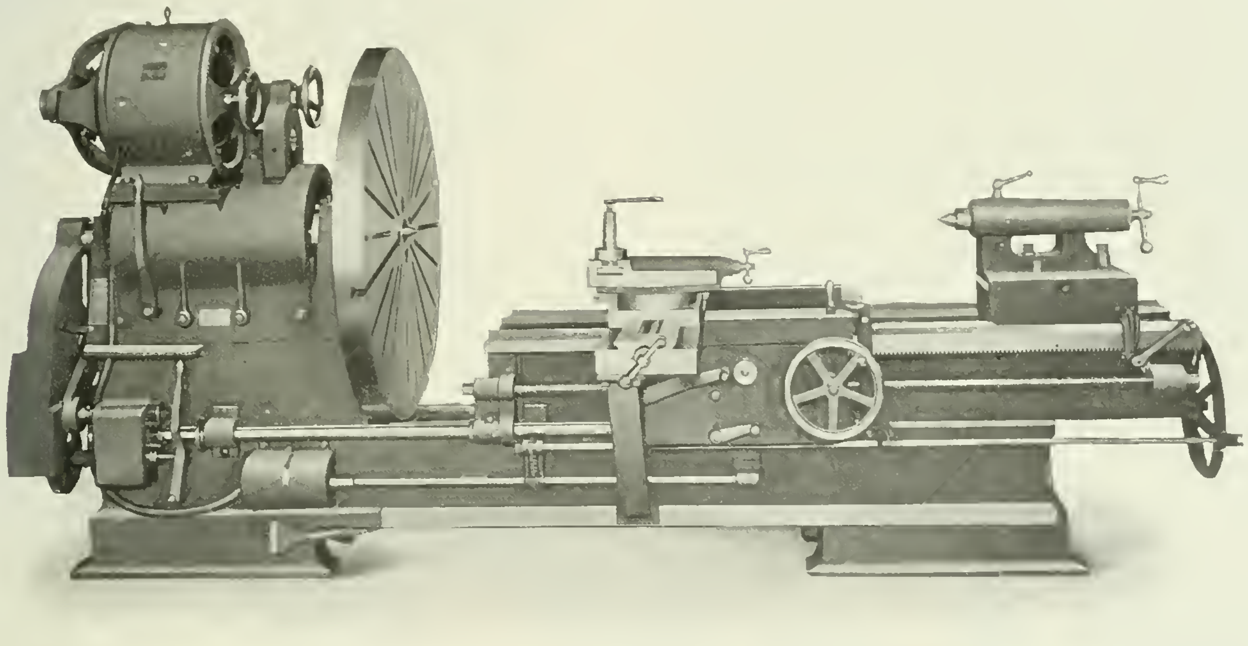
Figs. 3 and 4. Sectional View showing Driving and Feeding Mechanism

The feed is transmitted to the large work-table by a steel nut which rotates on a stationary screw, as shown in Fig. 4

The rotary feed nut is directly driven by a hardened steel worm-gear and worm running in oil. The large handwheel shown, which connects with the rotary nut through spiral gears running in oil, is for feeding the table by hand. The feed-box is built into the saddle so that the stresses are taken in the most direct manner and the number of joints is reduced to the minimum. The saddle is massive, and has a micrometer adjustment. The knee is of the Garvin closed-top construction, and it is adjusted vertically by a micrometer handwheel and screw which does not pass through the floor. The overhanging arm is exceptionally large, and the braces connect the saddle and arm, leaving the yoke free to be adjusted to suit the arbor and position of the cutter. All gears are protected as the illustrations show. The weight of this machine is 3050 pounds.

RAHN-LARMON GAP LATHE

The Rahn-Larmon Co., Cincinnati, O., is the manufacturer of the electrically-driven gap lathe shown in the accompanying illustration. This type of lathe is also built with a belt drive. As the gap lathe is particularly adapted for repair shops, the electrically-driven machine is often very desirable, aside from the advantages inherent to the motor drive, in that it enables the lathe to be located in an isolated part of the shop, or where the transmission of power by a shaft and belt would be impracticable.



Electrically-driven Gap Lathe, built by Rahn-Larmon Co.

The motor is attached to this lathe so as to conform with the general design, and power is transmitted directly to the spindle through gearing. The motor is mounted as close to the spindle as possible, to eliminate vibration at high speed. The entire headstock and the change gears are covered, thus protecting the operator. The starting and stopping of the motor is controlled by a lever mounted on the right side of the apron and within convenient reach. This lathe can be equipped with either a constant- or a variable-speed type of motor.

The design of the lathe in general is such as to insure a rigid machine of simple construction. The top or extension bed can be adjusted to any width of gap within the range of the lathe, by means of a handwheel which operates a screw of coarse pitch. Of course, this adjustment also greatly increases the maximum distance between the centers. Both the main and top beds are very heavy, and the latter is accurately planed and fitted, thus insuring accuracy of alignment between the spindles and carriage for all positions. The spindle is hollow and is made of a special carbon steel. The boxes are made of the best gun metal and they are provided with means for taking up wear.

The carriage is gibbed to the bed both in front and back, and it has a long continuous bearing on the bed. When using the cross-feed, the carriage can be firmly locked, and it is so arranged that the tool-rest can be brought close up to the gap when necessary. The front of the carriage has an extension which is firmly braced, as shown, thus allowing extra travel for the tool-rest in order that the tool may operate on the largest diameter that can be swung in the gap. The apron is of simple design and all the gears, as well as the rack, are made of steel, while the stud pins are hardened and ground.

A large range of both longitudinal and cross feeds is obtained by shifting the change-gear lever attached to the feed-box, and the feeds are so arranged that no two can be thrown into operation simultaneously. A safety device also prevents the breaking of the feed-box gears, or those in the apron, either because of accident or carelessness. The screws for the compound rest and cross-feeds have graduated micrometer disks.

The equipment regularly furnished with this lathe includes a countershaft, steadyrest, follow-rest, large and small faceplates, wrenches and a full set of change gears. Additional equipment, which can be furnished extra, consists of a taper attachment, extension turning rest, turret on the carriage, chucks, turning tools, faceplate chuck, or any special tool-rest. This lathe has a swing of 24 inches when in the closed position, and a swing of 48 inches through the gap.

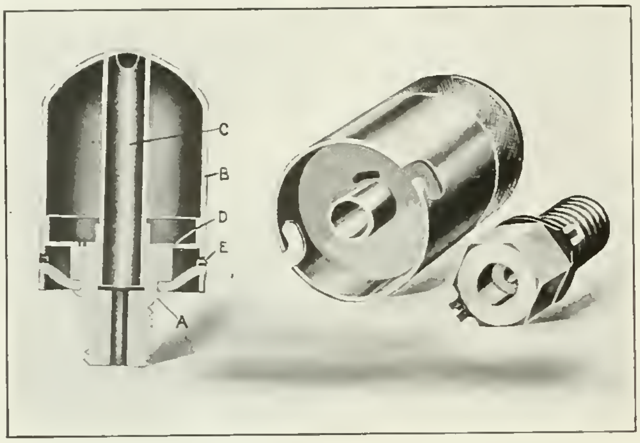
TWENTIETH CENTURY LOOSE-PULLEY OIL CUP

The oil cup illustrated herewith is designed to automatically oil loose pulleys without using any more lubricant than is needed to keep the bearing in good condition. The cup after being filled will run from one to three weeks, the time depending on the number of starts and stops, speed, etc., and all the oil put into the cup goes to the bearing, but the feed is so regulated as to eliminate waste by flooding.

The oil is fed from the cup *B* to the central feeding tube *C* by centrifugal force, the operation being automatic. When the pulley is started, the centrifugal force caused by the rotation carries the lubricant to the top of the cup and into the tube which is provided with small apertures as shown in the sectional view. This tube serves as a measuring device for the charge of oil to be delivered to the bearing. The two or three slow rotations accompanying the starting and stopping of the pulley, cause the tube to be filled and a part of its contents to be discharged to the bearing. In this way sufficient oil is delivered to keep the bearing well lubricated.

The view to the right shows how the cup is detached from the threaded nipple, which is screwed in the loose pulley,

when it is necessary to refill it. The cup *B* is first removed by hand and it is then filled through the central feed pipe *C*. Small vent holes are provided at *D* to allow the air to escape. The cup is easily replaced on the nipple by slightly rotating it so as to engage springs *E*, which enter the slots shown,



Automatic Loose-pulley Oil Cup

thus locking the cup in place. This filling operation can be performed with the pulley in any position, thus doing away with the necessity of shifting the belts or turning the shaft to bring the oil hole at the top.

This cup is made of thin pressed steel and it is so light that counterbalancing is unnecessary. It is, however, strong and there are no moving or wearing parts. The American Specialty Co., 834 Monadnock Building, Chicago, Ill., is the manufacturer.

FAY & SCOTT CENTERING MACHINE

Fay & Scott, Dexter, Me., are the builders of the double-end centering machine shown in Fig. 1. The bed of this machine is a standard lathe bed type and there are two centering heads as shown. The left-hand head is stationary and the one to the right is adjustable along the entire length of the bed. This adjustment is effected by a handwheel which operates through a rack and pinion. The two centering heads are pivoted so that by tilting them slightly, either the drill or the countersink can be brought into the centering position or in alignment with the center of the work. The spindles are fed in or out by hand levers which connect with the spindles by means of a rack and pinion.

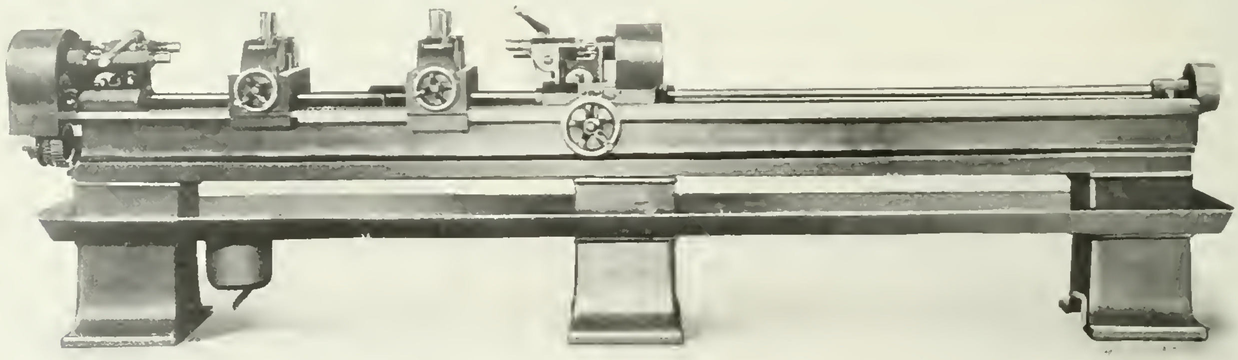


Fig. 1. Fay & Scott Double-end Centering Machine

The construction of the stationary head to the left, is clearly shown in Fig. 2, which is a detail view with the protective covering removed. This view also shows the two chucks in which the work to be centered is held. These are of the self-centering type and have jaws of hardened steel that are operated simultaneously by means of right- and left-hand screws. The position of these chucks on the bed can be varied according to the length of the work. The driving mechanism for the spindle consists of a shaft extending the entire length of the machine. This shaft is driven by a belt, and connection is made with the spindles by silent chains. The spindles are made of hammered steel and are provided with renewable bronze bearings.

The countershaft furnished with this machine has tight and loose pulleys and double-brace self-oiling hangers. Special fixtures for holding work of any kind can also be supplied. The principal dimensions of this machine are as follows: Maximum swing over bed, 18 inches; maximum distance between drills (10-foot bed), 60 inches; taper of spindles, No. 2 Morse; speeds of drill and countersink spindles, 425 and 250 revolutions per minute, respectively; size of

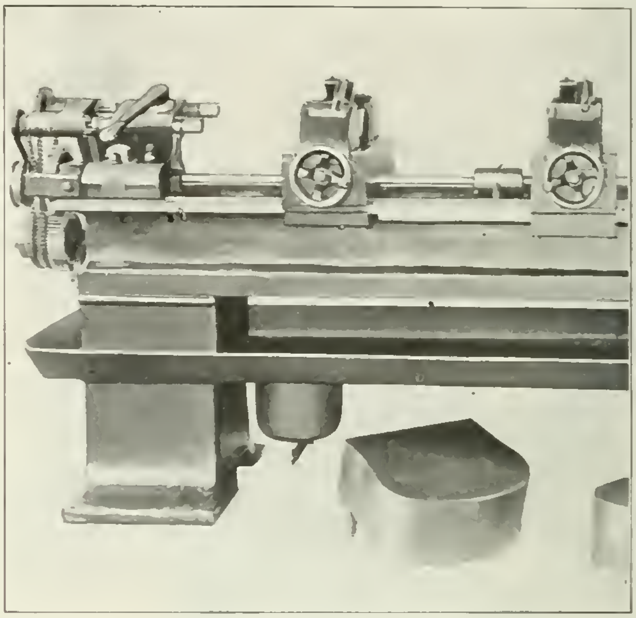


Fig. 2. Detail View of Fay & Scott Centering Machine

spindle bearings, 1 1/4 inch by 9 inches; maximum capacity of chucks, 6 inches. The weight of the 10-foot machine is 3500 pounds, and the weight per foot of bed is 100 pounds.

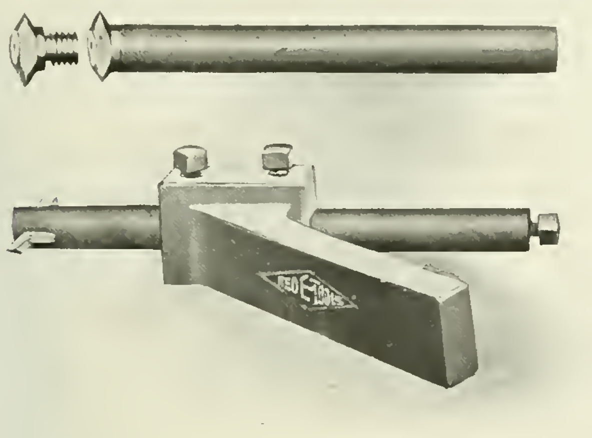
BORING AND INTERNAL THREADING TOOL

A boring-bar and internal threading tool that has just been placed on the market by the Ready Tool Co., Bridgeport, Conn., is shown in the accompanying view. The cutter of the boring tool is held in place by a set-screw in the end of the bar, which forces a rod, extending through the bar, up against a sliding wedge that securely holds the cutter against all movement. When it is necessary to sharpen the cutter, the set-screw in the end is loosened, which releases the wedge and permits the cutter to be taken out. When the sharpened cutter is again placed in the holder, it is located at the same height as before, without the necessity of adjustment.

The bar is rigidly held in the holder by a sliding dog which is forced down by the two set-screws shown; the dog avoids marring the bar and holds it rigidly. This method of clamping also provides means of adjustment so that the bar can

be replaced by a piece of 3/4- or 5/8-inch solid steel in case this should be necessary for boring small holes.

In addition to the boring-bar, an internal threading tool is furnished with this holder. This threading tool, which is shown in the upper view, has a circular cutter screwed in

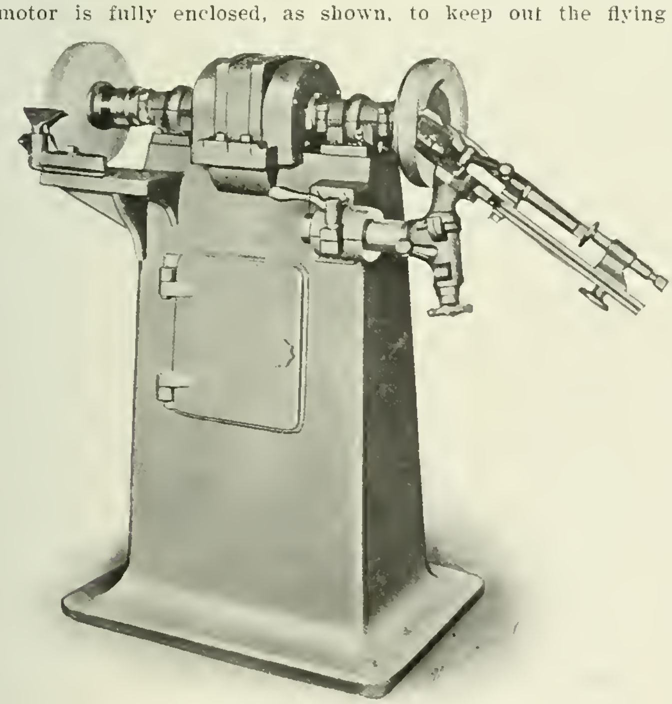


Boring and Internal Threading Tool, manufactured by the Ready Tool Co.

the end that is ground to a 60-degree angle, so that the "one grind" feature, common to the tools made by this company, is applicable in this case. Extra cutters for either the boring or threading tools can be supplied.

MOTOR-DRIVEN COMBINED TWIST DRILL AND DRY GRINDER

The Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., is now building the combination twist drill and dry grinder illustrated herewith. One end of this machine is a plain grinder for doing miscellaneous work, and the other is arranged for grinding twist drills. The grinder is electrically driven by either a direct- or alternating-current motor. The motor is fully enclosed, as shown, to keep out the flying



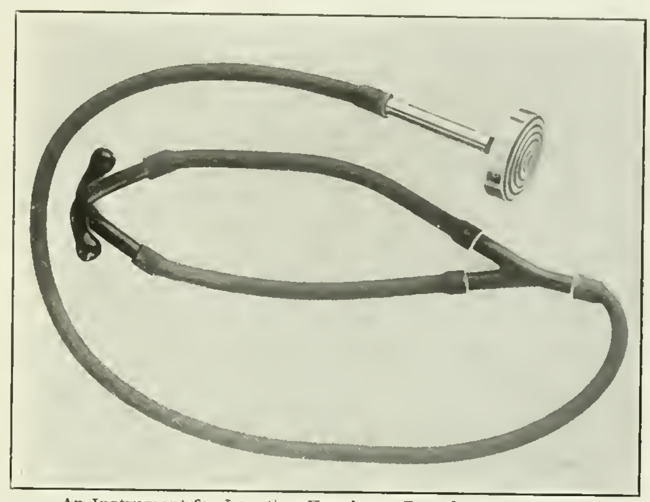
Combined Twist Drill and Dry Grinder, built by Bridgeport Safety Emery Wheel Co.

particles of emery, and the bearings are bolted directly to the base, thus giving a very solid construction. This motor has ample power to drive wheels up to 12 inches in diameter. The bearings are of bronze and ring-oiled. They are extra long, as the illustration shows, and can be renewed if this becomes necessary owing to wear. These bearings have a length of 8 inches and a diameter of 1 3/8 inch. The twist drill grinder, which is made by the Washburn Shops, is clamped in a split sleeve bolted to the column. The particular grinder shown is a No. 1 size, but this twist drill grinding attachment can also be applied to the No. 1/2 and No. 2 machines built by this company.

THE VIBRACATOR OR SOUND INTENSIFIER

The vibracator, as the name implies, is used for detecting "knocks" or excessive vibrations in machinery, due either to wear or defective adjustment, and it is particularly useful for determining the location and probable cause of extraneous noises connected with mechanism that is encased and therefore not visible. This instrument is scientifically designed, and all sounds are greatly intensified by it, so that even very light blows or pounds can easily be located. It has at one end a corrugated hardened steel diaphragm, the vibrations of which are transmitted by the air enclosed in the head, up through the rubber tube shown, to the ears. This diaphragm is only a few thousandths of an inch thick, it being made as thin as possible to draw the metal to the corrugations. The ear tips are held in place, when the instrument is in use, by concealed springs, so that the hands are left free.

This instrument is used by placing the corrugated diaphragm against that part of the machine which seems to be nearest the cause of the trouble. If an encased mechanism



An Instrument for Locating Knocks or Pounds in Mechanism

is being tested, the diaphragm is moved over the exterior surface of the casing until the knocking is centralized or the instrument is located where the sound is greatest. If the construction of the mechanism being tested is known, the probable defect can then be determined. It is very essential that the ear tips be well inserted in the ears, in order to exclude all external sounds, and thus secure the maximum sensitiveness. The vibracator not only enables defects to be located quickly, but its use also often makes it unnecessary to dismantle more than the section that needs repairing. The vibracator is manufactured by Hopewell Bros., Newton, Mass.

NEW MACHINERY AND TOOLS NOTES

Keyseater: John T. Burr & Sons, 429 Kent Ave., Brooklyn, N. Y. Portable shaft keyseater, also adapted for use in the lathe by removing the hand-crank, pinion and pinion stud. The keyseater is placed between the lathe centers and is driven by a driver fastened to the faceplate.

Tapping and Threading Attachment: J. C. Barrett Co., Hartford, Conn. Combined tapping and threading attachment that can readily be applied to lathes. The change for either tapping or threading is made by simply reversing the attachment. It is equipped with an adjustable gage for use on duplicate work.

Swinging-Frame Grinder: Pittsburg Emery Wheel Co., Pittsburg, Pa. Swinging-frame grinding machine adapted for steel and malleable iron foundries, crucible steel plants, etc., for grinding fins and gates from castings or for doing similar work. This grinder is made in two styles, one being driven by a belt from the lineshaft and the other by a motor.

Keyseater: F. L. Schmidt, 11th Ave. & 21st St., New York City. Portable hand-operated keyseater with a capacity for lengths up to 8 inches and a width of 1/2 inch. On the return stroke the cutter is automatically lifted, and the leverage of the operating handle can be varied according to the size of the keyseat. The machine weighs, complete, 86 pounds.

Polishing Stand: Gardner Machine Co., Beloit, Wis. Polishing stand, the wheels of which are fully enclosed by dust-hoods when in operation. The wheels are made in either 14- or 16-inch sizes, and an abrasive cloth band is stretched over a backing of felt by a device which maintains a constant

tension. The bearings are lubricated with compression grease cups.

Electric Hoist: Euclid Crane & Hoist Co., Euclid, O. Electric hoist having scored hoisting drum with sufficient surface to prevent overwinding; three reductions of spur gears; and a load brake. All the high-speed mechanism runs in a bath of oil, and other bearings are supplied with grease cups. An effective limit attachment prevents the bottom block from going too high because of carelessness.

Surface Grinder: C. G. Garrigus Machine Co., Bristol, Conn. Surface grinder designed for manufacturers using dies for presses, stamps and for other work where surface grinding is required. Beneath one of the two wheels there is an 8- by 15-inch table. This table is adjustable vertically by a handwheel, and it can also be moved up and down the column to any position. The opposite wheel is provided with a tool-rest.

Semi-Automatic Welding Machines: Toledo Electric Welder Co., Langland & Knowlton Sts., Cincinnati, O. Power-driven machine for electrically butt welding wire, in which from fourteen to twenty welds can be made per minute, depending on the size of the stock. The operator places the work between the clamping jaws and removes it after a weld has been completed. All other operations are performed automatically.

Power-driven electric spot welder for welding sheet metal. The operation of this machine is similar to a power punch-press, and it will make from forty to one hundred welds per minute, depending on the thickness of the metal welded. It is operated by a foot-pedal switch that is counterbalanced to stop the machine automatically if necessary.

Shaper: Hendey Machine Co., Torrington, Conn. Motor-driven shaper, with motor mounted on a bracket at the rear which can be rocked to and from the base to secure the proper belt tension. The machine has a friction drive which enables the operator to start or stop it with the motor running; it also provides a quick and easy control that facilitates setting the tool to any desired position. Motors can be furnished for either direct or alternating current.

Cutter Grinder: Northampton Emery Wheel Co., Leeds, Mass. Machine for grinding straight and spiral cutters, side mills, etc. It is provided with an adjustable rest connected with the slide that holds the cutter being ground. This slide has an adjustable stop at the rear to regulate the amount of grinding. The face grinding attachment can be tilted to any angle and also has an adjustable stop for the slide. The mill is held perfectly rigid while being ground, by a plunger that locks into the teeth.

Buffing Lathe: Ransom Mfg. Co., Oshkosh, Wis. Buffing lathe of the type that can be driven from a lineshaft or countershaft beneath the floor, the belt being entirely enclosed. The belt shifter is in the form of a small handle and is conveniently located at the front. One-half turn of this handle serves to shift the belt. The machine has long dustproof ring-oiling babbitted bearings and bearing caps arranged to take up wear. A door is located in the back of the pedestal, thus giving ready access to the belt if necessary.

Cylinder Boring Machine: Barrett Machine Tool Co., Meadville, Pa. Horizontal cylinder boring machine designed for boring and facing, simultaneously, all kinds of cylinders and other cylindrical work within its capacity. The boring-bar has a continuous feed, in either direction, of thirty inches. A quick-change feed-box provides changes of feed varying from 1/32 to 3/8 inch per revolution of the bar. There are two heavy facing arms that can be started and stopped at will. The machine can be furnished for belt or motor drive.

Grinders: Springfield Mfg. Co., Bridgeport, Conn. Rotary surface grinder having a work-table, housings, and cross-rail similar to a vertical boring mill. On the cross-rail two grinding heads are mounted, one being vertical and the other horizontal. The vertical head can be swiveled for grinding angular work, and it is directly driven by an electric motor. Both heads are provided with automatic trips. The speed of the work-table can be changed for various diameters by means of change gears. The table is 45 inches in diameter.

Improved form of Standard No. 4 car-wheel grinder. The bed is very heavy, and the wheel-heads are of an entirely new design. The overhead works are carried on columns attached to the bed. This machine will grind wheels up to 43 inches in diameter.

Cylinder Boring and Reaming Attachment: Garvin Machine Co., Spring & Varick Sts., New York City. Boring, reaming, and lapping attachment applicable to this company's No. 15 plain miller and specially designed for automobile cylinder work. It has an adjustable boring head containing three tools, that is mounted on a special horizontal head bolted solidly to the face of the miller and clamped to the overhanging arm. The regular feed of the table is used as well as the automatic stops. The adjustment of the knee on the column enables the different cylinder holes to be located easily.

Mandrel Press: C. T. Eames Co., Kalamazoo, Mich. Mandrel press so designed that by changing the position of a single pin, a simple or compound leverage may be obtained. When the press is operated by a simple lever, the ram has a movement of 2 inches for each stroke and the force applied at the end of the lever is multiplied 135 times. By engaging a pin and compounding the leverage, the ram stroke is decreased to 3/8 inch and the power is increased five times. The ram is square and is operated by a rack and pinion. The work-table may be adjusted vertically by a hand crank.

Ring Wheel Chuck: Charles H. Besly & Co., Chicago, Ill. Pressed steel ring wheel chuck for holding cylindrical or ring grinding wheels. It is furnished in connection with Besly grinders for roughing off scale and excess stock from work which is too rough to be ground economically with emery cloth disks. The construction of the chuck is such that there are no external projections, thus insuring safety for the operator. The grinding ring is clamped on the circumference only. These chucks are furnished for 10-, 12-, 14-, 15-, 18-, 24- and 30-inch wheels and for various types of grinders.

Hand Tachometer: Schuchardt & Schutte, Cedar & West Sts., New York City. Combined hand tachometer and cutmeter for indicating rotative speeds as well as the cutting speeds of various machine tools. The results are instantly shown on the dial in revolutions per minute and feet per minute without the necessity of calculating or using a watch. Four different speed ranges are provided, which may be selected according to requirements. There is only one spindle for all ranges of speed and adjustments are effected by simply shifting a thumb-slide. This is an accurate, durable and compact instrument.

Radial Drill: Midland Machine Co., Detroit, Mich. Thirty-inch radial drill possessing the advantage of a sensitive machine combined with the productive capacity of the radial type. No gears are employed in the drive or the reversing device, and power is transmitted by a 2-inch belt running at high speed. The spindle runs in dustproof ball bearings and there are six spindle speed changes. The feed is by a long lever having a ratchet device that automatically releases in the upward position. The spindle can be traversed quickly by means of a small handwheel. This machine is compactly built and occupies a small amount of floor space.

Vertical Bench Miller and Drilling Machine: R. M. Clough, Tolland, Conn. Combination vertical bench drilling and milling machine having a capacity for holes up to ½ inch and for mills up to ½ inch or larger, if necessary. The table has a working surface of 16 by 5¼ inches, a longitudinal movement of 10 inches, and a transverse movement of 5 inches. The feed-screws have micrometer dials reading to thousandths of an inch, and the feed can be disengaged at any predetermined point by adjustable stop gages. The spindle sleeve has a movement of 4 inches, and means are provided for clamping the spindle for milling operations.

Milling Machine: E. S. Lea, Lamberton & Lalor Sts., Trenton, N. J. Combination vertical and horizontal milling machine designed for a wide range of work. This machine is of the column and knee type and is radically different from the conventional design. The head may be adjusted to bring the cutter in horizontal and vertical positions or in any intermediate angular position. The head also has an in-and-out adjustment. The drive is by a seven-step cone at the rear engaging a square shaft that transmits power to the cutter spindle through gearing. The table has a working surface of 7½ by 22 inches and vertical range under the spindle up to 17½ inches.

Grinding Machine: Black Rock Machine Co., Bridgeport, Conn. Special grinder intended for grinding tapering plugs or similar parts up to four inches in length. By means of a special headstock it is also adapted for grinding washers up to four inches in diameter. A large cup grinding wheel is used, and the drive is self-contained, no countershaft being required. The rotation of the work and reciprocating motion of the grinding head are controlled by a foot lever. When this lever is released, the carriage always stops with the grinding wheel away from the work. This machine is compact in its construction and is said to be free from any tendency to chatter or vibrate.

Upright Drilling Machine: Frontier Iron Works, Buffalo, N. Y. Twenty-four-inch heavy-duty sliding-head drill press with back-gears, wheel, lever and power feeds, and an automatic stop. The spindle is made of high-carbon steel and it has a quick return. It is operated by a steel rack and pinion and worm-gearing, the worm running in an oil bath. The spindle sleeve has a sliding collar for regulating the automatic stop mechanism. The knee is very heavy and has a long bearing on the column. It is raised and lowered by means of worm-gearing through a rack and pinion. This machine can be equipped with the company's well-known tilting table. It drills to the center of a 24½-inch circle.

Sand Sifter: Arcade Mfg. Co., Freeport, Ill. Machine for riddling sand in the foundry, consisting of two wire-cloth cylinders, one within the other, mounted horizontally in a frame. The respective diameters of the two cylinders are 14 and 24 inches. The sand to be sifted is shoveled into the inner cylinder at one end and both cylinders are rotated either by hand or power. By means of a system of lugs and

rollers the cylinders are jolted four times during each revolution, which disintegrates the lumps and prevents the sand from clogging the screen. The sand passes through the sieve as fast as it is shoveled in and the sieve is tilted slightly, so that foreign matter is discharged through a chute at one end.

Cam Grinding Attachment: Landis Tool Co., Waynesboro, Pa. Attachment designed for grinding cams while in place on their shafts, and adapted to solid shafts having cams integral, or those of the built-up type with detachable cams. It is constructed on the swinging principle, the main table holding the work and master cam, being suspended from bearings at the ends. The work is held between centers, and the master cams are brought in contact with a roller which gives a swinging motion to the table, thus reproducing the cam shapes on the work. This attachment can be used on plain and universal grinders of 12- and 16-inch swing, and it is applied by simply clamping it to the table after removing the head- and foot-stock.

Radial Drill: Kane & Roach, Niagara & Shonnard Sts., Syracuse, N. Y. Radial drilling machine claimed to be one of the largest built in this country. The radius of the arm is 9 feet, work 8 feet high can be placed under the spindle, and the column has an overall height of 14 feet. The arm is raised and lowered by power, and the head also has power feed on the radial arm for use in milling large castings, the machine being adapted to milling, boring, and drilling operations. The control of the machine and the speed variations are effected by manipulating two levers at the left of the head. Four feed changes are available, and the spindle is counterbalanced with a coil spring. The dimensions of the base are 10 by 14 feet, and the approximate weight of the machine is 13 tons.

Accident Preventor: Geuder, Paeschke & Frey Co., St. Paul Ave. & 15th St., Milwaukee, Wis. Safety device for punching, stamping, cutting, embossing and drawing presses, etc. The device consists of a folding gate which extends downward in advance of the punch, thus effectually blocking an approach to the die. As the punch completes its operation, the folding gate instantly moves upward, entirely out of the workman's way. The device is so connected with the clutch-operating lever that it works automatically and does not reduce the output of the press. As the gate is of lattice work, the die is always visible. In case the operator, with his hands or otherwise, interferes with the downward movement of the gate, the clutch pin will not engage and the punch cannot descend. This device can be attached to any style of press without altering the clutch or treadle.

Rotary Magazine: Cleveland Automatic Machine Co., Cleveland, O. Rotary magazine feeding attachment for the Cleveland automatic screw machine, that will handle work having wings and projections of a varying diameter. It consists of a magazine wheel to which are attached bushings that are made to suit the parts to be machined. The work is mounted on these bushings by the operator, who can attend to several machines, and the magazine is indexed for each revolution of the turret, thus bringing the parts successively before a conveyor which removes them from the bushings and conveys them to the machine chuck. One side of the magazine wheel has a series of countersunk holes in which a spring-plunger enters to locate the magazine in the correct position. The conveyor can revolve freely on the spindle, and this rotary movement takes place when the work has been gripped with the chuck and before the conveyor has been withdrawn.

Automatic Grinding Machine: Norton Grinding Co., Worcester, Mass. Grinding machine which operates automatically and is adapted to cylindrical work up to 6 inches in diameter. A magazine feed is used and the work is held, while being ground, between two plungers which locate it in a central position. Provision is made for changing the plunger end to suit various classes of work. The work is rotated while being ground, through a four-speed gear-box mounted on the carriage. The movement of the grinding wheel to and from the work is controlled automatically by a cam on a shaft at the rear, which connects by direct means with the slide. The adjustment of the wheel slide to compensate for wear, when this becomes necessary, is accomplished from the front of the machine. This grinder can also be arranged as a semi-automatic machine by a slight modification of the carriage and the substitution of centers for the automatic chucking mechanism.

Polishing Machine: Robinson Automatic Machine Co., Detroit, Mich. Automatic polishing machine designed for polishing stove plates or any surfaces that are free from abrupt angles. This machine is made in four sizes, and it can be operated by one man. The work while being polished is moved slowly in a longitudinal direction along a carriage operated by an endless chain, and the surface is polished by wheels which have, in addition to a rapid rotary motion, a backward and forward movement across the work. These wheels are made of glued cotton sections similar to those on hand polishers. The first wheel under which the work passes is usually covered with emery cloth to remove the scale, and the last one is a leather finishing wheel of the regular type. The machine is equipped with a blower having an opening back of each wheel to carry away the dust. It is claimed that a saving varying from 50 to 80 per cent on different classes of work, may be effected with this machine, as compared with hand labor.

Turret Lathe: Warner & Swasey Co., Cleveland, O. Combination turret lathe designed to handle a wide range of bar-stock work and forgings. Bar stock up to 3⅛ inches in diameter can be fed through the automatic chuck, and lengths up to 36 inches can be turned at one chucking. Castings and forgings up to 15 inches in diameter can be handled with the chucking outfit. The swing over the bed is 23 inches and over the carriage 17½ inches. The turret is of the hollow, hexagon type and measures 16½ inches across the faces. The turret saddle has ten feed changes, and there are twelve independent adjustable stops that are indexed with the turret and operate automatically. The carriage is of the side type, and has a square turret for holding four tools. It also has ten automatic, longitudinal and cross feeds. There are six independent adjustable stops for the longitudinal travel and the cross feed has one stop in each direction. The turret and carriage have separate feed-rods, so that the feeds are independent of each other, and both are provided with adjustable automatic trips. This machine is built with either a cone or single pulley type of drive.

* * *

T. R. ALMOND MFG. CO.'S EVENING SCHOOL

An evening school has been opened by the T. R. Almond Mfg. Co., at its factory in Ashburnham, Mass., to teach the machinists how to read and make mechanical drawings. This is in harmony with the progressive policy of the company, it being the belief that the broader the knowledge of the employes, the better the work produced.

The accompanying halftone illustration shows the drawing school in session. It will be noticed that the improvised tables, constructed of boards and wooden horses, are lighted with Almond "Flexo" lamps, conveniently arranged to meet every requirement of lighting.

This instructive work, instituted by the chief draftsman, Mr. K. P. Albridge, will be continued under his direction. A

Evening School of the T. R. Almond Mfg Co held in the Shop. Note the Improvised Tables

course consisting of twenty-four lessons has been planned, which will supply the knowledge most needed by the employes of the company. For the purpose of simplifying the technical problems, and to convey the elementary principles to the best advantage, Mr. Albridge intersperses his work with lectures illustrated with black-board drawings.

School lessons are held twice a week and all who have enrolled will be given a broad and comprehensive knowledge of mechanical drawings, ranging from elementary problems to working drawings in gearing. The classes will be continued until the completion of the twenty-four lessons and will be resumed in the fall. Needless to say, the project has awakened keen interest among the men, and the opening session showed a generous representation.

* * *

Every man has a right to his choice of grinding wheels, but the best way to make an intelligent choice is by occasional experimenting with an open mind to determine the relative merits of various makes.

SPRING MEETING OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring meeting of the American Society of Mechanical Engineers was held in Pittsburg, May 30–June 2, the meeting place being Carnegie Institute and the headquarters Hotel Schenley, nearby. The registration of members was 300, and guests 346, making a total registration of 646. The registration of members was the largest of any spring meeting since the Chicago meeting in 1904. The inspection trips to various plants in Pittsburg and vicinity were of unusual interest, and the opportunities to see the manufacture of cement, butt- and lap-welded tubes, heavy engines, steel, etc., were keenly enjoyed by all. The local committee, of which Mr. E. M. Herr was chairman and Mr. Elmer K. Hiles, secretary, was untiring in its efforts to make the meeting successful in every way. A handsome and interesting 56-page booklet was issued containing illustrations and brief descriptions of the leading industries of Pittsburg (most of which were open to inspection by members), historical matters and general features of interest to the visiting engineers.

A pleasing incident of the opening session Tuesday evening was the presentation in behalf of the membership of a beautifully engrossed and illuminated testimonial to Col. E. D. Meier, president, in remembrance of his seventieth birthday. Announcement was made that Col. Meier would later be presented with his portrait done in oils.

lowed by a visit in the afternoon to the Universal Portland Cement Co.'s plant at Universal, Pa., which has a capacity of 10,000 barrels of slag cement per day. A special train of Pullman cars was provided by the company to transport the members and guests to the plant. On the return trip the Westinghouse Electric & Mfg. Co.'s, and Westinghouse Machine Co.'s, works at East Pittsburg were inspected.

Following the reading of the paper on "Milling Cutters and Their Efficiency," by A. L. DeLeeuw, (see May number for abstract), Mr. Elmer H. Neff of the Brown & Sharpe Mfg. Co. read a discussion by Mr. Parker of the same company, which disclosed the fact that the Brown & Sharpe Mfg. Co. has used milling cutters with wide spaced teeth for a number of years with success, when the conditions were favorable. While certain advantages were conceded, the wide spaced milling cutter in Mr. Parker's opinion is poorly adapted for general work. The power of many milling machines in use is inadequate, as are the clamping facilities also, the effect being pounding of the work which loosens it in the vise and produces unsatisfactory results. In his closure, Mr. DeLeeuw deplored the fact that the Brown & Sharpe Mfg. Co. had not made the results of its investigations public and saved others the trouble and expense of conducting independent experiments.

In the discussion of the paper "A Pressure Recording Indicator for Punching Machinery," Mr. Julian Kennedy briefly remarked that in his opinion a more reliable means for indicating the pressure of a punch than a hydraulic cylinder and piston, is a steel bar supported at the ends and loaded in the center. A uniformly tempered steel bar would give an accurate index of the load and not be subject to leakage, frictional resistance and other drawbacks attending the use of hydraulic cylinders and pistons.

Fig. 1. The American Society of Mechanical Engineers' Party at the Universal Portland Cement Co.'s Works, Universal, Pa., May 31

Following is a list of the papers read and discussed:

"Some Problems of the Cement Industry," by Walter S. Landis.

"Edison Roll Crushers," by W. H. Mason.

"Power and Heat Distribution in Cement Mills," by L. L. Griffiths.

"The Assembly of Small Interchangeable Parts," by John Calder.

"Process of Assembling a Small and Intricate Machine," by Halcolm Ellis.

"Quantity Manufacture of Small Parts," by F. P. Cox.

"Milling Cutters and Their Efficiency," by A. L. DeLeeuw.

"Discussion of Large Gas Power Plants," by A. E. Maccoun and others.

"The Work of the U. S. Bureau of Mines," by S. B. Flagg and C. D. Smith.

"Stresses in Tubes," by Reid T. Stewart.

"The Purchase of Coal," by D. T. Randall.

"Energy and Pressure Drop in Compound Steam Turbines," by F. E. Cardullo.

"The Pressure-Temperature Relations of Saturated Steam," by L. S. Marks.

"A Pressure Recording Indicator for Punching Machinery," by G. C. Anthony.

"Commercial Application of the Turbine Turbo-Compressor," by R. H. Rice.

"Reciprocating Blast Furnace Blowing Engines," by W. Trinks.

"Power Forging, with Special Reference to Steam-Hydraulic Forging Presses," by Barthold Gerdau and George Mesta.

The papers on the cement industry were appropriately fol-

Copies of a schedule of standard weight flange fittings and extra heavy flange fittings were circulated, but no discussion of importance developed. The schedule has been adopted by the National Association of Steam and Hot Water Fitters, and the American Society of Mechanical Engineers will probably recommend it as a standard for general use of engineers. The policy of the A. S. M. E. is to adopt no standard as such, but to print data in the proceedings of the Society, thus in effect recommending them to the consideration of members.

An event of general interest was the visit to the National Tube Co.'s works at McKeesport to inspect the manufacture of butt- and lapp-welded tubes. The plant is one of the best in the world, being completely equipped for the production of tubes from the ore. The tube mill is said to be the largest building in the world, being 600 feet wide, 1600 feet long, and covering an area of 23 acres. The members inspecting the plant went by street cars and most of them returned by boat, taking the special excursion steamer that had been

chartered for the day and which touched up at McKeesport dock on the return trip to the city.

Thursday evening was the occasion of a reception and dance at the Hotel Schenley for members, ladies and other guests.

On Friday an inspection trip was taken to the Carnegie Steel Co.'s works at Duquesne, and the Mesta Machine Co.'s works at West Homestead, to see the manufacture of steel and the building of large blowing and rolling mill engines.

Friday evening was the occasion of a smoker and entertainment given in honor of the American Society of Mechanical Engineers by the Engineers' Society of Western Pennsylvania, in the Union Club, Frick Building, on which occasion Mr. George H. Neilson presented "A Near History of Crucible Steel," which, quoting from the program, was a wonderful effort, as witness: "This erudite elucidation enounces every evolution, exposes erstwhile elusive errors, eclaircizes each esoteric essential, eliminates extraneous cristical evanescent, eccentricities, even excogitates exceptionally exact ectypes embracing every element."

* * *

The great White Star liner *Olympic*, arrived in New York harbor June 21 on her first voyage. The new vessel is 882½ feet long, 92½ feet wide, 97 feet from bottom of keel to boat deck, 66,000 tons total displacement and 45,000 tons register. The *Olympic* is equipped with triple screws driven by reciprocating engines and a turbine. The outboard propellers are driven by engines and the center propeller by the low-pressure turbine supplied with exhaust steam from the reciprocating engines. The great size of the vessel is indicated by the weight of some of the gear. The rudder alone, which is electrically operated, weighs 100 tons, the anchors 15½ tons each, the center propeller 22 tons and the outboard or "wing" propellers 38 tons each. Each link of the anchor chain weighs 175 pounds. The main dining room is 90 feet wide by 114 feet long, and seats 532 persons. The vessel has accommodations for 650 first-class passengers, 500 second-class, and 1500 third-class. The officers and crew, including the stewards' department, number 860.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-fourth annual convention of the American Railway Master Mechanics' Association and the forty-fifth annual convention of the Master Car Builders' Association, were held at Atlantic City, N. J., June 14 to June 21, inclusive. The American Railway Master Mechanics' Convention was held June 14, 15 and 16, and the Master Car Builders' Convention June 19, 20 and 21, the order of priority alternating with that of last year, as is the long-established custom.

The technical program of the American Railway Master Mechanics' Association consisted for the greater part as usual of topical discussions and papers on various phases of locomotive design and operation, as follows:

June 14.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Smoke Preventing Devices for Firing-up Locomotives at Terminals"; "Best Construction of Locomotive Frames."

June 15.—Discussion of reports on: "Main and Side Rods"; "Piston Rods and Crossheads"; "Repair Equipment for Roundhouses"; "Water Treatment"; "Lubrication of Locomotive Cylinders"; "Consolidation of the American Railway Master Mechanics' and Master Car Builders' Associations"; "Locomotive Performance Under Different Degrees of Superheated Steam," by Prof. C. H. Benjamin.

June 16.—Discussion of reports on: "Safety Appliances"; "Design, Construction and Inspection of Locomotive Boilers"; "Contour of Tires"; "Steel Tires"; "Flange Lubrication"; "Minimum Requirements for Headlights."

The following officers were elected for the A. R. M. M. Association:

President, H. T. Bentley, Chicago & Northwestern Ry.
First vice-president, D. F. Crawford, Pennsylvania Lines.
Second vice-president, T. Rumney, Erie R. R.
Third vice-president, D. R. MacBain, L. S. & M. S. Ry.
Treasurer, Angus Sinclair, 114 Liberty St., New York.
Secretary, Joseph W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

The program of the Master Car Builders' Association was also largely made up of reports and papers, as follows:

June 19.—"Revision of Standards and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe Equipment."

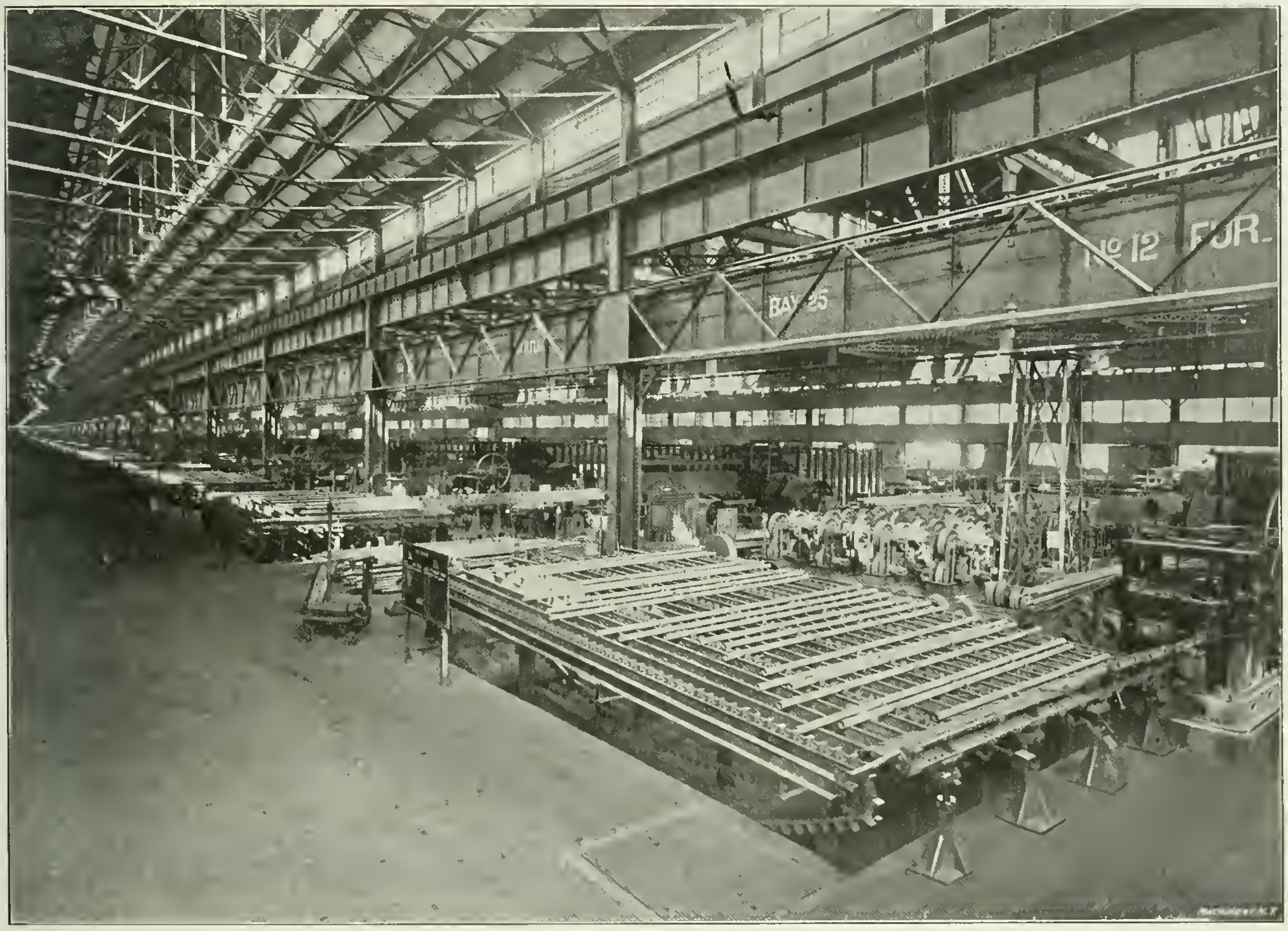


Fig. 2. Interior of the National Tube Co.'s Tube Mill at McKeesport, Pa., visited June 1 by the A. S. M. E.

June 20.—Discussion of reports on: "Rules for Loading Materials"; "Rules of Interchange"; "Prices for Labor and Materials for Steel Cars"; "Coupler and Draft Equipment"; "Car Wheels"; "Safety Appliances"; "Revision of Code of Air Brake Tests"; "Freight Car Trucks"; "Refrigerator Cars."

June 21.—Discussion of reports on: "Consolidation of Master Car Builders' and Master Mechanics' Associations"; "Springs for Freight Car Trucks"; "Lumber Specifications"; "Train Lighting and Equipment"; "Train Pipe Connections for Steam Heat."

The following officers were elected for the M. C. B. Association:

President, A. Stewart, Southern Ry.
First vice-president, D. F. Crawford, Pennsylvania Lines.
Second vice-president, C. E. Fuller, Union Pacific R. R.
Third vice-president, M. K. Barnum, Illinois Central R. R.
Treasurer, J. S. Lentz, Lehigh Valley R. R.
Executive Committee—F. W. Brazier, N. Y. C. & H. R., C. A. Schroyer, C. & N. W., and A. Kearney, N. & W.

The Railway Supply Manufacturers' Association held an exposition of railway car and locomotive parts, and supplies, apparatus, etc., on Young's New Pier. This exhibit of railway supplies is one of the most important held annually in the United States, and grows yearly in importance. Last year the exhibit space was 71,500 square feet and many would-be exhibitors were turned away. This year the total exhibit space was increased about 5000 square feet, and still accommodations were lacking for about seventy concerns. About 260 exhibits were assigned spaces and 70 applicants for space were turned away.

An improved Pond car-wheel lathe on the Boardwalk near the exhibition pier was in operation—demonstrating the great capacity of high-speed steel, the power of the modern machine tool and the ability of the well-trained men in charge. An example of the demonstration was a pair of 36-inch steel-tired coach wheels finished in seventeen minutes from the time of rolling them into the lathe to the time they were rolled out of the way and another pair put in place. Pneumatic clamps for toolposts and tailstocks and pneumatic adjusting cylinders for the tailstocks reduced the physical labor of operation to a minimum. The lathe was driven by a 55 H. P. electric motor.

The exhibit of the United Engineering & Foundry Co., on Mississippi Ave., comprising a complete forging plant on a flat car, attracted much attention. The plant consisted of a steam-hydraulic intensifier forging press of 150 tons capacity, vertical steam boiler and Tate, Jones & Co., Inc., oil fuel furnace. Billets weighing 200 pounds were quickly and almost noiselessly drawn into shapes approximating the dimensions of locomotive piston-rods.

Exhibitors of Metal-working Machines, Accessories and Allied Products

Ajax Mfg. Co., Cleveland, Ohio. Machine-made forgings.

American Tool Works Co., Cincinnati, Ohio. Motor-driven 24-inch engine lathe (see March and June, 1911, numbers for illustrated descriptions); 24-inch back-geared crank shaper; 3-foot back-geared and 6-foot plain radial drilling machines.

American Vanadium Co., Pittsburg, Pa. Vanadium iron and steel products, comprising locomotive parts, automobile parts, etc., some of which had been subjected to severe physical tests to demonstrate great elasticity and strength.

Armstrong-Blum Mfg. Co., Chicago, Ill. "Marvel" automatic high-speed hacksaw.

Armstrong Bros. Tool Co., Chicago, Ill. Lathe and planer tool-holders, ratchet drills, lathe dogs, and other high-grade accessories made by this company.

Besly & Co., Charles H., Chicago, Ill. Patternmakers' disk grinder, taps, oil, babbitt spiral circles, etc.

Bullard Machine Tool Co., Bridgeport, Conn. 42-inch vertical turret lathe (see June number for illustrated description); 64-inch boring drill, maxi-mill type, both motor driven and running.

Cleveland Twist Drill Co., Cleveland, Ohio. Demonstrations of high-speed drills and reamers.

Cochrane-Bly Co., Rochester, N. Y. 8-inch capacity cold saw cutting-off machine; 4½-inch capacity cold saw cutting-off machine; automatic saw sharpener; die filing machine.

Crucible Steel Co. of America, Chicago, Ill. Exhibit of "Rex AA" high-speed steels and tools made of same.

Davis-Bournonville Co., New York, N. Y. Oxy-acetylene welding and cutting equipment for railroads and large manufacturing plants, navy yards, etc.

Detroit Hoist & Machine Co., Detroit, Mich. Pneumatic hoists, motors, etc.

Foster Co., Walter H., New York, N. Y. Hydro-pneumatic radial drill; all-geared multi-spindle drill and pneumatic staybolt nipper.

General Electric Co., Schenectady, N. Y. Centrifugal air compressor, portable air compressor for railway shops and other electrical apparatus for railway purposes.

Goldschmidt Thermit Co., New York, N. Y. Appliances for making thermit welds, samples of welding, etc.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Hand-operated portable chain hoists, screw hoists and differential hoists.

International Correspondence Schools, Scranton, Pa. Books, and work done by students.

Jessop & Sons, Inc., Wm., New York, N. Y. Samples of Jessop tool steels.

Johns-Manville Co., H. W., New York, N. Y. Asbestos products.

Landis Machine Co., Waynesboro, Pa. Double-head 1½ inch Landis bolt cutter, single-head Landis bolt cutter; open die head for turret lathes, etc.

Landis Tool Co., Waynesboro, Pa. 16- by 72-inch plain self-contained grinding machine and 12- by 32-inch universal grinding machine.

Lucas Machine Tool Co., Cleveland, Ohio. Lucas horizontal boring machine and power forcing press.

Manning, Maxwell & Moore, Inc., New York, N. Y. Hancock inspirators, valves, Celfor drills, steam gages, etc.

Matthews-Davis Tool Co., St. Louis, Mo. Davis expansion boring tools.

National Tube Co., Pittsburg, Pa. Kewanee pipe fittings, comprising unions, union ells, tees; flange unions; test pieces from boiler tubes, etc.

Niles-Bement-Pond Co., New York, N. Y. New model motor-driven car-wheel lathe in operation.

Rockwell Furnace Co., New York, N. Y. Furnaces for heat treatment of metals.

Royersford Foundry & Machine Co., Inc., Royersford, Pa. Sells roller bearing shaft hanger box; power punch and shear.

Sellers & Co., Inc., William, Philadelphia, Pa. Locomotive injectors and accessories; locomotive wheel lathe parts, etc.

Sprague Electric Works of General Electric Co., New York, N. Y. Armored air brake hose; pneumatic and hydraulic hose; armored electric conductors; etc.

Underwood & Co., H. B., Philadelphia, Pa. Pipe bender and straightener; portable cylinder boring bar, etc.

Union Mfg. Co., New Britain, Conn. Complete line of chucks made by the company.

Van Dorn & Dutton Co., Cleveland, Ohio. Electrically-operated portable drilling and reaming machines.

Vandyck Churchill Co., New York, N. Y. Higley cutting-off machine.

Warner & Swasey Co., Cleveland, Ohio. New hollow hexagon turret lathe.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Alternating and direct current motors, control apparatus, etc.

Yale & Towne Mfg. Co., New York, N. Y. Chain blocks, trolleys, electric hoists, hardware, etc.

* * *

SUMMER MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The summer meeting of the Society of Automobile Engineers was held in the Algonquin Hotel, Dayton, Ohio, June 15-17, and the following program of technical papers and discussions was presented:

June 15.—Opening address by the president, Henry Souther. Reports of Standards Committee Division: (*a*) "Iron and Steel Division," Henry Souther; (*b*) "Aluminum and Copper Alloys Division," W. H. Barr; (*c*) "Seamless Steel Tubes Division," H. W. Alden; (*d*) "Nomenclature Division," P. M. Heldt; "The Question of Long- Versus Short-Stroke Gasoline Motors," by J. B. Entz; "Long Addendum Gears," by E. W. Weaver; "The Influence of the Engineer on the Sales Department," by William P. Kennedy. Report of Wheel Dimensions and Fastenings for Tires Division.

Discussions.—"Special Methods of Loading Commercial Vehicles"; "Dumping Trucks"; "Auxiliary Apparatus for Commercial Vehicles"; "Trailers for Commercial Vehicles"; "Location of Working and Emergency Brakes."

June 16.—"Elements of Ball and Roller Bearings Design," by Arnold C. Koenig; "Worm Gears and Wheels," by E. R. Whitney. Reports of Standards Committee Division: (*e*) "Ball Bearings Division," David Fergusson; (*f*) "Broaches Division," Charles E. Davis; (*g*) "Carbureter Division," G. G. Behn; (*h*) "Frames Division," James H. Foster.

Discussions.—"Transmission Location—Whether on Rear Axle or Attached to Car Frame"; "Underslung Frames."

June 17.—"Rotary Gasoline Motors," by C. E. Mead; "Some Points on the Design of Aluminum Castings," by H. W. Gillett; "Oversize Standards for Pistons and Rings," by James N. Heald. Reports of Standards Committee Division: (*i*) "Lock Washer Division," J. E. Wilson; (*j*) "Sheet Metals Division," James H. Foster; (*k*) "Springs Division," A. C. Bergmann, (*l*) "Miscellaneous Division."

Discussions.—"Multiple-Disk Clutches"; "Six-Cylinder Versus Four-Cylinder Motors of Equal Rating."

SMALL FLEXIBLE SHAFT AND MACHINES BY WHICH IT IS MADE

The accompanying line engraving Fig. 1 shows at *A* a drawing of a small flexible shaft (full size) made by the Veeder Mfg. Co., Hartford, Conn. As will be noted, this flexible shaft is composed of alternate links and sleeves held together by pins passing through holes in the sleeves and elongated openings in the links. At *B* and *C* in the same illustration the links and sleeves are shown twice their actual size, in order to clearly indicate their appearance. The sleeves are cut off in an automatic screw machine from tubing, the ends being slightly chamfered at the same time. The links are also formed and cut off in an automatic screw machine. In the following are illustrated and described the machines used for drilling the holes in the sleeves, and for milling the elongated holes in the links.

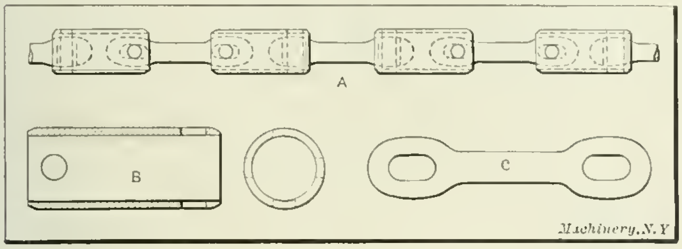


Fig. 1. A Simple Construction of Flexible Shaft—Upper View is Full Size, Lower Views are Twice Actual Size

For drilling the sleeves, the machine illustrated in Fig. 2, which drills the four holes in the sleeves at once, is used. In Fig. 3 is shown a line engraving giving the details of the construction of this four-spindle machine. By referring to Figs. 2 and 3, it will be seen that the drills are guided in bushings in a stud in the center of the machine, in which the sleeve is inserted. The sleeve is held while drilling by a draw-in chuck operated by handle *F*. Each of the spindles is driven from a pulley of its own by a round belt, the spindle pulleys being placed underneath the bench on which the machine is mounted, and all are driven from a common driving pulley. The drills are fed into the work by a slight movement of handle *A*. This handle is inserted in the rim of a large spur gear which engages with a pinion opposite each of the drill spindles, as shown clearly in Fig. 2. This pinion is also shown in the sectional view in Fig. 3, and is indicated by the letter *B*. On the stud *C*, on which this pinion is mounted, gear teeth are also cut, engaging with a circular rack *D* which is mounted on the drill spindle. In this way the motion from handle *A* is transmitted through the spur gear into which it is inserted, and through gears *B* and *C*, to the drill spindle, feeding it in or removing it from the work, as the case may be. As it is required that the spindle move back and forth in its pulleys, a special kind of sliding keyway provided with rollers, as shown at *E* in Fig. 3, has been provided.

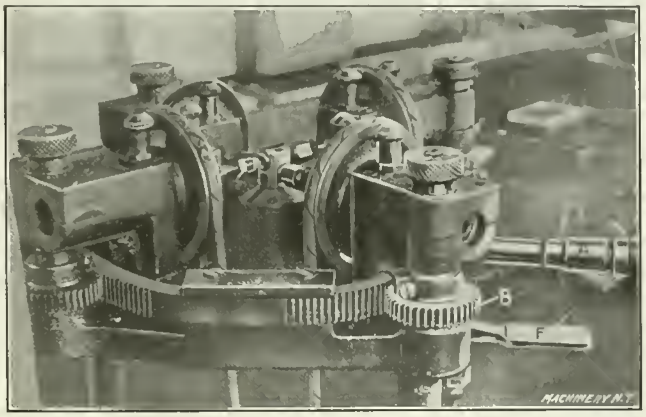


Fig. 2. Sleeve Drilling Machine

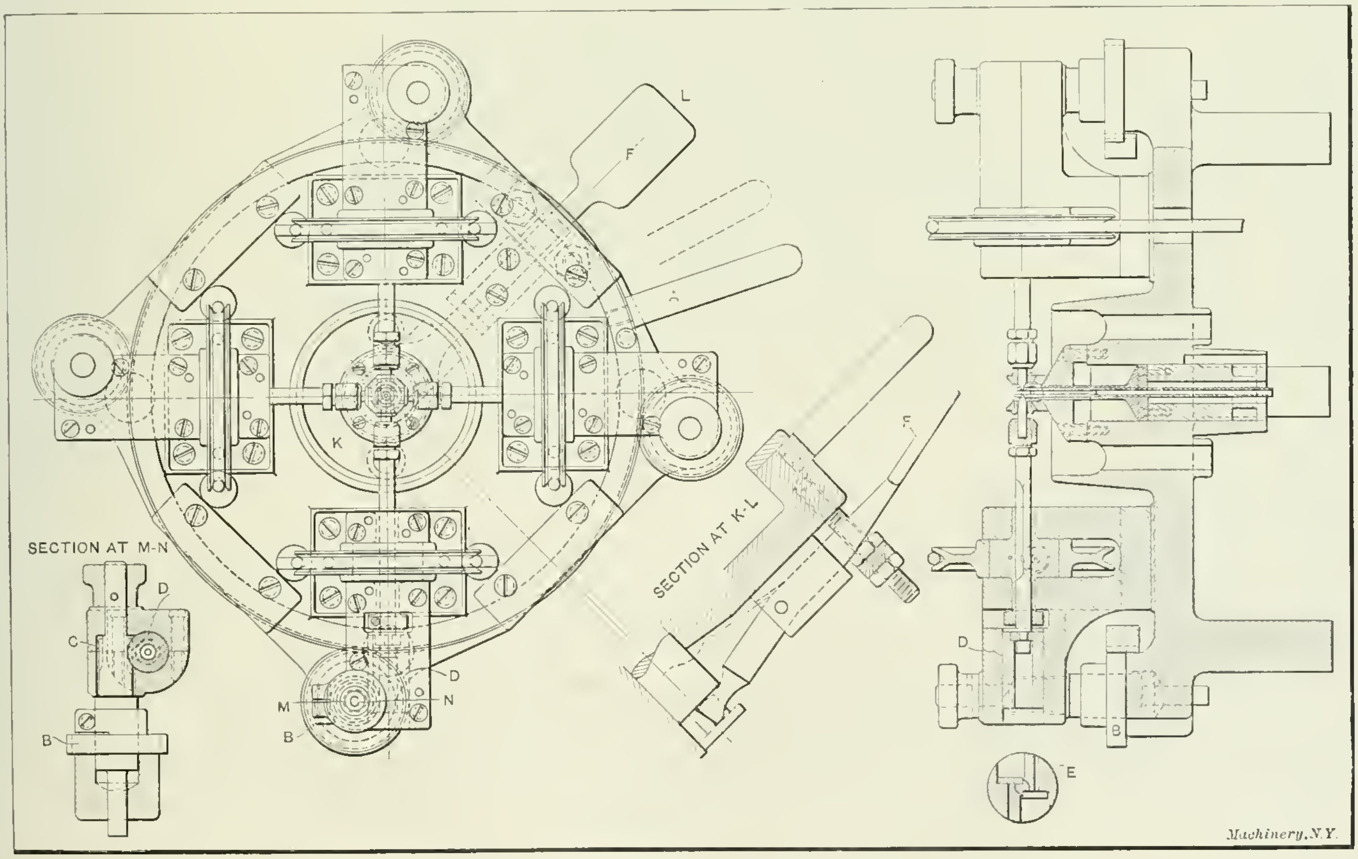


Fig. 3. Construction of Sleeve Drilling Machine

For milling the elongated hole in the ends of the links *C*, Fig. 1, the machine shown in Fig. 4 is used. The links are held in the small holder *A* shown removed from the machine and resting against its base. Two links can be clamped in this holder at once, one on each side of the center stud, the links being held in a horizontal position while milling. The oblong holes in the links are milled by small end-mills held in the two spindles of the machine shown at *B*. When in operation, the machine mills the two elongated slots at one end of the two links at once, and then the slots at the other end. It will be noticed that slide *A* is provided with two grooves *C* on the extending stem. At *D* is a locking arm which can engage with either of these two grooves. When the locking

arm engages with the outer groove, the holes in one end of the links are being milled, and as soon as the operation is completed, the locking arm is lifted, the slide is pulled out and the arm placed in engagement with the inner of the two grooves *C*. Now the two remaining slots in the links are

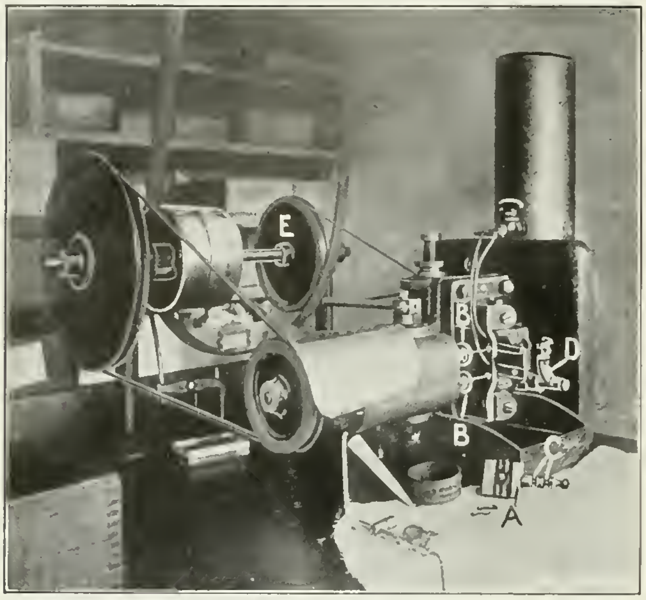


Fig. 4. Machine for Milling Oblong Holes in Flexible Shaft Links

milled. The operation is very rapid. While milling, slide *A* is reciprocated by a motion transmitted to the machine from pulley *E*, so that the end-mill will cut an oblong hole in the link.

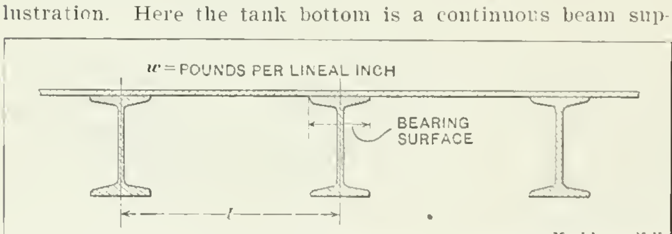
* * *

MAXIMUM CENTERS OF BEAMS FOR STEEL TANK BOTTOMS

By EDMUND B. LA SALLE*

In designing steel tanks, it is necessary to know the spacing of the supporting beams for a given head of water and a given thickness of plate; sometimes two of these factors are known, and it is required to find the third. Having to design numbers of steel-tank floor systems for the company with which the writer is connected, the accompanying table was developed.

The working conditions of the floor are shown in the illustration. Here the tank bottom is a continuous beam sup-



Section of Bottom of Steel Tank showing Continuous Beam Analogy

ported by I-beams or wooden beams, as required by specification. Now the maximum bending moment for a continuous beam is given by different authorities as either $\frac{wl^2}{12}$ or $\frac{wl^2}{13}$ where w is the weight per lineal inch and l, the distance between centers in inches. The table is based on the latter value, which is approximately the same as that given by Trautwine for a continuous beam with six or more supports. With beams spaced by these original tables it appeared that the flooring was unduly strong, so for that reason the maximum bending moment formula was changed to $\frac{wl^2}{15}$ by changing the denominator from 13 to 15, which, when introduced into the beam equation, reduces the weights of the parts.

That this assumption of a smaller bending moment is justifiable may be readily recognized by a little consideration. The floor plate, when resting on the supporting beams, has a bearing surface never less than 3 inches in width; thus the actual unsupported distance between beams is reduced by that amount. This, however, is not considered in the value of l introduced in the bending moment formula, so that compensation is obtained by changing the constant. Also, when the deflection is large the plate will assume a corrugated surface with a curve like the catenary. The writer considers that this tends to substitute a pure tensile stress for that of bending; this, however, is his own assumption.

As an example, suppose it is desired to find the center distances of supporting beams when 5/16-inch plate is used as flooring under a 26-foot head of water. By looking up the table, the spacing will be found to be 18 inches. It might be mentioned that, in the table, the maximum assumed stress is taken as 15,000 pounds per square inch, which works out to a factor of safety of about 4.

TABLE OF MAXIMUM CENTERS OF BEAMS

Maximum Centers of Beams in Inches

Thickness, Inches	Height of Water in Feet											
	4	6	8	10	11	12	13	14	15	16	17	18
3/16	27½	22½	19½	17½	16	15¾	15¼	14¾	14[illegible]	13¼	13¼	12¾
1/4	36¾	30	26	23¼	22	21½	20¼	19½	18¾	18¼	17¾	17¼
5/16	46	37½	32½	29	27¾	26½	25½	24½	23¾	23	22¼	21⅝
3/8	55	45	39	34¾	33¼	31⅞	30½	29½	28½	27½	26¾	26
7/16	64	52½	45⅝	40½	38¾	37½	35⅝	34⅝	33¼	32½	31¼	30⅝
1/2	73½	60	52	46½	44¼	42⅝	40¾	39¼	38	36¾	35⅝	34⅝

Thickness, Inches	Height of Water in Feet											
	19	20	21	22	23	24	25	26	27	28	29	30
3/16	12½	12¼	12	11¾	11½	11¼	11	...	...	...	...	...
1/4	16¾	16⅝	16	15⅝	15¼	15	14⅝	14⅜	14⅛	13⅞	13⅝	13⅜
5/16	21	20½	20	19½	19½	18¾	18⅝	18	17⅞	17¼	17	16¾
3/8	25¼	24⅝	24	23½	23	22½	22	21⅝	21¼	20⅞	20½	20⅛
7/16	29½	28¾	28	27⅜	26⅞	26½	25⅝	25½	24⅞	24½	23⅞	23½
1/2	33¾	32¾	32	31¼	30⅝	30	29⅝	28¾	28¼	27¾	27¼	26¾

Thickness, Inches	Height of Water in Feet											
	32	34	36	38	40	42	44	46	48	50	55	60
1/4	13	12⅝	12¼	11⅞	11⅝	11¼	11	...	...	...	...	...
5/16	16¼	15¾	15¼	14⅞	14¾	14½	13⅞	13½	13¼	13	12⅝	11⅝
3/8	19¼	18⅞	18⅜	17⅞	17⅝	17	16⅜	16¼	15⅞	15½	14⅞	14¼
7/16	22¾	22	21⅝	20⅞	20⅝	19⅞	19⅝	19	18⅝	18½	17¼	16½
1/2	26	25¼	24½	23⅞	23¼	22⅝	22½	21⅝	21½	20¾	19⅝	19

* Address: 159 Harrison St., Batavia, Ill.

* * *

The man who undertakes the cultivation of strength of character simply by learning to say No, is likely to develop more cussed crankiness than real character, because other things than negatives are necessary in a strong character.

* * *

PERSONALS

William Wolfred, for the past five years general foreman of the Atlas Engine Works, Indianapolis, Ind., assumed the superintendency of the motor shops of the same company June 12.

Willard C. Brinton, formerly with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is now assistant vice-president of the United States Motor Co., 61st St. and Broadway, New York City.

R. H. Wadsworth, formerly assistant superintendent of the Waverley Co., Indianapolis, Ind., has been made general superintendent and works manager of the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

H. A. Hunt has been appointed Eastern sales agent for the Edgar Allen American Manganese Steel Co., with headquarters at New Castle, Del. The appointment was made in order to fill the vacancy caused by the resignation of Mr. V. W. Mason, Jr.

Joseph V. Woodworth, formerly superintendent of the Harwood Mfg. Co., Brooklyn, N. Y., and author of several books on machine shop practice, is now with the Taft-Peirce Mfg. Co., Woonsocket, R. I., as consulting engineer and expert in sheet-metal formation and punch and die practice.

L. A. Breitinger, president and general manager of the American Cuckoo Clock Co., Philadelphia, Pa., recently invented and installed a device in his plant which enables persons in any part of the works to immediately shut down all the machinery either in that particular department or the entire plant in a few seconds.

George Braithwaite, factory manager of the Stevens-Duryea Co., Chicopee Falls, Mass., has resigned to become production manager of Thomas B. Jeffrey & Co., Kenosha, Wis. Mr. Braithwaite was first employed by the Stevens-Duryea Co. nine and a half years ago as a toolmaker, and his rapid rise is due to his native ability as a manager of men. Substantial testimonials of regard were presented to Mr. Braithwaite by the six hundred and fifty employes upon his departure.

John M. Shrigley, president of the Williamson Free School of Mechanical Trades, was honored with the degree of Master of Arts by Swarthmore College at her recent commencement, June 7, 1911. It is interesting to note that Swarthmore is the first college to especially honor a person who has devoted his whole career, in educational lines especially, to industrial work, which has been the relation of President Shrigley to school life. The degree was given in recognition of Williamson and her achievements under the efficient management of the president.

W. H. Stillwell, electrical engineer, has just joined the engineering and selling force of the J. S. Bretz Co., the importers of the F. & S. annular ball bearings, German steel balls, U. & H. master magneto, and Bowden wire mechanism. Mr. Stillwell, who graduated from Purdue University in 1906, has since that time been associated with the Westinghouse Electric & Mfg. Co., and during the past year has specialized on the sale of motors and controllers for electric vehicles. He will make his headquarters at the New York office of the J. S. Bretz Co., looking after the trade in Cleveland and all the territory east of it, included in the Middle and New England states.

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OBITUARY

W. H. Herbert, director of Alfred Herbert, Ltd., Coventry, England, from the time of formation of the company, in 1894, died at his residence, The Grange, Coventry, June 10.

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COMING EVENTS

July 6-8.—Semi-annual meeting of the American Society of Heating and Ventilating Engineers, Chicago, Ill. W. W. Macon, secretary, 29 West 39th St., New York.

August 15.—Annual meeting of the International Railroad Blacksmiths' Association, Toledo, Ohio. A. L. Woodworth, secretary, Lima, Ohio.

August 29-Sept. 1.—Nineteenth annual convention of the Traveling Engineers' Association, at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Car Shops, East Buffalo, N. Y.

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York City.

SOCIETIES AND COLLEGES

Newberry College, Newberry, S. C. Register 1910-1911; announcements for 1911-1912.

Delaware College, Newark, Del. Register for 1910-1911; announcements for 1911-1912.

Louisiana State University, Baton Rouge, La. Catalogue, 1910-1911; announcements, 1911-1912.

David Ranken, Jr., School of Mechanical Trades, St. Louis, Mo. Second annual catalogue, 1911-1912.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering, 1911-1912.

New Mexico School of Mines, Socorro, N. M. Annual register for 1910-1911; announcements for 1911-1912.

NEW BOOKS AND PAMPHLETS

Magnetic Properties of Heusler Alloys. By Edward B. Stephenson. 38 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin is a contribution of data on the subject of magnetic alloys, and describes fully the methods of magnetic testing, thermal analysis and photo-micrography used in the work. The results show that an alloy of ferro-magnetic properties comparable with those of cast iron can be made of the non-magnetic components copper, manganese and aluminum, and that the magnetic properties depend largely on the heat treatment.

Air-Brake Catechism. By Robert H. Blackall. 352 pages, 4½ by 7 inches. 117 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.

Through so many editions (this is the twenty-fifth) has this book passed, that but little further need be said regarding its value. It fully covers all the air-brake equipment manufactured by the Westinghouse Air Brake Co., describing it in a manner calculated to be intelligible to the class of men for whom it is written. In addition, it contains 2000 questions and answers, intended as examination questions for engineers and firemen, and all other railroad men, preparing to pass an examination on the subject of air brakes.

Train Rule Examinations Made Easy. By G. E. Collingwood. 234 pages, 4 by 6½ inches. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $1.25.

Throughout the book the author has endeavored to explain the train rules and train orders in such a way as to make them as clear as possible. The factors which have been instrumental in developing the present system of train operation are mentioned whenever it seems necessary to better enable the student to understand the necessity of any particular rule. The rulings throughout are based on those made from time to time by the American Railway Association. The 234 pages of text is divided into twenty chapters, touching on all phases of the subject.

Das Skizzieren von Maschinenteilen in Perspektive. By Carl Volk. 37 pages, 6 by 9 inches. 68 illustrations. Published by Julius Springer, 3 Monbijouplatz, Berlin N., Germany. Price, 40 cents.

As the name implies, it is a text book on methods of making perspective drawings. Although printed in the German language, it is so profusely illustrated throughout that even to one unfamiliar with the language the book is very instructive. Considering first very simple rudimentary sketches, the principles and methods are gradually developed until complex mechanisms such as are met in daily drafting-room practice, are taken up, and explained step by step.

Spontaneous Combustion of Coal. By S. W. Parr and F. W. Kressmann. 87 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin describes a series of experiments directed toward the determination of the fundamental causes underlying the spontaneous combustion of coal. These causes may be summarized as follows: (1) external sources of heat, such as contact with steam pipes, hot walls, and the impact of large masses in the process of unloading, height of piles, etc.; (2) fineness of division; (3) moisture; (4) activity of oxidizable compounds, such as iron pyrites. An historical review of the literature upon the spontaneous combustion of coal is given in the appendix.

La Compagnie des Chemins de Fer de Paris a Lyon et a la Mediterraanée a l'Exposition Internationale de Turin, 1911. 26 pages, 8 by 12 inches. Illustrated, 11 plates.

It is very rarely that such a thoroughly gotten up book as this one, describing the rolling stock exhibited at Turin by the Paris to Lyon and the Mediterranean Railway Company, is ever published by any railway. Being in French will make it a closed book to many, which is unfortunate, so valuable is it in setting forth the best practice in French (and consequently continental European) rolling stock construction. The profuse illustrations give a good idea of the degree of comfort made possible by some of the beautiful designs of passenger cars. The eleven plates referred to illustrate locomotives and their characteristics.

Inventor's Pocket Library. 4 by 9 inches. Ten pamphlets in the set, varying from four to six pages each. Published by the Engineer Searching Co., 1403.5 New York Ave., N.W., Washington, D. C.

This series of pamphlets, dedicated to the brotherhood of inventors, contains ten talks on patent subjects for young inventors, warning them of the various pitfalls, and instructing them in the fundamentals of patent law. The titles of the ten pamphlets are: The Language of Two Letters; Hints, Tips and Don'ts for Inventors; The "Brotherhood" Protective Caveat; Inventor's Catechism; Inventor's Dictionary; American Wastes the Inventor's Opportunity; Why Success or Failure in Invention?; The Superstition of Secrecy; Educational and Protective Value of Sketching; and Engineer or Lawyer Searching.

Practical Instructor and Reference Book for Locomotive Firemen and Engineers. By Chas. F. Lockhart. 362 pages, 5 by 7 inches. 88 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $1.50.

The incentive for writing this book lies in the realization by the author that the locomotive engineer who does not combine technical knowledge with that gained from practice is fast giving way to the more progressive type. With that object in view, the author has endeavored to combine technical knowledge with practical experience in such a way as to make the book thoroughly intelligible to all engineers and firemen; the author has made good service of his practical knowledge in so doing. Throughout the idea of simplicity seems to have been kept well to the fore, and in order that it might be useful for ready reference as well as for a test, it is subdivided to such an extent that the desired points can be readily gotten at. There are six main parts as follows: The Fireman's Duties; General Description of the Locomotive, Its Construction and Operation; Locomotive Breakdowns and Their Remedies; Air Brakes; Extracts from Standard Rules, and Questions for Examination.

Principles of Industrial Engineering. By Charles B. Going. 174 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York. Price, $2.

In the beginning of manufacturing when the number of individuals employed in any one shop, mill or factory was comparatively small, the science of management was without shape or form, although probably every manager worked in harmony with certain principles, if he was successful. These principles being largely an expression of personality, were accepted as attributes of men rather than something capable of classification and definition. The past quarter century of unparalleled industrial development has been marked by the organization and formulation of certain principles of management applicable to large and small industries. This book in review is composed principally of the text of lectures delivered by the author before the senior students in mechanical engineering, Columbia University, modified somewhat to suit non-technical readers. The contents by chapters are as follows: "The Origin of the Industrial System"; "Reflex Influences of the Industrial System"; "Principles of Industrial Organization"; "Forms of Industrial Ownership"; "The Nature of Expense"; "Distribution of Expense"; "Labor—The Primary Wage System"; "Labor—Philosophies of Management"; "Materials."

CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Bulletins 4826 and 4827 on water and air flow meters, respectively.

General Electric Co., Schenectady, N. Y. Bulletin 4851 on electricity in the service of steam railroads.

General Electric Co., Schenectady, N. Y. Bulletin 4835 on electrically-driven pumps, centrifugal and reciprocating types.

Rock Island Mfg. Co., Rock Island, Ill. Catalogue F of Rock Island vises for machinists, blacksmiths, steam-fitters, electricians, etc.

Hammacher, Schlemmer & Co., cor. 4th Ave. and 13th St., New York. Catalogue No. 427 on Colt's quick-acting clamps for woodworkers.

General Electric Co., Schenectady, N. Y. Bulletin 4825 on a line of moderate priced alternating- and direct-current switchboard instruments.

Multiple Unit Electric Co., New York. Circular of the Kohn system replaceable unit electric heating appliances for commercial and scientific work.

General Electric Co., Schenectady, N. Y. Bulletin 4845 on horizontal steam turbine generators of from 100 to 1000 kilowatts capacity at 3600 revolutions per minute.

AUTOMOBILE CLUB OF AMERICA, 54th and 55th Sts., west of Broadway, New York. Bulletin of the facilities for testing motors and automobiles with rules for scientific tests.

FLASHILL & GRAY, London, Canada. Catalogue of B and G rotary single strand barb wire machine (see MACHINERY, January, 1911, for description of the principle of operation).

CROCKER-WHEELER CO., Ampere, N. J. Circular of Remek transformers, describing the general method of construction, and giving data of interest to electrical engineers and users.

VULCAN SOOT CLEANER CO., Pittsburg, Pa. Catalogue of the "Vulcan" soot cleaner for removing soot and ashes from the heating surfaces of boilers, and thus increasing boiler efficiency.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4819 on alternating-current switchboard panels with oil switches on panels for three-phase, three-wire circuits of 480 and 600 volts, 25 to 60 cycles.

UNITED ENGINEERING & FOUNDRY CO., Pittsburg, Pa. Catalogue of high-speed forging presses of the steam-hydraulic intensifier type, built for all classes of forging, shearing or pressing, 100 tons to 12,000 tons capacity, all with single lever control.

HESS-BRIGHT MFG. CO., 21st St. and Fairmount Ave., Philadelphia, Pa. Catalogue of ball bearings for woodworking machinery, illustrated with examples of woodworking machines equipped with Hess-Bright annular and thrust ball bearings.

NATIONAL CARBON CO., Cleveland, Ohio. Bulletin on the "Practical Operation of Arc Lamps," containing also practical electrical data useful to linemen, electricians, electrical engineers, etc. The bulletin contains 76 pages, and will be sent free on request.

GISHOLT MACHINE CO., Madison, Wis. Leaflet briefly describing the growth of the company's business and giving the reason for the name "Gisholt." "Gisholt" is the name of the boyhood home in Norway of the founder of the business, Mr. John A. Johnson.

CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa., builder of steam and hydraulic forging, bending and flanging tools, calendar 18 by 26½ inches, June, 1911, to May, 1912, inclusive. The calendar illustrates the double and single column types of steam hammers.

CENTURY MFG. CO., Cleveland, Ohio. Circular of the Century adjustable steel drafting table made in thirteen sizes, ranging in price from \$6.50 to \$54. For the smaller sizes the tables are made with basswood tops, and for the larger sizes with Michigan white pine tops.

MARIS BROS., 56th St. and Gray's Ave., Philadelphia, Pa. Catalogue of I-beam trolleys, plain and geared types. The trolleys are made of steel, except the wheels, which are of cast iron with chilled treads, for 4-inch to 18-inch I-beams and from ¼ to 10 tons capacities.

ARMSTRONG BROS. TOOL CO., 313 N. Francisco Ave., Chicago, Ill. Circular of the Armstrong drop-forged steel lathe dogs and clamps. The lathe dogs are made with single screw up to 6 inches capacity, and with two screws up to 8 inches capacity. The clamps are made up to 12 inches capacity.

PULSOMETER STEAM PUMP CO., 17 Battery Place, New York. Catalogue No. 17 on the "pulsometer," a steam pump without pistons or rotors. The pulsometer is largely used by contractors for draining trenches, excavation of cellars, sewers, etc., being unaffected by the grit or gravel that ruin a piston pump.

OTTO GAS ENGINE WORKS, 33rd and Walnut Sts., Philadelphia, Pa. Bulletin No. 34, illustrating and describing the Otto gasoline electric tool car for railway maintenance-of-way work. It is used for conveying men and tools to points along the track and for supplying the necessary power to operate electric track tools.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Bulletin illustrating large office buildings in New York City equipped with Cutler-Hammer apparatus. The bulletin includes a large scale map of Manhattan Island, incidentally showing the locations of the New York plant of the Cutler-Hammer Mfg. Co., and its up- and down-town offices.

HESS-BRIGHT MFG. CO., 21st St. and Fairmount Ave., Philadelphia, Pa. Catalogue of ball bearings for flour and feed milling machinery of the annular and thrust bearing types. It is claimed that the use of ball bearings and milling machinery greatly reduces the power consumption and eliminates the risk of fires incident to hot bearings.

CHICAGO AUTOMATIC SCREW MACHINE CO., Oakley Ave., Kinzie St. and C. & N. W. tracks, Chicago, Ill. General catalogue of automatic screw machines built in five styles and capacity from ¾ to 2 inches, inclusive; also Chicago semi-automatic threader, metal saw; spring chucks and feeders and automatic screw machine equipment in general.

HESS MACHINE WORKS, 25th & Callowhill Sts., Philadelphia, Pa. Circulars of file grinding and file cutting machinery. The file cutting machines are furnished in seven sizes, having capacities from the largest to the smallest files. The file grinding machine is designed for grinding file blanks preliminary to the cutting operation; it is built in two sizes, having capacities from 18-inch to 3-inch files.

SCHUCHARDT & SCHUTTE, Cedar and West Sts., New York City. Circular of a hand tachometer of improved form, made in seven styles ranging in price from \$25 to \$38, and registering 300 to 12,000 revolutions per minute. The "S & S" tachometers indicate not only the number of revolutions of shafts and spindles, but by using the measuring disk, the peripheral speed of pulleys or belt speeds can be read directly.

VANADIUM SALES CO. OF AMERICA, Frick Bldg., Pittsburg, Pa. Special number of *American Vanadium Facts*—convention issue for the American Foundrymen's Association held in Pittsburg in May. The number is devoted to vanadium in cast iron, vanadium steel castings, and vanadium in bearing metals; it contains photographs of special vanadium steel castings for locomotive work, locks of the Panama Canal, etc.

UNION TWIST DRILL CO., Athol, Mass. Catalogue No. 100, on milling and high-power cutters of high-speed steel. The Union Twist Drill Co. is manufacturing the new line of milling cutters developed by the Cincinnati Milling Machine Co. under the direction of its chief engineer, A. L. DeLeeuw (see MACHINERY, April, 1911, for abstract of paper by A. L. DeLeeuw, on these cutters and their characteristics read before the Spring 1911 meeting of the American Society of Mechanical Engineers).

BOSTON GEAR WORKS, Norfolk Downs, Mass. Catalogue E-4 containing directions for ordering gears; design of standard steel gears; lists of cut steel spur gears from 16 to 6 pitch, inclusive; cut cast-iron spur gears from 20 pitch to 4 pitch, inclusive; steel racks with generated teeth; finished brass spur gears; brass racks; cut brass internal gears; steel miter and bevel gears; cast-iron miter and bevel gears; brass miter and bevel gears; steel worms and cast-iron worm-gears; iron, brass and steel helical gears; sprocket wheels and chains; universal joints, etc.

GREENLEE BROS. & CO., Rockford, Ill. Sectional catalogue of railway car shop and special woodworking machinery, comprising chisel mortisers; horizontal and vertical car borers; multiple spindle and gang borers; power feed and power self-feed rip saw benches; single and double automatic horizontal cut-off saws; variety, universal and cabinet saw benches; light and heavy, single and double tenoners, gainers and vertical saws; jointers, variety woodworkers, and sash and door machines; stickers and outside molders, mine timber machines; cutter heads and specialties; chisel bits, augers and other tools.

GENERAL FIRE EXTINGUISHER CO., 1 Liberty St., New York, has issued a special bulletin on the Asch Bldg. in New York, where nearly one hundred and fifty persons lost their lives. The bulletin illustrates the horrors of the fire and emphasizes the importance of equipping manufacturing plants containing highly inflammable materials with automatic sprinklers. Had the Triangle Shirtwaist Co.'s factory in the Asch Bldg. been equipped with automatic sprinklers, the fire undoubtedly would have been confined to a very small blaze that could have been quickly extinguished without the panic and the terrible resulting loss of life.

FOOS GAS ENGINE CO., Springfield, Ohio, has collected data for a bulletin No. 92 on the relative economy of internal combustion engines, operating on petroleum and distillates. A 23-horsepower engine working at full load on kerosene at 5 cents a gallon shows a fuel cost of \$1.55 for a ten-hour day. A gasoline engine under the most favorable conditions would use 31¼ gallons of fuel, which at 12 cents per gallon would cost \$3.75. The total saving for 300 working days is \$660 in favor of the oil engine. Inasmuch as kerosene as low as 4 cents a gallon may be obtained in many places, and oils are available at 2½ cents, the advantage is even greater than indicated in the foregoing.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis. Attractive bulletin illustrating the plant and products of the company, which is one of the leading concerns in Milwaukee. The plant occupies a tract of twenty acres and includes a main factory building 414.4 by 360 feet, comprising the girder and erecting shops, trolley assembling, machine shops, electrical department, castings storage, stock-rooms, templet and carpenter shops. Other buildings are the storage shed, foundry, pattern-shop, power house and office building. The products illustrated comprise: traveling cranes; charging machines; electric hoists; telpher hoists, switches, turntables and crossovers for monorail system; motors; controllers; I-beam trolleys; horizontal, drilling and boring machines; grab buckets, etc.

TRADE NOTES

H. W. JOHNS-MANVILLE CO., 100 William St., New York, recently acquired the sole American rights to the well-known English packing "Sea" rings.

FORT WAYNE ELECTRIC WORKS, was merged with the General Electric Co. June 1, and will hereafter be known as Fort Wayne Electric Works of the General Electric Co.

GREENLEE BROS. & CO., Rockford, Ill., have transferred their general machinery sales office for car shops and special woodworking machinery from Chicago, Ill., to Rockford, Ill.

CARPENTER KERLIN GEAR & MACHINE CO., maker of cut gears, has changed its corporate name to Carpenter-Tew Gear Co., and has removed its factory and office to Bush Terminal Bldg., Factory No. 5, Brooklyn, N. Y.

L. S. STARRETT CO., Athol, Mass., announces that its New York store is now permanently located in new and larger quarters at 150 Chambers St., where a complete stock of fine mechanical tools is in charge of Mr. L. G. Kuhn, manager.

BILLINGS & SPENCER CO., Hartford, Conn., has begun the construction of a 40- by 113-foot, three-story and basement addition to its storehouse and shipping department. A new pickling house measuring 20 by 30 feet, and a heat-treatment or annealing room, 35 by 60 feet, are also being added.

SPRAGUE ELECTRIC CO., 527 West 34th St., New York, was merged with the General Electric Co., Schenectady, N. Y., June 1. The business will be conducted under the name of Sprague Electric Co. Works of the General Electric Co., and under the same organization as heretofore, with Mr. D. C. Durland general manager.

AUTOMOBILE CLUB OF AMERICA, New York, will conduct a competitive test of aeronautical motors. The winner will be awarded a cash prize of \$1000. Entry blank and rules for the test can be obtained from the Testing Laboratory, The Automobile Club of America, 54th and 55th Sts., West of Broadway, New York.

ERIE CITY IRON WORKS, Erie, Pa., has completed its new stack and tank shop building, 300 feet by 100 feet, which is up to date in every respect, both as to the building and equipment. The company is now prepared to quote prices on all sizes of tanks, including air-pressure tanks, water pressure tanks, sugar tanks, drip tanks, ordinary light steel tanks, etc.

THOMAS D. ANDREWS, instructor of engineering, School of Mines and Industries, Bendigo, Victoria, Australia, requests manufacturers of machine tools, mining machinery, pumping machinery, steam and gasoline engines, cranes, hoists, steel work, etc., to send their catalogues for filing in the school library, where they will be referred to by students studying engineering.

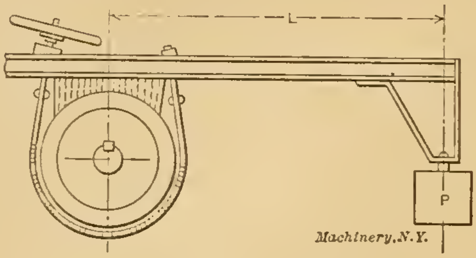
ANDERSON & TAYLER, Ford Bldg., Detroit, Mich., is a partnership recently formed by Edward L. Anderson, industrial engineer with office formerly in the Newberry Bldg., and Theron C. Tayler, mechanical engineer, located in the Ford Bldg. The partners will maintain a testing laboratory in the Newberry Bldg., and their work will consist of examinations, tests and reports on economy, efficiency and capacity of power and industrial plants and accessories.

TATE, JONES & CO., INC., Empire Bldg., Pittsburg, Pa., exhibited an interesting demonstration car at the Atlantic City convention of the American Railway Master Mechanics' and Master Car Builders' associations. The car contains an upright boiler arranged for using oil fuel and a large oil-fired forging furnace, designed by Tate, Jones & Co., Inc., and a hydraulic forge press built by the United Engineering & Foundry Co., of Pittsburg. The outfit was in full operation and attracted many railway men interested in economical and efficient blacksmith shop equipment.

OTTO GAS ENGINE WORKS, Philadelphia, Pa., has appointed Mr. M. A. Johnson, 537 S. Dearborn St., Chicago, Ill., its representative in the Western territory. Mr. Johnson's territory comprises Illinois, southern Michigan and Wisconsin, eastern Iowa, eastern Missouri and part of Indiana. A complete stock of Otto engines and repairs is carried at Chicago permitting of prompt service to the trade. Mr. Johnson was for a number of years sales manager with the Fairbanks, Morse Co., of Chicago, covering the central West. Prior to that connection he was with the Champion Harvester Co.

FICHTEL & SACHS, Schweinfurt, Germany, makers of the "F. & S." annular ball bearings, and whose American representative is the J. S. Bretz Co., have begun an action against the R. I. V. Co., the importers of the "R. I. V." bearing, for infringement of the side entrance slot filling patents which they own. The bill of complaint alleges infringement of both the Kouns patent No. 537,689, and the Blinn patent No. 818,734, for improvements in ball bearings. The value of these patents, and others used in combination with them,

HORSEPOWER FROM DYNAMOMETER LOADS—I



H. P. = horsepower.
N = number of revolutions per minute.
P = weight hung on brake arm or read on scale, in pounds,
L = distance from center of pulley to point where weight P is attached, in feet.

$$\text{H. P.} = \frac{2\pi LPN}{33{,}000}$$

If L = 5 feet 3 inches, this formula reduces to:

$$\text{H. P.} = \frac{NP}{1000}$$

The table below gives the horsepower when L = 5 feet 3 inches.

P	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	660	700
	Revolutions per Minute = N																					
12	2.88	3.12	3.36	3.6	3.84	4.08	4.32	4.56	4.8	5.04	5.28	5.52	5.76	6	6.24	6.48	6.72	6.96	7.2	7.45	7.92	8.4
14	3.36	3.64	3 92	4.2	4.48	4.76	5.04	5.32	5.6	5.88	6.16	6.45	6.73	7	7.28	7.56	7.84	8.12	8.4	8.68	9.24	9.8
16	3.84	4 16	4.48	4.8	5.12	5.44	5.76	6.08	6.4	6.72	7.04	7.36	7.68	8	8.32	8.64	8.96	9.28	9.6	9.9	10.56	11.2
18	4.32	4.68	5.08	5.4	5.76	6.12	6.5	6.85	7.2	7.56	7.92	8.28	8.65	9	9.36	9.7	10.08	10.45	10.8	11.17	11.88	12.6
20	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10	10.4	10.8	11.2	11.6	12.0	12.4	13.2	14.0
22	5.28	5.72	6.16	6.6	7.04	7.48	7.92	8.36	8.8	9.25	9.7	10.12	10.57	11	11.4	11.9	12.3	12.75	13.2	13.6	14.5	15.4
21	5.76	6.24	6.83	7.2	7.68	8.16	8.65	9.13	9.6	10.08	10.57	11.05	11.52	12	12.4	12.9	13.4	13.9	14.4	14.9	15.8	16.8
26	6.24	6.76	7.28	7.8	8.32	8.84	9.36	9.9	10.4	10.92	11.45	11.97	12.5	13	13.5	14.0	14.6	15.1	15.6	16.1	17.1	18.2
28	6.73	7.3	7.84	8.4	8.96	9.53	10.1	10.65	11.2	11.78	12.33	12.9	13.4	14	14.5	15.1	15.7	16.2	16.8	17.3	18.5	19.6
30	6.9	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0	12.6	13.2	13.8	14.4	15	15.6	16.2	16.8	17.4	18.0	18.6	19.8	21.0
32	7.68	8.33	8.96	9.6	10.25	10.80	11.5	12.15	12.8	13.45	14.1	14.72	15.36	16	16.6	17.2	17.9	18.5	19.2	19.8	21.1	22.4
34	8.16	8.85	9.5	10.4	10.9	11.56	12.25	12.9	13.6	14.3	14.97	15.65	16.3	17	17.7	18.3	19.0	19.7	20.4	21.1	22.4	23.8
36	8.65	9.36	10.2	10.8	11.5	12.25	12.95	13.7	14.4	15.1	15.85	16.5	17.4	18	18.7	19.4	20.1	20.9	21.6	22.3	23.8	25.2
38	9.12	9.9	10.6	11.4	12.17	12.9	13.7	14.45	15.2	15.9	16.7	17.5	18.25	19	19.7	20.5	21.3	22.0	22.8	23.6	25.1	26.6
40	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4	19.2	20	20.8	21.6	22.4	23.2	24.0	24.8	26.4	28.0
42	10.08	10.9	11.76	12.6	13.4	14.4	15.2	16.0	16.8	17.65	18.5	19.3	20.1	21	21.8	22.7	23.5	24.3	25.2	26.0	27.7	29.4
44	10.56	11.45	12.3	13.2	14.08	14.96	15.85	16.7	17.6	18.5	19.35	20.2	21.1	22	22.9	23.75	24.6	25.5	26.4	27.3	29.0	30.3
46	11.05	11.96	12.9	13.8	14.7	15.65	16.57	17.5	18.4	19.3	20.2	21.1	22.1	23	23.9	24.8	25.8	26.7	27.6	28.5	30.3	32.2
48	11.5	12.5	13.4	14.4	15.3	16.3	17.3	18.2	19.2	20.1	21.1	22.1	23.0	24	25.0	25.9	26.9	27.8	28.8	29.7	31.5	33.6
50	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25	26.0	27.0	28.0	29.0	30.0	31.0	33.0	35.0
52	12.5	13.5	14.5	15.6	16.6	17.7	18.7	19.7	20.8	21.8	22.8	23.9	25.0	26	27.0	28.1	29.1	30.18	31.2	32.2	34.3	36.4
54	12.9	14.0	15.1	16.2	17.2	18.3	19.4	20.5	21.6	22.7	23.7	24.8	25.9	27	28.1	29.2	30.2	31.3	32.4	33.5	35.6	37.8
56	13.4	14.5	15.7	16.8	17.9	19.0	20.1	21.3	22.4	23.5	24.6	25.7	26.9	28	29.1	30.2	31.4	32.5	33.6	34.8	37.0	39.2
58	13.9	15.1	16.2	17.4	18.5	19.6	20.9	22.0	23.2	24.3	25.5	26.7	27.8	29	30.2	31.3	32.4	33.6	34.8	35.9	38.2	40.6
60	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0	25.2	26.4	27.6	28.8	30	31.2	32.4	33.6	34.8	36.0	37.2	39.6	42.0

Contributed by W. Riehl

HORSEPOWER FROM DYNAMOMETER LOADS—II

H. P. = horsepower.
N = number of revolutions per minute,
P = weight hung on brake arm or read on scale, in pounds.
L = distance from center of pulley to point where weight P is attached, in feet.

$$\text{H. P.} = \frac{2\pi LPN}{33{,}000}$$

If L = 5 feet 3 inches, this formula reduces to:

$$\text{H. P.} = \frac{NP}{1000}$$

The table gives the horsepower when L = 5 feet 3 inches.

P	120	130	140	150	160	170	180	190	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500
	Revolutions per Minute = N																							
60	7.2	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0	25.2	26.4	27.6	28.8	30.0
65	7.8	8.45	9.1	9.75	10.4	11.05	11.7	12.35	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0	27.3	28.6	29.9	31.2	32.5
70	8.4	9.1	9.8	10.5	11.2	11.9	12.6	13.3	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0	29.4	30.8	32.2	33.6	35.0
75	9.0	9.75	10.5	11.25	12.0	12.75	13.5	14.25	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0	31.5	33.0	34.5	36.0	37.5
80	9.8	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0	33.6	35.2	36.8	38.4	40.0
85	10.4	11.0	11.9	12.7	13.6	14 4	15.3	16.1	17.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0	35.7	37.4	39.1	40.8	42.5
90	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0	37.8	39.6	41.4	43.2	45.0
95	11.4	12.3	13.3	14.25	15.2	16.15	17.1	18.05	19.0	20.9	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0	39.9	41.8	43.7	46.6	47.5
100	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0	44.0	46.0	48.0	50.0
105	12.6	13.7	14.7	15.75	16.8	17.8	18.9	19.9	21.0	23.1	25.2	27.3	29.4	31.5	33.6	35.7	37.8	39.9	42.0	44.1	46.2	48.3	50.4	52.5
110	13.2	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22.0	24.2	26.4	28.6	30.8	33.0	35.2	37.4	39.6	41.8	44.0	46.2	48.4	50.6	52.8	55.0
115	13.8	14.9	16.1	17.2	18.9	19.55	20.7	21.7	23.0	25.3	27.6	29.9	32.2	34.5	36.8	39.1	41.4	43.7	46.0	48.3	50.6	52.9	55.2	57.5
120	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0	26.4	28.8	31.2	33.6	36.0	38.4	40.8	43.2	45.6	48.0	50.4	52.8	55.2	57.6	60.0
125	15.0	16.2	17.5	18.7	20.0	21.2	22.5	23.7	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	52.5	55.0	57.5	60.0	62.5
130	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0	28.6	31.2	33.8	36.4	39.0	41.6	45.2	47.8	49.4	52.0	54.6	57.2	59.8	62.4	65.0
135	16.2	17.5	18.8	20.2	21.6	22.9	24.3	25.6	27.0	29.7	32.4	35.1	37.8	40.5	43.2	45.8	48.6	51.4	54.0	56.8	59.4	62.2	64.8	67.5
140	16.8	18.4	19.6	21.0	22.4	23.8	25.2	26.6	28.0	30.8	33.6	36.4	39.2	42.0	44.8	47.6	50.4	53.2	56.0	58.8	61.6	64.4	67.2	70.0
145	17.4	18.8	20.3	21.7	23.2	24.6	26.1	27.57	29.0	31.9	34.8	37.7	40.6	43.5	46.4	49.3	52.2	55.1	58.0	60.9	63.8	66.7	69.6	72.5
150	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0	33.0	36.0	39.0	42.0	45.0	48.0	51.0	54.0	57.0	60.0	63.0	66.0	69.0	72.0	75.0
160	19.4	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0	35.2	38.4	41.6	44.8	48.0	51.2	54.4	57.6	60.8	64.0	67.2	70.4	73.6	76.8	80.0
170	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0	37.4	40.8	44.2	47.6	51.0	53.4	57.8	61.2	64.6	68.0	71.4	74.8	78.2	81.6	85.0
180	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0	39.6	43.2	46.8	50.4	54.0	57.6	61.2	64.8	68.4	72.0	75.6	79.2	81.8	86.4	90.0
190	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0	41.8	45.6	49.4	53.2	57.0	60.8	64.6	68.4	72.2	76.0	79.8	83.6	86.4	91.2	95.0
200	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	44.0	48.0	52.0	56.0	60.0	64.0	68.0	72.0	76.0	80.0	84.0	88.0	92.0	96.0	100.0
210	25.2	27.3	29.4	31.5	33.4	35.7	37.8	39.9	42.0	46.2	50.4	54.6	58.8	63.0	67.2	71.4	75.6	80.0	84.0	87.2	92.5	96.7	101.0	105.0
220	26.4	28.6	30.8	33.0	35.2	37.4	39.6	41.8	44.0	48.4	52.8	57.2	61.6	66.0	70.4	74.8	79.2	83.6	88.0	92.4	96.8	101.0	105.0	110.0
230	27.6	29.9	32.2	34.5	36.8	39.1	41.4	43.7	46.0	50.6	55.2	59.8	64.4	69.0	73.6	78.4	82.8	87.5	92.0	96.6	101.0	106.0	110.0	115.0
240	28.8	31.2	33.8	36.0	38.4	40.8	43.2	45.6	48.0	52.8	57.6	62.4	67.2	72.0	76.8	81.6	86.4	91.2	96.0	101.0	105.0	110.0	115.0	120.0

Contributed by W. Riehl

HORSEPOWER FROM DYNAMOMETER LOADS—III

H. P = horsepower,
N = number of revolutions per minute.
P = weight hung on brake arm or read on scale, in pounds,
L = distance from center of pulley to point where weight P is attached, in feet.

$$\text{H. P.} = \frac{2 \pi L P N}{33{,}000}$$

If L = 2 feet $7\frac{1}{2}$ inches, this formula reduces to:

$$\text{H. P.} = \frac{NP}{2000}$$

The table gives the horsepower when L = 2 feet $7\frac{1}{2}$ inches.

P	Revolutions per Minute = N																							
	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620	640	660	680	700	720	740	760	780	800
3	0.51	0.54	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.84	0.87	0.9	0.93	0.96	0.99	1.02	1.05	1.08	1.11	1.14	1.17	1.2
4	0.68	0.72	0.76	0.80	0.84	0.88	0.92	0.96	1.0	1.04	1.08	1.12	1.16	1.2	1.24	1.28	1.32	1.36	1.4	1.44	1.48	1.52	1.56	1.6
5	0.85	0.90	0.95	1.0	1.05	1.10	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7	1.75	1.80	1.85	1.90	1.95	2.0
6	1.02	1.08	1.14	1.20	1.26	1.32	1.38	1.44	1.5	1.56	1.62	1.68	1.74	1.8	1.86	1.92	1.98	2.04	2.1	2.16	2.22	2.28	2.34	2.4
7	1.19	1.26	1.33	1.4	1.47	1.54	1.61	1.68	1.75	1.82	1.89	1.96	2.03	2.1	2.17	2.24	2.31	2.38	2.45	2.52	2.59	2.66	2.73	2.8
8	1.36	1.44	1.52	1.60	1.68	1.76	1.84	1.92	2.0	2.08	2.16	2.24	2.32	2.4	2.48	2.56	2.64	2.72	2.8	2.88	2.96	3.04	3.12	3.2
9	1.54	1.63	1.72	1.8	1.89	1.98	2.07	2.16	2.25	2.34	2.43	2.52	2.61	2.7	2.79	2.88	2.97	3.06	3.15	3.24	3.33	3.42	3.51	3.6
10	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
11	1.87	1.98	2.09	2.2	2.31	2.42	2.53	2.64	2.75	2.86	2.97	3.08	3.19	3.3	3.41	3.52	3.63	3.74	3.85	3.96	4.07	4.18	4.29	4.4
12	2.04	2.16	2.28	2.4	2.52	2.64	2.76	2.88	3.0	3.12	3.24	3.36	3.48	3.6	3.72	3.84	3.96	4.08	4.2	4.32	4.44	4.56	4.68	4.8
13	2.21	2.34	2.47	2.6	2.73	2.86	2.99	3.12	3.25	3.38	3.51	3.64	3.77	3.9	4.03	4.16	4.29	4.42	4.55	4.68	4.81	4.94	5.07	5.2
14	2.38	2.52	2.66	2.80	2.94	3.08	3.22	3.36	3.5	3.64	3.78	3.92	4.06	4.2	4.34	4.48	4.62	4.76	4.90	5.04	5.18	5.32	5.46	5.6
15	2.55	2.7	2.85	3.0	3.15	3.3	3.45	3.6	3.75	3.9	4.05	4.2	4.35	4.5	4.65	4.8	4.95	5.1	5.25	5.4	5.55	5.7	5.85	6.0
16	2.72	2.88	3.04	3.20	3.36	3.52	3.68	3.84	4.00	4.16	4.32	4.48	4.64	4.8	4.96	5.12	5.28	5.44	5.6	5.76	5.92	6.08	6.24	6.4
17	2.88	3.05	3.22	3.4	3.57	3.74	3.91	4.08	4.25	4.42	4.59	4.76	4.93	5.1	5.27	5.44	5.61	5.78	5.95	6.12	6.29	6.46	6.63	6.8
18	3.06	3.24	3.42	3.6	3.78	3.96	4.14	4.32	4.5	4.68	4.86	5.04	5.22	5.4	5.58	5.76	5.94	6.12	6.3	6.48	6.66	6.84	7.02	7.2
19	3.23	3.42	3.61	3.8	3.99	4.18	4.37	4.56	4.75	4.94	5.13	5.32	5.51	5.7	5.89	6.08	6.27	6.46	6.65	6.84	7.03	7.22	7.41	7.6
20	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0
21	3.57	3.78	3.99	4.2	4.41	4.62	4.83	5.04	5.25	5.46	5.67	5.88	6.09	6.3	6.51	6.72	6.93	7.14	7.35	7.56	7.77	7.98	8.19	8.4
22	3.73	3.96	4.18	4.4	4.62	4.84	5.06	5.28	5.5	5.72	5.94	6.16	6.38	6.6	6.82	7.04	7.26	7.48	7.7	7.92	8.14	8.36	8.58	8.8
23	3.91	4.14	4.37	4.6	4.83	5.06	5.29	5.52	5.75	5.98	6.21	6.44	6.66	6.9	7.13	7.36	7.58	7.82	8.05	8.28	8.52	8.74	8.97	9.2
24	4.08	4.32	4.56	4.8	5.04	5.28	5.52	5.76	6.0	6.24	6.48	6.72	6.96	7.2	7.44	7.68	7.92	8.16	8.4	8.64	8.88	9.12	9.36	9.6
25	4.25	4.5	4.75	5.0	5.25	5.5	5.75	6.0	6.25	6.5	6.75	7.0	7.25	7.5	7.75	8.0	8.25	8.5	8.75	9.0	9.25	9.5	9.75	10.0
26	4.42	4.68	4.94	5.2	5.46	5.72	5.98	6.24	6.5	6.76	7.02	7.28	7.54	7.8	8.06	8.32	8.58	8.84	9.1	9.36	9.62	9.88	10.14	10.4
27	4.58	4.86	5.13	5.4	5.67	5.94	6.22	6.48	6.75	7.02	7.3	7.56	7.84	8.1	8.38	8.65	8.92	9.18	9.46	9.72	10.0	10.26	10.53	10.8
28	4.76	5.04	5.32	5.6	5.88	6.16	6.44	6.72	7.00	7.28	7.56	7.84	8.12	8.4	8.68	8.96	9.24	9.52	9.8	10.08	10.3	10.6	10.9	11.2
29	4.93	5.22	5.5	5.8	6.09	6.38	6.67	6.96	7.25	7.54	7.8	8.1	8.4	8.7	9.0	9.28	9.56	9.86	10.15	10.4	10.7	11.0	11.3	11.6
30	5.1	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.5	7.8	8.1	8.4	8.7	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.0

Contributed by W. Riebli

No. 145, Data Sheet, MACHINERY, August, 1911

STOCK FOR SCREW MACHINE PRODUCTS

Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000	Length of Piece and Cut-off Tool	Feet per 1000
0.050	4.2	0.240	20.2	0.430	36.1	0.620	52.1	0.810	68.1	1.000	84.0	1.380	116.0	1.760	147.9
0.055	4.6	0.245	20.6	0.435	36.6	0.625	52.5	0.815	68.5	1.010	84.9	1.390	116.8	1.770	148.7
0.060	5.0	0.250	21.0	0.440	37.0	0.630	52.9	0.820	68.9	1.020	85.7	1.400	117.6	1.780	149.6
0.065	5.5	0.255	21.4	0.445	37.4	0.635	53.4	0.825	69.3	1.030	86.6	1.410	118.5	1.790	150.4
0.070	5.9	0.260	21.8	0.450	37.8	0.640	53.8	0.830	69.7	1.040	87.4	1.420	119.3	1.800	151.3
0.075	6.3	0.265	22.3	0.455	38.2	0.645	54.2	0.835	70.2	1.050	88.2	1.430	120.2	1.810	152.1
0.080	6.7	0.270	22.7	0.460	38.7	0.650	54.6	0.840	70.6	1.060	89.1	1.440	121.0	1.820	152.9
0.085	7.1	0.275	23.1	0.465	39.1	0.655	55.0	0.845	71.0	1.070	89.9	1.450	121.8	1.830	153.8
0.090	7.6	0.280	23.5	0.470	39.5	0.660	55.5	0.850	71.4	1.080	90.8	1.460	122.7	1.840	154.6
0.095	8.0	0.285	23.9	0.475	39.9	0.665	55.9	0.855	71.8	1.090	91.6	1.470	123.5	1.850	155.5
0.100	8.4	0.290	24.4	0.480	40.3	0.670	56.3	0.860	72.3	1.100	92.4	1.480	124.4	1.860	156.3
0.105	8.8	0.295	24.8	0.485	40.8	0.675	56.7	0.865	72.7	1.110	93.3	1.490	125.2	1.870	157.1
0.110	9.2	0.300	25.2	0.490	41.2	0.680	57.1	0.870	73.1	1.120	94.1	1.500	126.1	1.880	158.0
0.115	9.7	0.305	25.6	0.495	41.6	0.685	57.6	0.875	73.5	1.130	95.0	1.510	126.9	1.890	158.8
0.120	10.1	0.310	26.1	0.500	42.0	0.690	58.0	0.880	73.9	1.140	95.8	1.520	127.7	1.900	159.7
0.125	10.5	0.315	26.5	0.505	42.4	0.695	58.4	0.885	74.4	1.150	96.6	1.530	128.6	1.910	160.5
0.130	10.9	0.320	26.9	0.510	42.9	0.700	58.8	0.890	74.8	1.160	97.5	1.540	129.4	1.920	161.3
0.135	11.3	0.325	27.3	0.515	43.3	0.705	59.2	0.895	75.2	1.170	98.3	1.550	130.3	1.930	162.2
0.140	11.8	0.330	27.7	0.520	43.7	0.710	59.7	0.900	75.6	1.180	99.2	1.560	131.1	1.940	163.0
0.145	12.2	0.335	28.2	0.525	44.1	0.715	60.1	0.905	76.0	1.190	100.0	1.570	131.9	1.950	163.9
0.150	12.6	0.340	28.6	0.530	44.5	0.720	60.5	0.910	76.5	1.200	100.8	1.580	132.8	1.960	164.7
0.155	13.0	0.345	29.0	0.535	45.0	0.725	61.0	0.915	76.9	1.210	101.7	1.590	133.6	1.970	165.5
0.160	13.4	0.350	29.4	0.540	45.4	0.730	61.3	0.920	77.3	1.220	102.5	1.600	134.5	1.980	166.4
0.165	13.9	0.355	29.8	0.545	45.8	0.735	61.8	0.925	77.7	1.230	103.4	1.610	135.3	1.990	167.2
0.170	14.3	0.360	30.3	0.550	46.2	0.740	62.2	0.930	78.2	1.240	104.2	1.620	136.1	2.000	168.1
0.175	14.7	0.365	30.7	0.555	46.6	0.745	62.6	0.935	78.6	1.250	105.0	1.630	137.0	2.050	172.3
0.180	15.1	0.370	31.1	0.560	47.1	0.750	63.0	0.940	79.0	1.260	105.9	1.640	137.8	2.100	176.5
0.185	15.5	0.375	31.5	0.565	47.5	0.755	63.4	0.945	79.4	1.270	106.7	1.650	138.7	2.150	180.7
0.190	16.0	0.380	31.9	0.570	47.9	0.760	63.9	0.950	79.8	1.280	107.6	1.660	139.5	2.200	184.9
0.195	16.4	0.385	32.4	0.575	48.3	0.765	64.3	0.955	80.3	1.290	108.4	1.670	140.3	2.250	189.1
0.200	16.8	0.390	32.8	0.580	48.7	0.770	64.7	0.960	80.7	1.300	109.2	1.680	141.2	2.300	193.3
0.205	17.2	0.395	33.2	0.585	49.2	0.775	65.1	0.965	81.1	1.310	110.1	1.690	142.0	2.350	197.5
0.210	17.6	0.400	33.6	0.590	49.6	0.780	65.5	0.970	81.5	1.320	110.9	1.700	142.9	2.400	201.7
0.215	18.1	0.405	34.0	0.595	50.0	0.785	66.0	0.975	81.9	1.330	111.8	1.710	143.7	2.450	205.9
0.220	18.5	0.410	34.5	0.600	50.4	0.790	66.4	0.980	82.4	1.340	112.6	1.720	144.5	2.500	210.1
0.225	19.0	0.415	34.9	0.605	50.8	0.795	66.8	0.985	82.8	1.350	113.4	1.730	145.4	2.550	214.3
0.230	19.3	0.420	35.3	0.610	51.3	0.800	67.2	0.990	83.2	1.360	114.3	1.740	146.2	2.600	218.5
0.235	19.7	0.425	35.7	0.615	51.7	0.805	67.6	0.995	83.6	1.370	115.1	1.750	147.1	2.650	222.7

Contributed by S. M. Hovis

No. 145, Data Sheet, MACHINERY, August, 1911

MACHINERY

August, 1911

METHODS AND MACHINES USED IN MANUFACTURING THE VEEDER CYCLOMETER

By ERIK OBERG*

WHILE a great deal has been published in the technical press relating to the interesting methods used by the Veeder Mfg. Co., of Hartford, Conn., no complete record has ever been published describing and illustrating in successive order the various operations required and the machines used in manufacturing the cyclometer made by this company. As many of the methods used are unique, the machinery of interesting construction, and the methods, in general, differ-

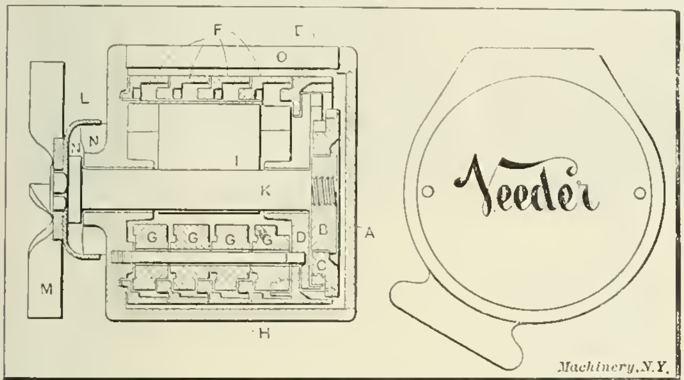


Fig. 1. Sectional View of the Veeder Cyclometer

ent from those in use in the ordinary machine shop, it has been thought worth while to publish a complete account.

The Veeder Mfg. Co. was formed in August, 1895, and began the manufacture of cyclometers in a small shop on State St., in Hartford. In 1896 a three-story factory was erected at Sargeant and Garden Sts., and to this was added in 1907 a concrete office building. Since that time the business has grown to such an extent that an addition which will double the capacity of the plant is now in course of construction.

The first product of the company was bicycle cyclometers, the manufacture of which is described in the present article.

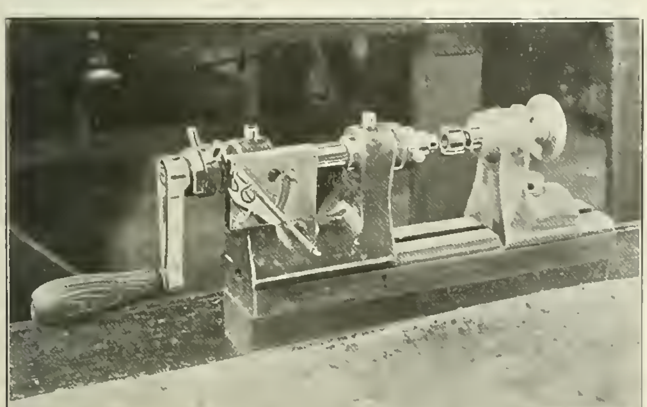


Fig. 2. Tapping Machine used for Cases

In addition, the company makes a number of different devices for measuring and recording distances, as well as revolution counters. A very important part of the company's business is the process developed for making die-castings. This process makes it possible to produce with little or no further machine work a great number of parts used in the instruments made. Die-castings are also made for other manufacturers, being used extensively in voting machines, cash registers, etc.

The Veeder Cyclometer

A section of the cyclometer, which is used for indicating the distance traveled on a bicycle, is shown in Fig. 1. A photograph of the various parts of the instrument, in actual size, is reproduced in Fig. 3. The various parts in Figs. 1 and 3 are denoted by the same letters. The parts named are as follows: *A*, name-plate; *B*, eccentric; *C*, eccentric gear; *D*, stationary gear; *E*, index gear; *F*, four index rings; *G*, four pinions; *H*, case; *I*, friction spring; *J*, pinion shaft; *K*, main shaft; *L*, dust cap; *M*, star-wheel; *N*, felt washers; *O*, crystal; *P*, two brass screws (shown in Fig. 3 only).

The case *H*, Figs. 1 and 3, is cast in an automatic die-casting machine. The castings are first inspected and slight burrs

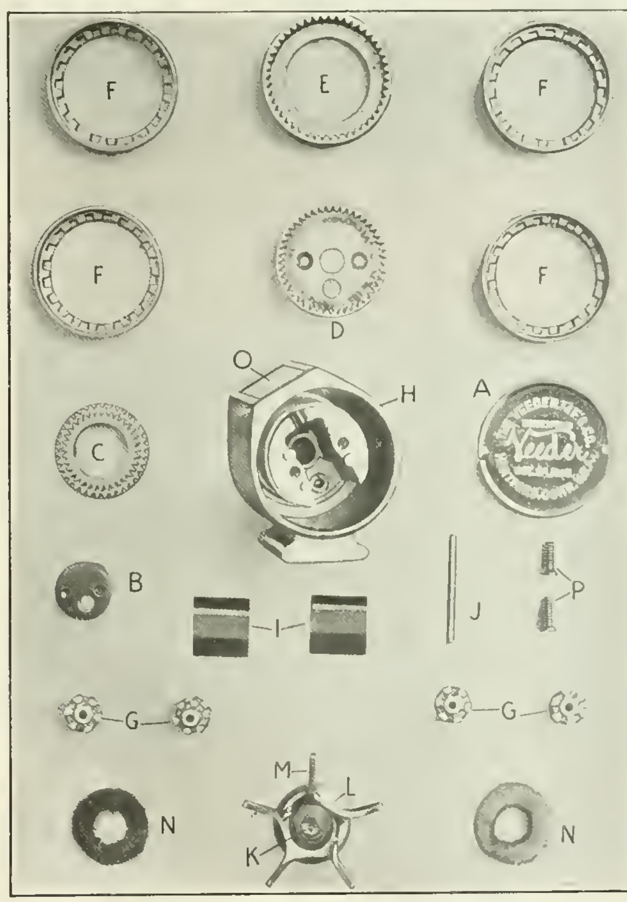


Fig. 3. Parts of the Cyclometer, Actual Size

removed by a hand tool, after which the sprue at the outside end of the hub is cut off in a bench lathe, the case being held by the hub inside of the case in a draw-in chuck. Owing to the fact that the die-casting metal is comparatively soft and the parts small, the cutting operations are very rapid, these sprues, for example, being cut off at the rate of 5000 in a nine-hour day, by one operator.

The next operation is to drill the main-shaft hole, the case being held in a jig and the hole drilled 0.0015 to 0.002 inch under-size in a sensitive bench drill press. In the next operation the two holes for the brass screws *P* which hold the stationary gear *D* to the case, are tapped. The tap holes are cast in the case and hence no tap-drilling is required. The tapping is done in the machine shown in Fig. 6; the operator moves the table up toward the tap by the tip of one finger, stops being provided beneath the table as shown. The tapping machine is provided with an automatic reverse, as indicated between the two pulleys, and nearly 4000 cases or 8000 holes can be tapped in a day of nine hours.

The threads in the case for the name-plate *A* are next cut.

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The machine and the tap used are shown in Fig. 2. The case is put onto a holder mounted in the tailstock of the machine, and the tap is revolved by the crank at the headstock end. A trip and positive stop are provided on the

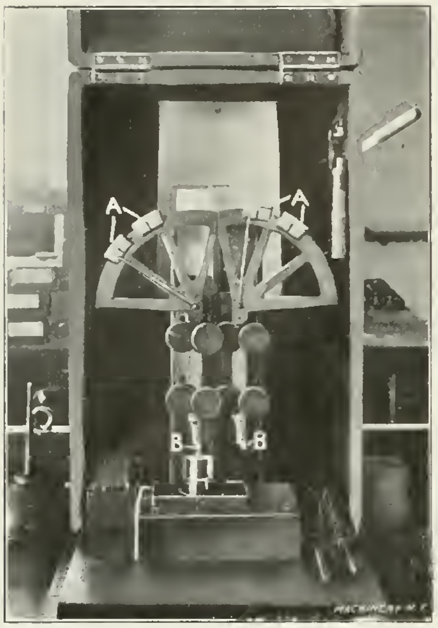


Fig. 4. Gage which multiplies 400 Times

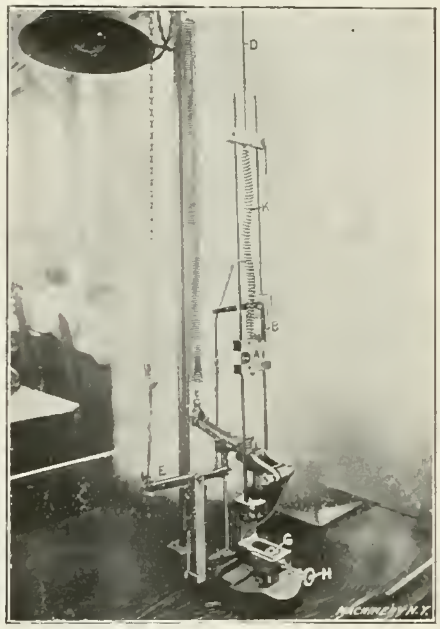


Fig. 5. Staking Machine

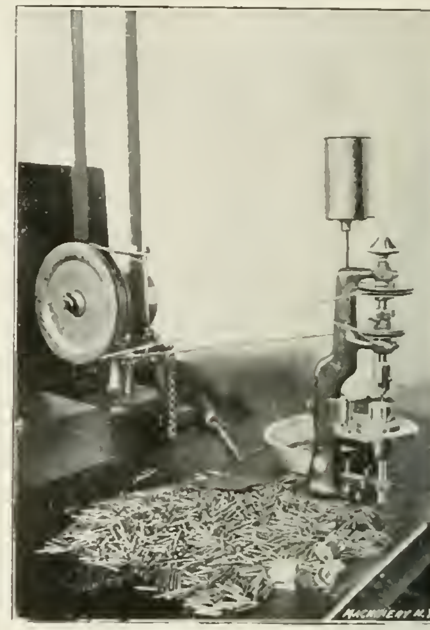


Fig. 6. Tapping Holes in Case for Brass Screws

machine as indicated at *A*, this trip and stop being engaged by two pins inserted in a collar on the spindle holding the tap. This spindle is threaded inside of the headstock with the same number of threads per inch as are to be cut in the


Fig. 7. Boards or Trays on which Cases are kept while passing through the Factory

case. When the required depth of thread has been cut, one pin trips the positive stop into position so that the next pin, which immediately follows, is brought against the positive stop. Hence the case is always threaded to the same depth,

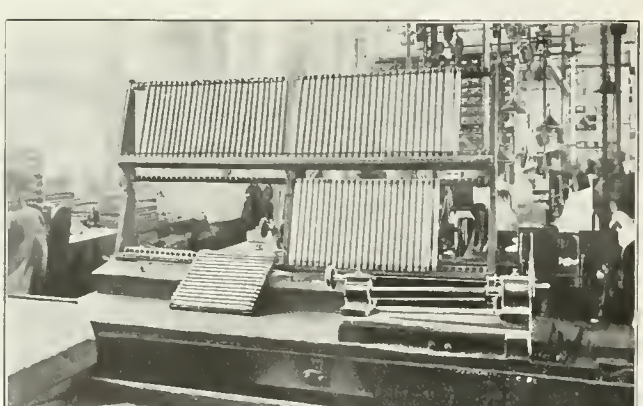


Fig. 9. Rods for Rings, Trays in which they are placed to dry, and Filing Lathe

which is necessary in order to insure that the name-plate will always come flush with the case when screwed into position. An operator can tap 4000 cases on this machine in a day.

The next operation is to put the name-plate in place, which is done in a small machine similar to the one in Fig. 2, holding the case in a specially shaped holder in the tailstock, and the name-plate, which has two small wrench holes in it, in the headstock. The name-plate is held by two small pins on the faceplate, which enter into the wrench holes, and is screwed into place in a manner similar to that in which the case is threaded. A tapered brass plug is then forced into


Fig. 8. Inserting the Crystal in the "Window" of a Veeder Cyclometer

the main-shaft hole in the other end of the case by means of a small arbor press, the case being thus entirely sealed up. The opening at *O*, Figs. 1 and 3, where the crystal is inserted, is still closed by a cover cast in place, which is later removed.

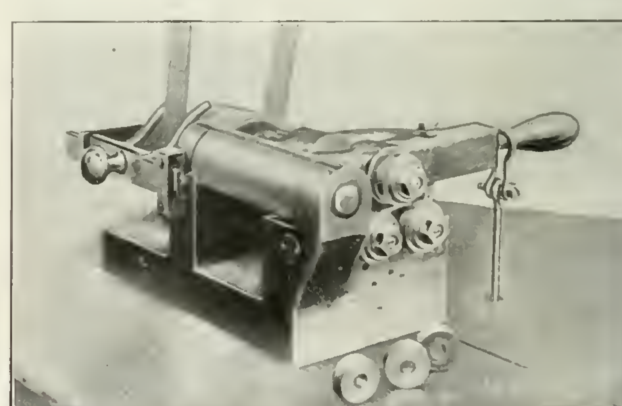
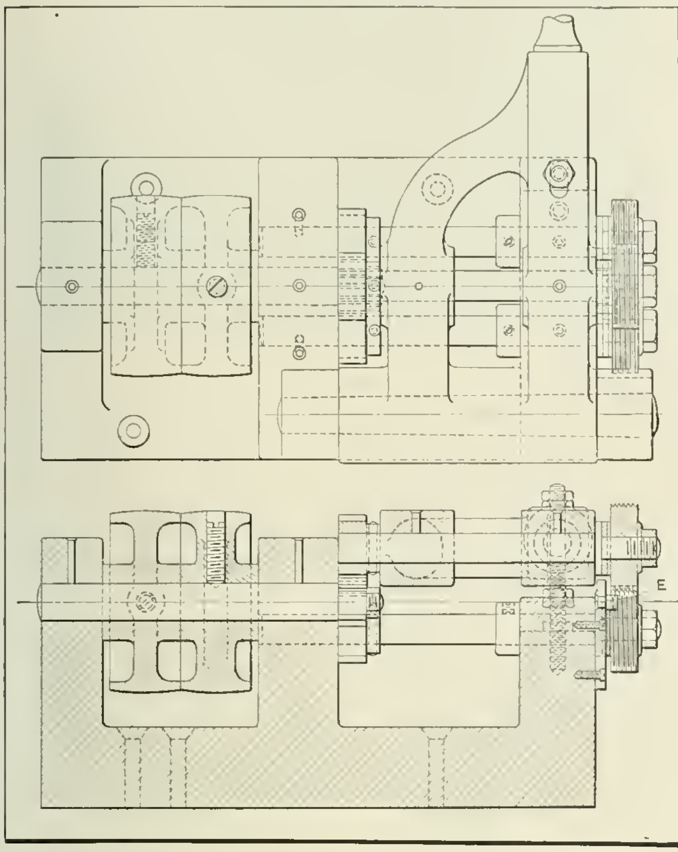


Fig. 10. A Thread-rolling Machine by Means of which 1000 Washers can be threaded in an Hour

The reason for sealing up the case is to make it possible to nickel-plate the outside without having any of the solution enter the inside of the case. After nickel-plating, the cases are again inspected, the plug closing up the main-shaft hole

is pulled out with pliers, the name-plate is removed in a machine similar to the one for putting it in place, and the cases are put into boards as shown in Fig. 7. These boards have a capacity for 100 cases, and from now on the cases, being kept in this manner during all subsequent operations, are thus automatically counted at all times.



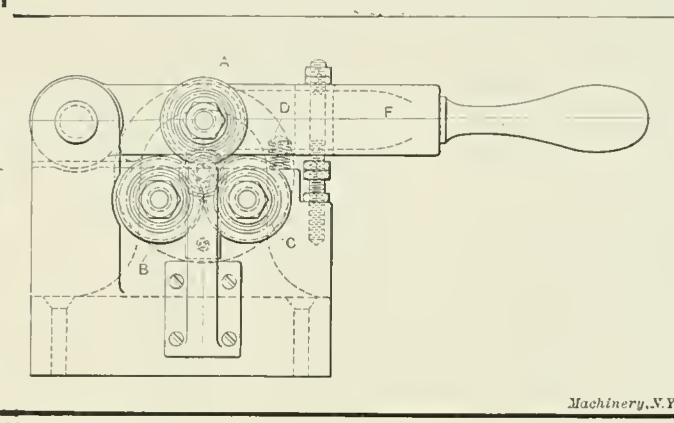


Fig. 11. Construction of Machine shown in Fig. 10

In the next operation, the opening for the crystal or "window," as it is called, is punched out, and then the main-shaft hole in the case is reamed to size and the outside end of the hub burnished. In order to gage the tool which finishes and burnishes the end of the hub, the reamer for the holes butts against an adjustable stop, and the burnishing tool is fastened in a holder which, in turn, is fastened to the shank of the reamer.

The length of the cases is next gaged in the multiplying gage shown in Fig. 4, the limit of permissible error being 0.001 inch. This gage is provided with adjustable dogs *A*, on each of which an indicating line is drawn, and which can be set any required distance apart to indicate any given limit. The setting of the dogs is accomplished by means of "setting gages" introduced beneath the measuring points *B*, these setting gages being provided with two shoulders, the difference in height of the shoulders being, in the present case, 0.001 inch. If the allowable limit be 0.002 inch, a plug with this distance between the two shoulders would be used, and the dogs *A* set accordingly. This being done all the inspector has to do is to see that the indicating needle does not pass by the indicating lines on the dogs on either side. The gage multiplies 400 times, so that 0.001 inch on the work tested shows a difference at the points of the indicating needle of 0.400 inch. This great multiplying effect is obtained partly by a system of levers and partly by an arrangement similar to that of a worm and a worm-wheel. One lever acts as one tooth in a worm-wheel, and the indicating needle is attached to another member which acts as a worm and which makes a considerable part of a revolution for an insignificant movement of the lever acting as a worm-wheel tooth.

In the next operation the crystals are inserted in place. The apparatus used for this purpose is shown in Fig. 8. It consists of an electric heater having two copper tubes, onto which the insides of the cases fit. In the illustration a case is shown in place on one tube while at *A* the other tube is shown with the case removed. When the device is in operation there is always a case on both tubes, the operator working upon one while the other is being heated. When the case is heated, and the cement for fastening the glass to the case is put on, it quickly melts and flows into the space between the glass and the case, thus holding the glass securely when cool. The case is now ready to be assembled to the other parts.

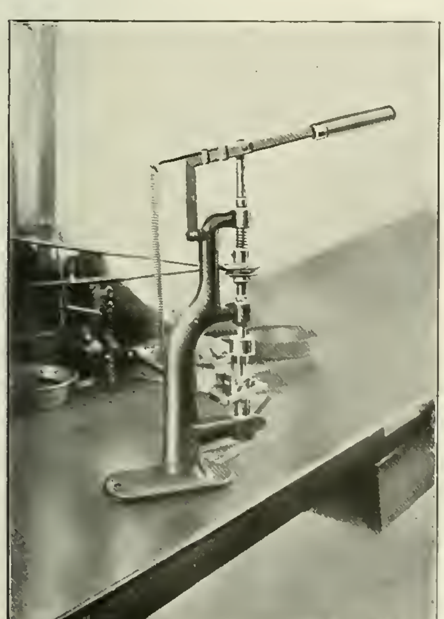


Fig. 12. A Bench Drill with Two-spindle Attachment

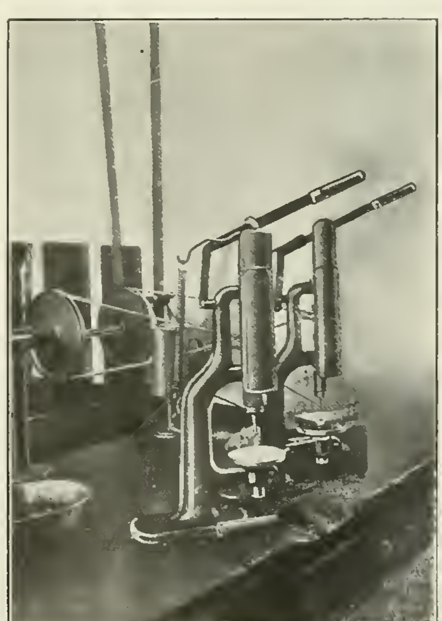


Fig. 13. Bench Drills for Drilling Holes in Eccentric

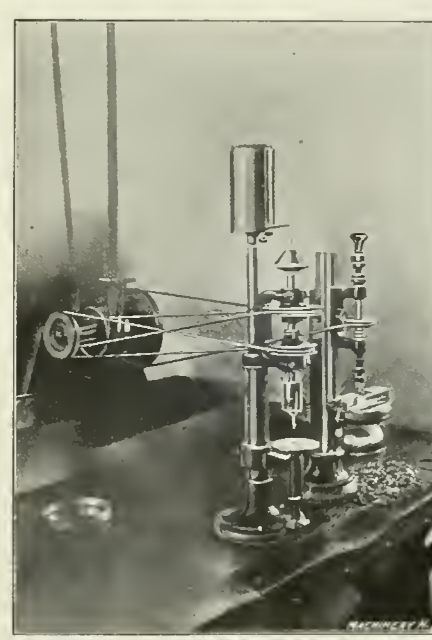


Fig. 14. Tapping Machine and Drill Press for Counterboring Eccentric

Index Gears and Rings

The index gears and rings are made from die-castings. They are first freed from the sprue in a trimming die, the

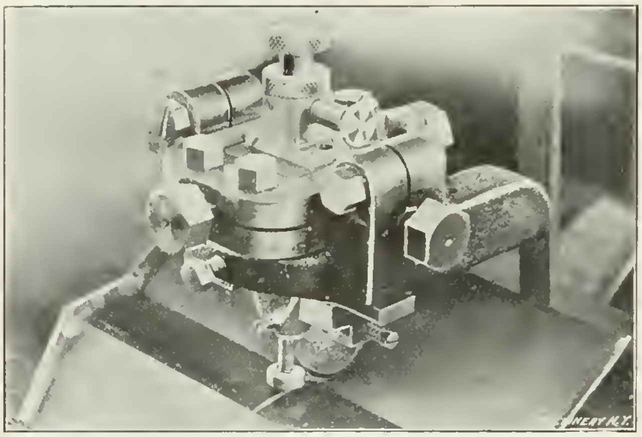


Fig. 15. General Appearance of Machine shown in Detail in Fig. 17

sprue acting as a handle for the operator while trimming, and making it possible to quickly handle these small pieces. The rings are next inspected to see that the castings are perfect, and are then put onto long rods as shown in Fig. 9, each rod holding 100 rings. A nut is screwed onto the end of the rod so as to hold the ring in place. The indicating numbers which give the number of miles traveled are cast in the rings so that the form of the figure is sunk down slightly below the surface of the ring. In order to make the figures easily readable, however, it is necessary to have them appear in a different color from that of the ring itself. The rods of rings are, therefore, painted all over either red or white, according to whether the figures are intended to be of one or the other color. The paint used is ordinary bicycle or metal enamel. The rings are

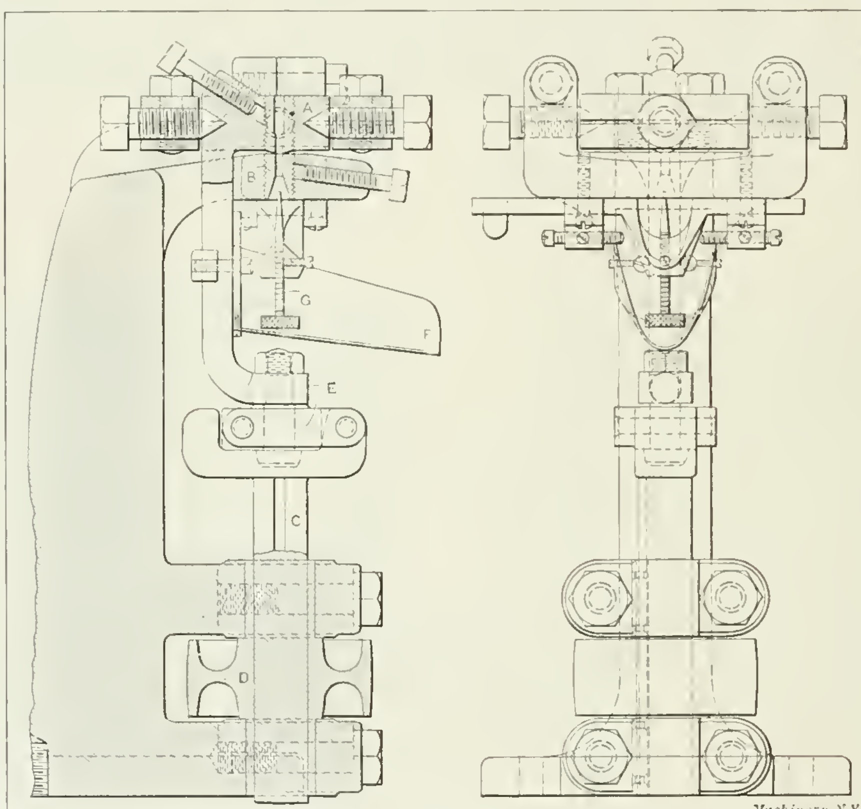


Fig. 17. Construction of Pinion Shaft Threading and Cutting-off Machine

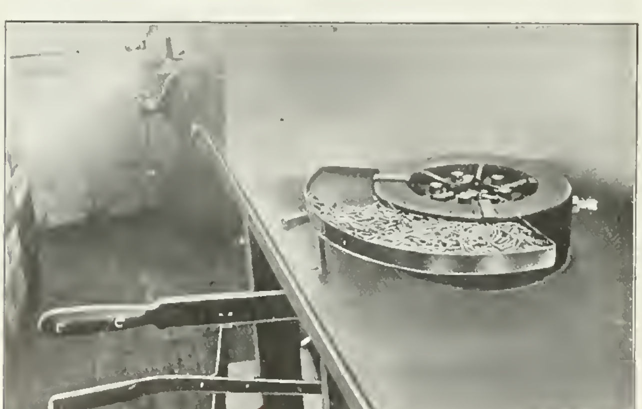


Fig. 18. Machine for Swaging Pentagon on End of Main Shaft

then put into trays holding about sixteen rods, one of these trays being shown in the lower part of Fig. 9. These trays are put into a gas oven where the enamel is dried for about five hours. When white enamel is used it is important that the rings are not subjected to too high a heat, as the enamel is

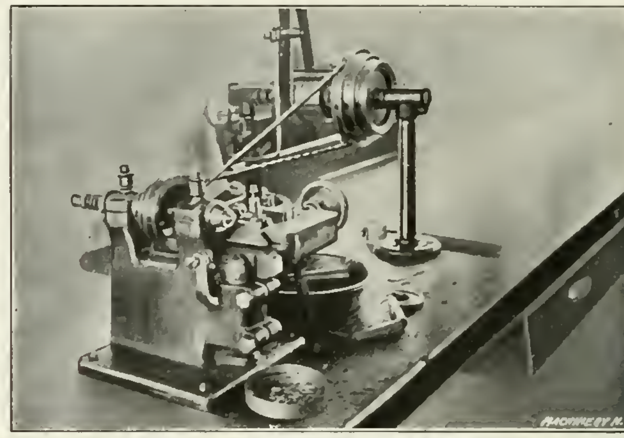


Fig. 16. Pinion Shaft Finishing Machine

then likely to turn yellow. When removed from the gas oven, the rods with rings are placed in a small filing lathe shown beneath the rows of rods in Fig. 9. The enamel on the rings is now filed off, and the rings sandpapered and brushed off with a wire brush. This filing, however, removes only the enamel on the outer surface of the rings, leaving the sunk-down figures red or white as desired.

After the rings have been filed, they are taken off the rods and burred by a slight touch on either side; this burring is done in order to get a satisfactory result in the subsequent oxdizing operation. They are then again put onto the rods and are oxidized, the black color due to the oxidization appearing on the metal only, but having no effect on the enamel remaining on the sunk-down figures, so that after oxidization the figures appear either

Fig. 19. Assembling Machine and Method of Lubricating Rings

red or white as the case may be, on a black background. After having been oxidized, the rings are again

inspected to see that the figures are in perfect condition and that the oxidizing is satisfactory. This inspection is done very carefully, and about 18 per cent of the rings are found not to meet the standard required. The rings may be filed over once to remove the oxidized surface, and may then be re-oxidized, but if not satisfactory the second time, they must be thrown away, as the figures are not deep enough to permit further filing.

The Name-plate

The name-plate *A*, Fig. 1, is made from brass blanks. The manufacturer's name is then stamped on it in a sub-press die at the rate of 1000 an hour. The 80-pitch thread on the outside or rim is then produced by a rolling process in the

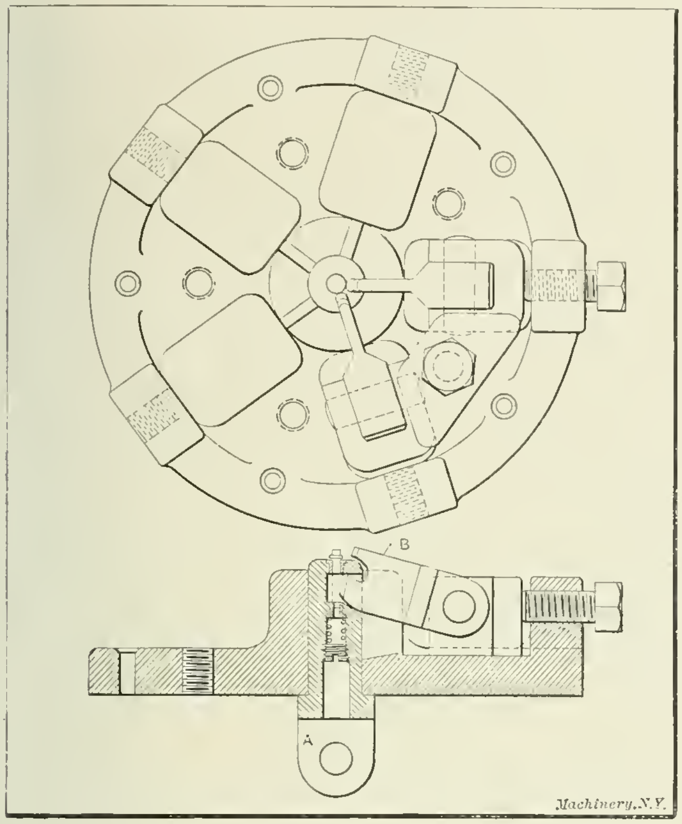


Fig. 20. Construction of Swaging Machine shown in Fig. 18

machine shown in Fig. 10. A line illustration of this machine is also shown in Fig. 11. The thread on the blank is produced between the three rollers *A*, *B* and *C* which are geared together. When the machine is in operation, all the rollers revolve continually. The operator puts in a blank between the rollers, the upper roller *A* being held away from the others by the spring *D*. When the blank has been put into position, flush against the stop *E*, the handle *F* is brought down, bringing the roller *A* in contact with the blank, which then spins out between the two rollers, a thread being meanwhile rolled on the periphery. The operation is very rapid, one operator being able to thread 1000 name-plates an hour. The most important operation in relation to this machine is the setting of the rollers in the proper position. Rollers *B* and *C* are first set by means of a plug, then roller *A* is moved around, before finally clamping it, until it is brought into such a relation to the other two rollers that a perfect thread will be produced on the blank.

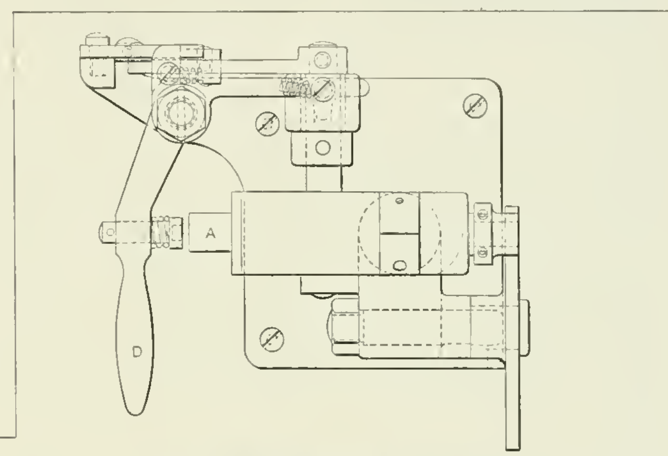
The next operation on the name-plate is to drill the two small wrench holes, which are 0.035 inch in diameter. These are drilled in the jig shown on the table of the bench drill press illustrated in Fig. 12. This drill has a two-spindle attachment for drilling the two holes at once. The name-plate is then burred or "swaged" on the outside, screwed into the case, and nickel-plated as already mentioned. The stationary gear, eccentric gear, and pinions are die-castings on which no machine work is done.

The Eccentric

The eccentric is made from brass blanks and is turned in the same machine that is used for facing the end of the hub of the case. Two small wrench holes are provided in the eccentric so as to facilitate the assembling and dis-assembling of the case. There is also a threaded hole in it for the end of the main-shaft as shown in Fig. 1. The wrench and main-shaft holes are drilled at the same time in the two bench drills shown in Fig. 13, the eccentric being held in a jig in which the wrench holes are first drilled from one side, the jig then being turned over and the main-shaft hole being drilled from the other side. In the next operation, the eccentric is first counterbored in one and then tapped in the other of the two machines placed side by side in Fig. 14. The tapping machine in Fig. 14 acts on the same principle as that shown in Fig. 6.

The Pinion Shaft

The operations on the pinion shaft *J*, Fig. 1, require one of the most interesting machines used. The machine for cutting off and producing the thread on the end of this shaft is shown in Fig. 15, its construction, however, being more clearly indicated in the line engraving Fig. 17. The shaft is cut off from



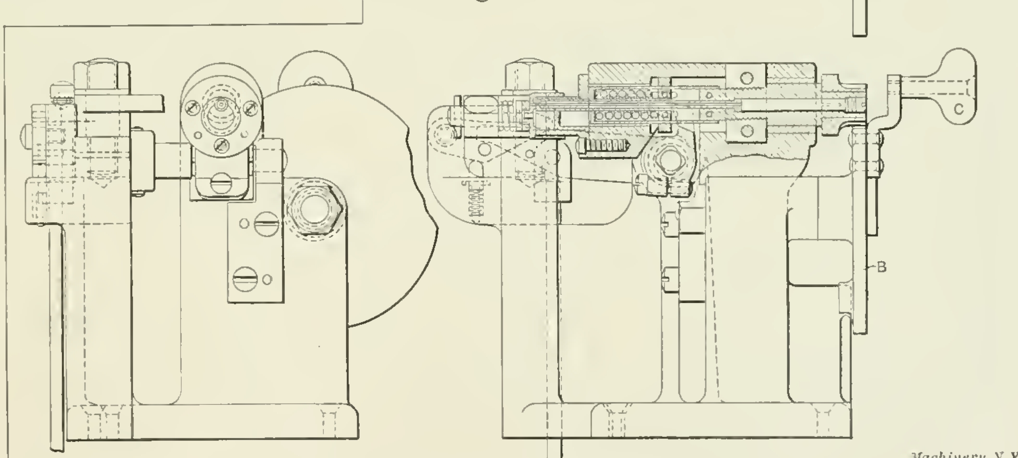


Fig. 21. Construction of Assembling Machine shown in Fig. 19

German silver wire 0.040 inch in diameter, and a thread having a pitch of 60 threads per inch is produced on its end previous to cutting off. The wire is pushed down from above through two dies *A* and *B*, Fig. 17. A treadle is connected to the shaft *C* by means of which this shaft can be pulled down. The rotary motion of shaft *C* is transmitted to it by pulley *D*. The yoke arrangement at *E* produces an oscillating motion of the upper die *A*, the wire being thereby brought against the sides of the lower die *B* on the inside of which, at the upper end, a thread is cut, which thread is thus reproduced or "rolled" on the end of the shaft. As the treadle is pushed down still further, the oscillating motion of the

upper die A becomes so great that it shears off the wire entirely. The cut-off part then drops down into a bin through tube F. About 8000 pinion shafts can be threaded and cut off per day. The stop G regulates the length of the shaft cut-off to within 0.003 inch. For finishing the pinion shaft to the correct length, it is put into the machine shown in Fig. 16 where it is held in a chuck against a positive stop and faced off to the right length with a small tool similar to a lathe tool.

The main shaft K is cut off in a screw machine; it is cut off 0.010 inch short on the end to which the star-wheel M. Fig. 1, is attached. The interesting operation on the main shaft is the swaging of a pentagon on the end to fit a pentagonal hole

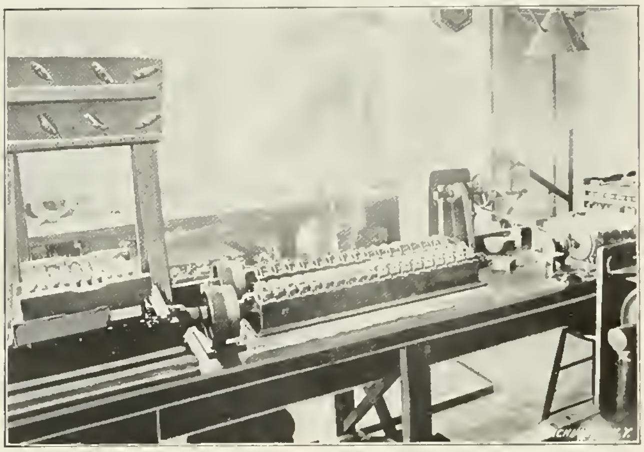


Fig. 22. Testing the Cyclometers by Running them the Equivalent of Fifty Miles

in star-wheel M. This pentagon is swaged by inserting the shaft in the device shown in Fig. 18, the principle of which is shown more clearly in the line engraving Fig. 20. One downward push on the handle shown in Fig. 18 is enough to produce a pentagonal shape on the end of the shaft. This swaging increases the length 0.010 inch, this being the reason for cutting off the shaft that amount too short. The device in Fig. 20 consists of five jaws operated by a handle attached by a link to the central plunger A which operates the five jaws B, the arrangement working on the toggle joint principle. The five jaws enter simultaneously, thus producing the desired shape. The star-wheel M, Fig. 1, is made from 1/32-inch flat stock. It is first blanked out, and then the pentagonal hole is pierced in a separate operation, and the wings twisted as indicated.

The dust cap L is made from brass and pierced for the main shaft. The dust cap, main shaft and star-wheel are then assembled by staking the end of the main shaft as indicated in Fig. 1. The machine used for this purpose is shown in Fig. 5. This machine is in effect a small drop hammer; the hammer A is held by the trip B, which when a foot lever is operated, releases it and permits it to fall. It is lifted up into position again by means of the rod D connected to an overhead clutch arrangement and operated through leverage arrangement E and a chain. The main shaft enters into the holder G and is pushed by means of knob H into position underneath the hammer and the plunger on which the hammer strikes. The tension of spring K above the hammer is adjustable so that any desired force of blow may be obtained.

Assembling

The parts are now ready for the assembling operations. One of the most interesting of these operations is the assembling of the pinion shaft J into the case H. The hole in case H is not threaded, but is cast to size slightly smaller than the diameter of the shaft; this latter having a thread on its end, is screwed into the softer metal and holds securely. The machine used for this operation is shown in the halftone Fig. 19, and its construction is indicated in the line engraving Fig. 21. Referring to the latter illustration, the pinion shaft is held in a draw-in chuck operated by a foot treadle, and the whole chuck is then moved back by one revolution of the gear B, having fastened to it handle C. The case is then put onto the holder A which is hollow so as to permit the inside of the hub to enter into it, and it is held in position by handle D. One revolution of gear B in the other direction now moves the pinion shaft forward, revolving it meanwhile and inserting it into the small hole in the bottom of case H.

In Fig. 19 is also shown a board with index rings. This illustration indicates the method of keeping all the parts when ready for assembling, the parts being brought in on boards and stored in a cabinet until the assemblers are ready. The studs on which the rings on the board in Fig. 19 are mounted, are provided with a threaded end at the top; and onto this threaded end screws a stud A having on it a small felt washer which is saturated with a mixture of clock oil and deflocculated graphite. As the assembler takes each ring from its stud, the inside of the ring must necessarily touch the felt washer and is thus automatically oiled. When all the rings have been removed from one stud, the operator removes the plug with the felt washer to the next, and so on, until all the rings on the board have been used in the assembling of the cyclometers. Considerable time is saved by this oiling arrangement, and the rings are all evenly oiled.

After the cyclometers are assembled, they are all tested, running the equivalent of fifty miles at high speed. Some of the testing machines, on which a great number of the instruments can be tested at once, are shown in Fig. 22. These instruments then pass a final inspection and are all numbered with consecutive numbers, the machine used for this numbering being similar to an ordinary typewriting machine, heavily built and making it possible to strike hard enough to make an impression on the comparatively soft die-casting metal.

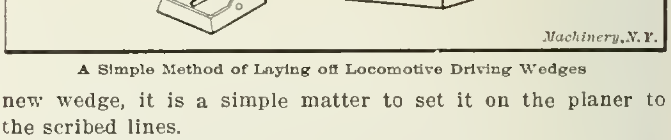
The foregoing description of the manufacturing operations required for making the simplest of the Veeder distance recording instruments, gives a general idea of the nature of the work in this plant, the ingenuity displayed in the design of special machinery, and the rapidity with which the various operations are performed. The important role that die-casting plays in this manufacture will also be readily recognized, as without the aid of this process it would be practically impossible to produce these instruments at a commercial price.

* * *

LAYING OFF LOCOMOTIVE DRIVING WEDGES

By JOHN A. COOK*

There are several ways of laying off driving wedges, but the following method is so simple and accurate that it seems to be in advance of all others. To lay off the new wedge, the old wedge is placed, back down, on the planer. A large parallel strip is then placed inside of the old wedge, and the new wedge placed on top of it, as shown in the accompanying illustration. If lines are now scribed on both sides of the



A Simple Method of Laying off Locomotive Driving Wedges

new wedge, it is a simple matter to set it on the planer to the scribed lines.

In laying out the new wedge it is best to face both sides of the groove, and also take a finishing cut off the inside of the wedge. Then to bring the wedge to the desired shape, the top surface of the wedge is planed, so that it will be made the same thickness at both ends as the old one.

* * *

According to *The Brass World* a good mixture for making white metal patterns is as follows: Tin, 7 pounds; lead, 7 pounds; antimony, 2 pounds.

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MACHINING AUTOMOBILE CONNECTING RODS

By E. H. PRATT*

The method of machining large quantities of connecting rods which is to be here described is that followed by one of the largest automobile manufacturers in Michigan. The connecting rod shown in Fig. 1 is somewhat larger than that ordi-

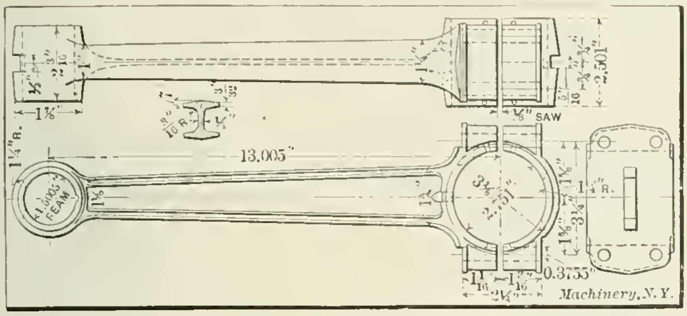

Fig. 1. Automobile Connecting-rod for a 5-by-6 Automobile Engine, Drop-forged from Special Steel

narily used on automobile engines and is of special steel, drop forged. The webs, though light, are designed to withstand the great strains which are set up in a 5 by 6, high-compression motor.

After pickling these rods to soften the scale, the fins left by the forging dies are ground off. They are then ready for the first milling operation which consists in facing one side of the two bosses, the jig shown in Fig. 2 being used for that pur-

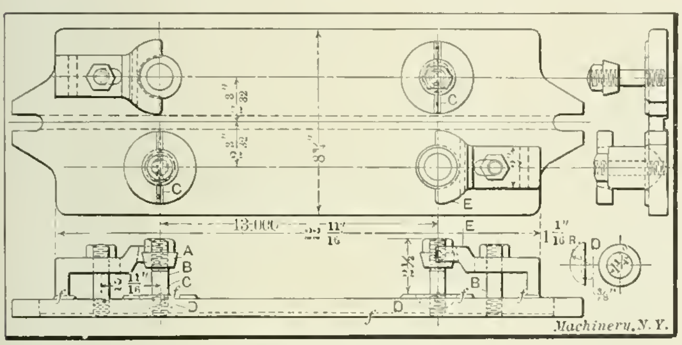

Fig. 2. Jig used in the First Operation, which consists in Facing One Side of the Two Bosses

pose. The forging as it comes from the hammer has a deep impression on both sides of each boss which not only reduces the weight to a minimum but also acts as an effective means for holding the rod during this operation.

The jig in Fig. 2 is designed to take care of any irregularities which may occur in the forging, chiefly those due to the faces of the bosses being out of square with each other, for, if clamped down on these uneven surfaces the rod would spring

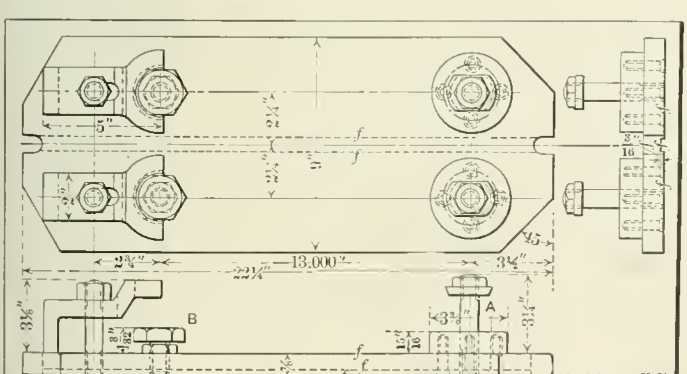

Fig. 3. Second Milling Operation—Jig for Holding the Rod while Milling the Other Side

and cause trouble in all succeeding operations. As before mentioned, the rods after they leave the hammer have deep impressions; in the crank end, this impression passes right through the boss, forming a hole large enough for the taper washer *A*. held in place by the stud *B* which passes through the hole. Instead of this end bearing over the entire surface there is a narrow bearing strip *C* which gives line contact and reduces the danger of springing. Also, under the piston end there is a circular segment *D* fitted to a socket in the casting and projecting high enough to be normally in a parallel plane with the minor bearing on the large end. Should there be any twist or unevenness in the bearing, this segment readily adjusts itself and may be clamped in this self-adjusted position by the Y-shaped clamps *E*. Two rods are machined in one jig at the same time, being reversed in order to facilitate the use of a smaller cutter.

The second milling operation is performed in the jig shown in Fig. 3, which is quite similar to that just described. In this case, however, the large boss has a full bearing *A* under the entire surface while the small boss has an adjustable stop *B* which may be set to take up any existing variation after the large end has been clamped down on *A*. As before, this small end is held with a Y-shaped clamp. It is very essential that the large end should have perfectly parallel faces on account

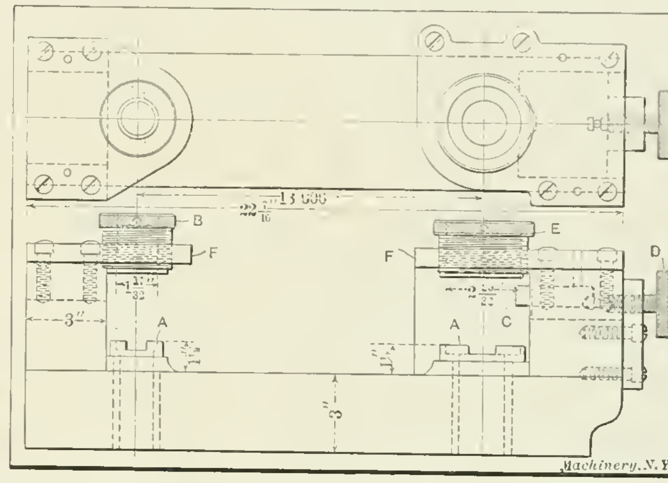

Fig. 4. Jig for Holding Rods during the Third Operation of Drilling the Ends

of its bushing, while the small end which has plenty of clearance in the piston is milled on one side only, merely for the purpose of producing a working surface for succeeding operations. The protruding bushing makes it unnecessary for both sides to be machined.

Both these jigs just described are placed on the milling table at the same time, about one and one-half times the diameter of

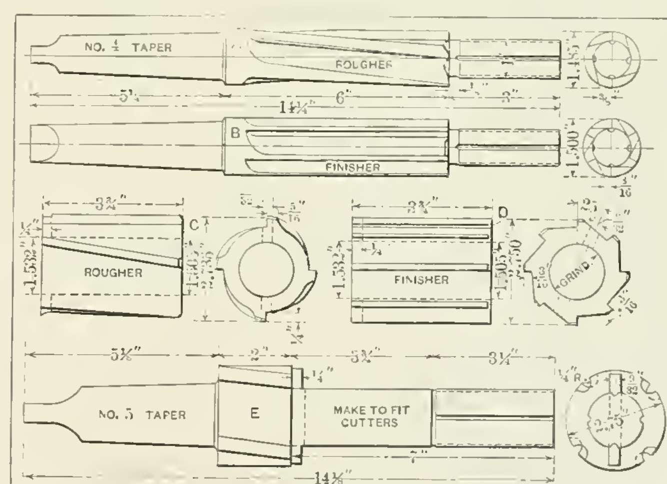

Fig. 5. Reamers for Use in the Third Operation with the Jig shown in Fig. 4

the cutter apart, so that when the latter is working on one set of rods, the operator is setting up another set on the other jigs. These jigs are set at the proper height so that the bosses will finish to the required thickness without cutter adjustment.

Drilling and reaming the holes in the large and small ends in the jig shown in Fig. 4 is the third operation. Owing to the great number of rods and the severe strains due to heavy cuts, it is necessary to make this jig exceptionally heavy and rigid. The rod is placed on stop bushings *A* in each end with the milled side down, and located endwise by a bushing *B*, which is bell-mouthed and fits over the small boss, bringing the hole directly in its center, and placing all the variation on the large

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end, where it is cared for by the sliding V-shaped piece *C* operated by the thumb-screw *D*. The large end is also held square on the milled surface by the bushing *E*. Bushings *B* and *E* are made of hardened steel with clearance holes for the reamers, as they are only used for locating and clamping. The plates *F* are also made of steel to withstand the constant wear

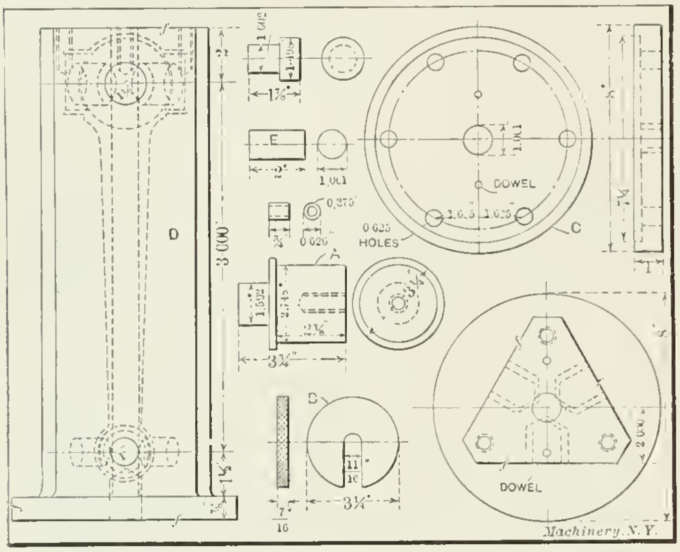


Fig. 6. Jig used in the Operation of Drilling the Bolt Holes for the Caps

on these parts, as are the stops *A* which are also hardened. These latter also serve as pilot bushings for the reamers.

The reamers used in connection with this jig are shown in Fig. 5. The roughing reamer for the small end is required to remove ½ inch stock and therefore must have considerable chip clearance. After experimenting with several styles of roughing tools and reamers, the best results were obtained with a reamer such as that shown at *A*, which is a four

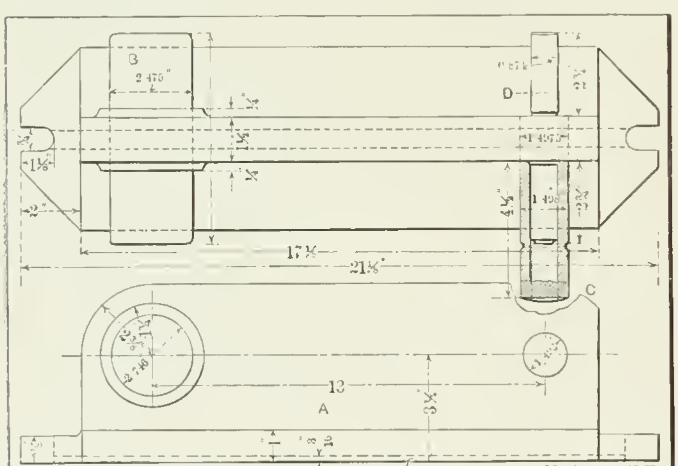


Fig. 7. Fourth Operation—Jig for Holding the Rods while Milling the Oil Grooves in the Ends

fluted spiral tool. This type of tool requires more high-speed steel than other types, but the necessary strength is added. The finishing reamer *B* is also solid and is made with six straight flutes. Their use has proved very satisfactory and the cost has been small. For the large end, however, in order to save steel, reamers of the shell type were adopted. The roughing reamer *C* has four spiral flutes, while the finishing one has eight straight flutes corresponding to the solid ones just described. These shell reamers are driven on a shank *E* which is made of hardened and ground tool steel, renewable at small cost.

The drilling and reaming just described is performed on a heavy six-spindle drilling machine, four jigs being used. Three jigs are on the machine at a time, which allows the six tools to work simultaneously while the operator is removing the finished rod and replacing it with a rough one in the fourth jig. The arrangement of tools in the spindles is as follows: 1. flat-twist roughing drill; 2. special three-fluted roughing drill; 3. small roughing reamer *A*; 4. large roughing reamer *C*; 5. small finishing reamer *B*; and 6. large finishing reamer *D*. Each rod when placed in the jig is left there until completed. Two holes are drilled and the jig is moved on to the next spindles for rough reaming and finally under the finishing reamers for the final operation, a finished rod being produced in seven minutes.

The next operation is drilling the holes for the cap-bolts, four of which are supplied with each rod. As the only available press was a small six-spindle drilling machine, the jig shown in Fig. 6 was constructed in order that this machine might be used, for, by its means, six spindles may be kept operative. As indicated, the jig is triangular in form and holds three rods at a time. The rods are placed on locating pins *A* set in the face of the triangular jig and having studs and slip washers such as that shown at *B* to hold them in place. Bushing plate *C* is placed on top of the triangular body; this plate is counterbored in order to insure an ample supply of cutting lubricant. The body *D* of the jig has a swivel pin *E* in its base-plate, upon which it can turn. As the top of the rod forging is convex, it is a difficult matter

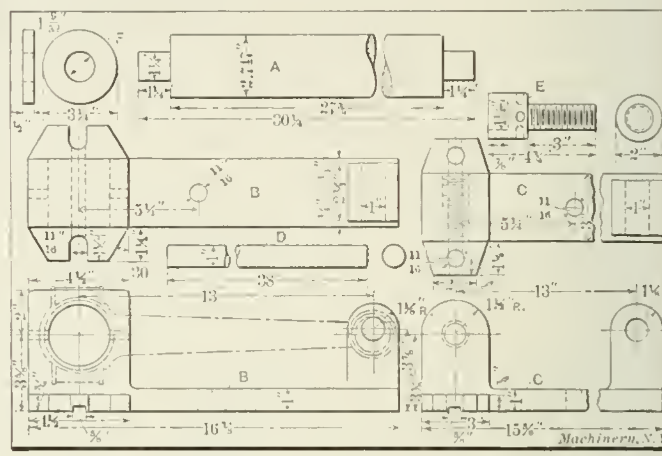


Fig. 8. Jig for the Fifth Operation, which consists of Sawing off the Caps and Milling the Bolt-head Seat

to make a drill enter with any degree of accuracy, so the following arrangement of drills is followed: Two 3/8-inch drills for spotting the holes on a convex surface, two 23/64-inch drills for making the holes, and two 3/8-inch finishing reamers; in this way two holes are finished in about three minutes. The rods are then reversed and the other two holes of the same end are completed in a similar manner.

The fourth operation consists of milling the oil grooves in the ends of the rod and is an operation performed in the jig shown in Fig. 7. Jig casting *A* is an inverted T-piece with a large plug *B* extending on each side the length of the connecting rod boss. The rods are slipped over this plug *B*, and as they are a close fit they require no clamps. The small end

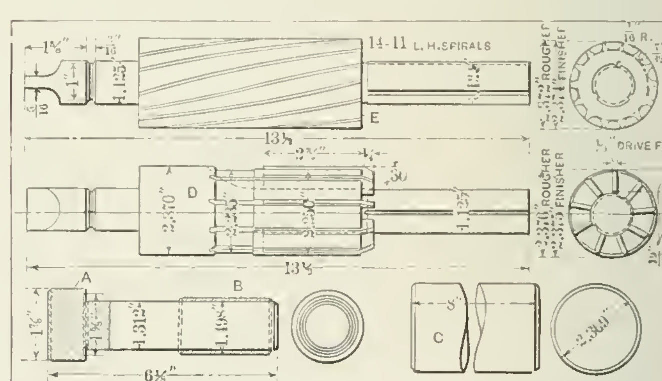


Fig. 9. Tools for Pressing the Bushings into the Rod and Tools for Finishing the Bushings

is located by a slip bushing *C* on a plug *D* which extends each side of the main casting as indicated.

Milling the flat seat for the bolt head and sawing off the cap is the fifth operation. The jig in Fig. 8, which is used for this purpose, has been especially designed with a view to rapid production. The construction is similar to that of the jig in Fig. 7; a long bar *A* fits horizontally through the body of the main bracket *B* and is held in the latter by

two set-screws passing through the sides. Two outside brackets C are also used for holding the rods in place. The small end of the rod is held as shown by the dot and dash outline of the rod, on a small rod D. Bracket B is stationary on the milling machine table, while the outside brackets C are shoved up towards the rods which are set on the cross bars A and D, five on each end, and when these brackets C are clamped down, clamp screw E is adjusted firmly against the washer F, holding the five rods on each end securely in position for the slotting operation.

The sixth operation is performed after the bushings have been assembled with the rod. The necessary tools for press-

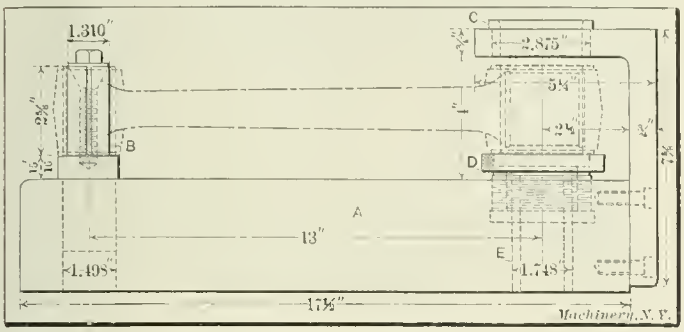


Fig. 10. Jig used with Tools D and E in Fig. 9

ing the bushings in the rod and also for finishing are shown in Fig. 9. The small bushing in the rod is of bronze and is first pressed in place with the plug A on which there is a hardened steel guide bushing B which enters the hole in the rod and guides the bearing bushing which is placed between the head of the plug A and this bushing B. As the bushing must project beyond the outside of the boss of the rod, some relief is given to the under-side of the head as indicated, to permit of this projection. The large bushing for the rod is a die-casting which is assembled on a hardened and ground plug C and is then forced in place between the rod and cap. The plug is then pressed out, leaving the rod ready for reaming. The reamers are of the inserted-blade type, shown at D, while the broaches shown at E have spiral flutes with the

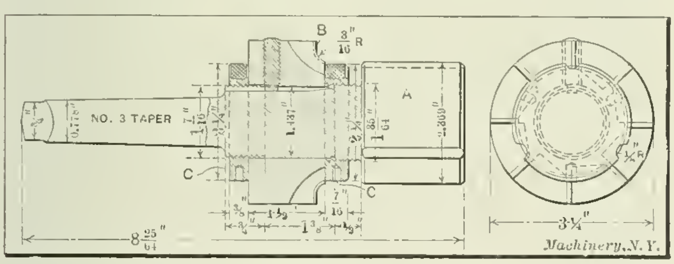


Fig. 11. Tool used in Seventh and Final Operation for Facing Ends of Bearing and Giving Radius to Edges

cutting edge removed, so that instead of cutting the metal away it compresses it into the rod and cap, forming a still more perfect bearing than that left by the plug C.

For the use of these reamers the jig shown in Fig. 10 is employed. The jig has a heavy cast-iron body A. The small end of the rod fits an expanding plug B which is lightly screwed down. The rod is then swung under the bushing C which is a guide bushing for the finishing reamer only. Screw bushing D is then adjusted onto the large end of the rod until it touches the connecting-rod bushing. The rod is then centered by the roughing reamer and the plug B expanded until it holds the rod securely. Bushing E is the guide for the roughing reamer and broaches. The order in which the reamers and broaches, shown in Fig. 9 at D and E, are used is: Roughing reamer of 2.370 inches diameter; rough broach, 2.372 inches diameter; finishing broach 2.374 inches diameter; and finishing reamer 2.375 inches in diameter. This may seem a lot of work to increase the diameter of the hole only 0.005 inch, but it produces a bearing that requires little or no scraping to form a perfect fit.

The seventh and final operation is performed by the tool shown in Fig. 11. This operation consists of facing the bushing to the required width and turning the corner radius to the finished form. A pilot A on the end of the cutter holder, guides the cutter B centrally in the hole. The knurled nuts C are adjusting collars for taking up the wear of the cutter. In operation, two stop plates are used for limiting the depth of feed of the cutter; these stop plates are circular washers set on the lower end of the pilot.

By this method of machining rods the assembling cost is reduced to a minimum, for if the rod be perfectly square with the crankshaft, no straightening is required, and a minimum amount of scraping produces a perfect fit, resulting in a long-lived bearing and a rod of minimum cost.

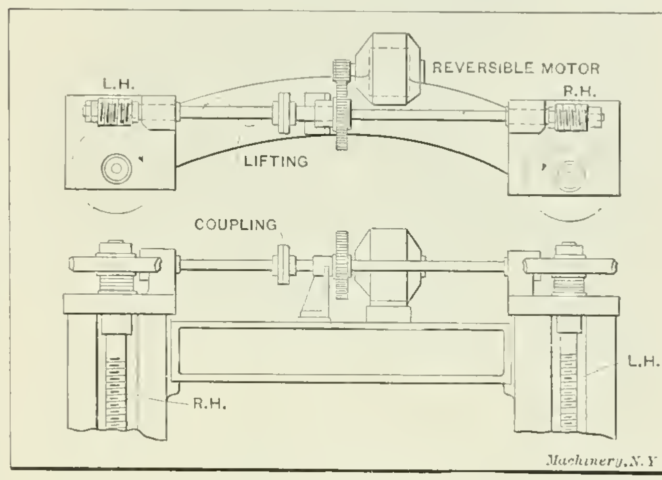
* * *

POINTS IN THE DESIGN OF A POWER ELEVATING CROSS-RAIL

By A. W. BOASE*

The illustration shows a power device for raising and lowering the cross-rail of a large planer or boring mill, which embodies some interesting points in machine design. One of the chief points in the design is the cheap and efficient means provided to overcome the thrust of the worms. No thrust washers or ball bearings are required as the thrust is absorbed by the shaft itself either by compression or tension, being in tension when raising the cross-rail.

Another interesting point to notice is the central drive; the motor is geared to the shaft in the center. This is a feature which many draftsmen forget to provide and buyers forget



Power Cross-rail Elevating Device embodying Good Points in Machine Design

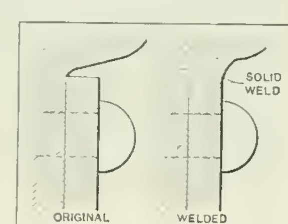
to ask for. The location of the drive in the center eliminates cross-winding tendency when traversing the cross-rail up or down.

A third point of interest to designers is the advantage of having the worm shaft in two parts; when in two parts it is a simple matter to erect the machine. The holes in the couplings are marked off after the cross-rail is leveled. The holes are then drilled and reamed with the assurance that both screws will work in unison and carry their due proportion of the load. The coupling also makes it easier to dismantle the machine, as may be necessary before erecting it in a crowded shop.

* * *

SECTIONING A WELDED JOINT

In reply to a question concerning the proper manner in which to show a welded joint in cross-section, the *Engineering News* gives the accompanying illustration as its suggestion of a good means of showing such a weld. The characteristics would seem to be that the section lines of the one member of the weld are made to merge into and conform with the section lines of the other member of the weld, thus retaining the identity of the two parts.



Method of Sectioning a Welded Joint

* * *

The vacuum process of cleaning is now extensively used in cleaning the upholstery of railway coaches.

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DROP-FORGE DIE-SINKING—2

By CHESTER L. LUCAS* and J. W. JOHNSON†

In the previous installment of this article, the primary operations in the laying out and sinking of drop-forging dies, as well as the machines and tools used for roughing out the impressions, were illustrated and described. In the following, a full description will be given of the hand tools used by the die sinker and their manipulation, this really being the most difficult and particular part in the making of dies for drop forgings. Additional information will also be given on the making and operating of drop-forging dies and other data of importance.

Finishing the Impression—The Hand Work

The really difficult work of die sinking is the hand work that is necessary to finish the impression; at least this part of the work requires more patience and manual skill than the

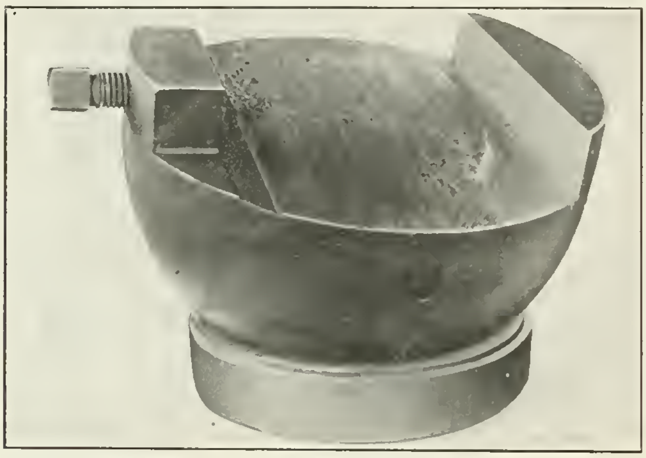

Fig. 13. Ball Vise used in Holding Dies for Hand Work

machine operations connected with die sinking. Some impressions are full of corners and irregular places that must be chipped out and smoothed by hand, nearly every job having a number of such places. These places must be chipped, scraped, riffled and polished, and to facilitate this finishing, the die is held in the ball vise shown in Fig. 13. This useful device, almost too well known to be described, rests on a pad of leather, which in shop practice is made by coiling up a short length of two-inch belting, and riveting it at intervals. By the use of the ball vise, the die may be held at any desired angle or position, and will remain where put with sufficient stability to resist any ordinary chipping or filing.

Chisels and Chipping

Die-sinker's chisels are made preferably of Jessop's steel, but any good tool steel will do in the absence of Jessop's. The

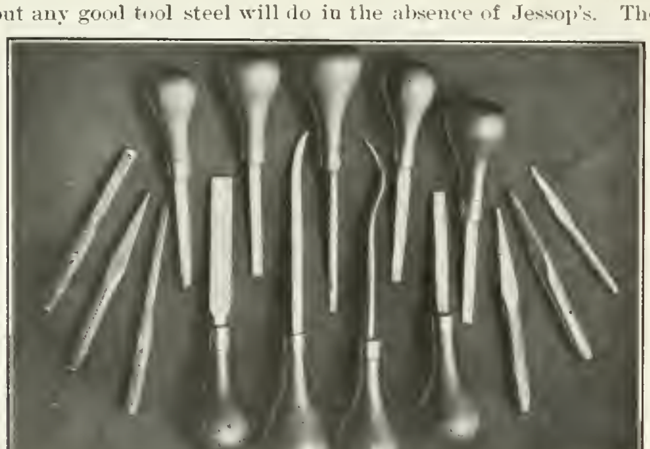

Fig. 14. Chisels and Scrapers used in Die Sinking

stock should be hexagon or octagon, and forged out to the shapes best suited to the work. Two or three dozen shapes and sizes of chisels are necessary for the different shaped places that must be chipped out in the general run of work. The most useful shapes are the round and flat varieties, some of which are shown in Fig. 14. The round variety embraces a great many different curves, all of which are eventually used. The flat varieties should run from 1/32 inch to 1/2 inch in width. After hardening, the chisels should be drawn to a light blue, this temper being the same as that given the ordinary cape chisel, and which will be found a good ordinary temper. The die-sinker's chipping hammer, illustrated in Fig. 15, is flat-faced and double-ended, so that it can be used either end. To aid the die sinker in chipping out parts of the impression that are to be the same depth, depth gages like those shown in

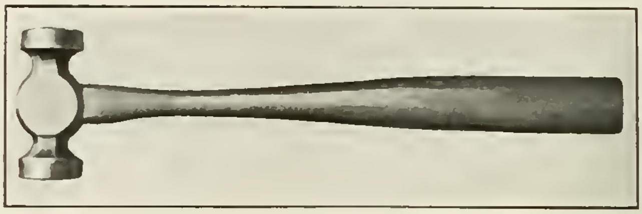

Fig. 15. Die-sinkers' Chipping Hammer

Fig. 16 are used, and occasionally the micrometer depth gage will be found indispensable; but there are few jobs that require such accuracy. In Fig. 16 are also shown the two shrink rules that are used in laying out the die impressions.

In chipping out the stock from the corners and other places that cannot be milled, there are a few general rules that should be followed. It is always advisable to chip down or away from the outline of the impression, for by so doing there will be no danger of breaking out "chunks" at the ends of the cuts. In using flat chisels care should be taken to leave as little work for the corners to do as possible, for the corners are the weakest parts of flat chisels. Oil should be used sparingly on the cutting edges of all chisels. For convenience in picking out the different chisels, it is a good plan to keep them, points up, in round cans or boxes. In all chipping, the die-sinker should "make haste slowly", taking light cuts and

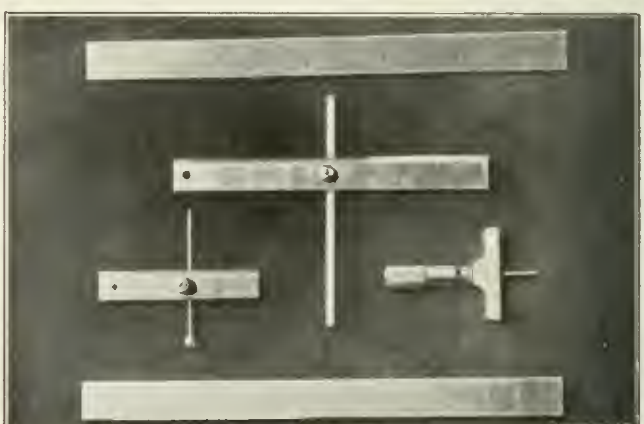

Fig. 16. Shrink Rules and Gages used in Laying Out and Sinking the Impressions

many of them, frequently trying the templets and depth gages so as to be sure he is not taking out too much stock.

Fig. 18 shows the die-sinker chipping out what appears to be a simple part of an impression, but in reality it is an awkward place, being the oval end of the impression for a chain shackle. The second impression is the forming impression; both impressions have been milled out as much as possible and are now being cleaned up by chipping, after which scraping and riffling will follow before the rest of the impressions are milled. In most cases, however, it is best to complete the milling while the die is on the die-sinking machine.

Scraping, Riffling and Polishing

The idea of the chipping is to remove as much stock as possible from the impression, that cannot be milled or otherwise machined. Of course, it is impossible to finish the die by chipping alone; therefore, after the bulk of the steel is taken out by milling and chipping, the impression must be smoothed by scraping and riffling.

Scrapers are of several different types. Nearly every mechanic is familiar with the three-cornered and half-round scrapers, and both of these tools are used at times in scraping out a die; but by far the most useful kinds of scrapers are those made of square and half-round straight sections. These

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scrapers are short, made to cut on the end only, and "pare" out the stock very quickly. As shown in Fig. 14 these tools are fitted into short, round handles that fit the hanu snugly.

After grinding and stoning the edge of the scraper, the corners are slightly stoned off so that there will be no tendency to "dig in". By the use of the scrapers, the nigh points left by the chipping operation are reduced, and the surface of the impression smoothed. Fig. 17 shows the method of

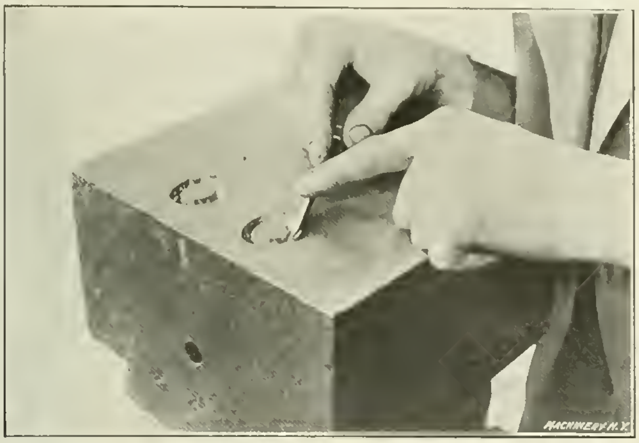

Fig. 17. Scraping Out the Impression

holding the scraper; in this instance the die-sinker is scraping out the oval end of the shackle impression, the milling and chipping having been finished. Scraping is not intended to remove much of the stock, but is more of a finishing operation. By scraping alternately in different directions, the impression is kept free from grooves and ridges. Should there be any chatter marks left by the milling operation, they may be taken out by scraping.

As soon as the die impression has been finished as regards dimensions with the scrapers, the surface may be carefully smoothed by riffling. The rifflers, or small bent files, may be obtained in a large variety of shapes, sizes and cuts. As the illustration Fig. 19 shows, the riffler is held lightly in the hand and is worked back and forth over the surface to be smoothed. In other words, it is filing, on a small scale. A collection of the most useful of the different rifflers is shown in Fig. 21. The most common form is the "spoon" riffler, which comes in many different grades of curves, its name describing its shape perfectly. By turning the riffler while using, many different grades of curves may be obtained, so that there are few spots in a die that cannot be reached with a spoon riffler.

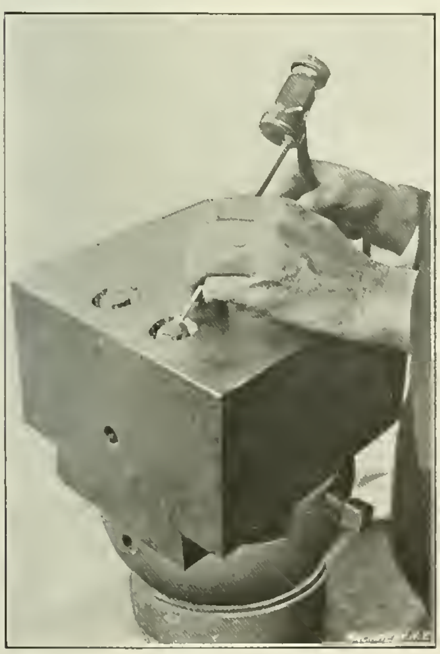

Fig. 18. Chipping Out the Die

Next in point of usefulness comes the flat riffler, which is made in different curves and widths to take care of the flat surfaces and panels in the impressions. Other styles are the hook riffler, the knife riffler and the round taper riffler. As with scraping, the rifflers must be worked over the surface with ever-changing directions to prevent the formation of grooves and ridges.

As a final finish to the impression, emery cloth, wrapped around a file or a piece of wood should be applied to every part of the impression, until the surface is perfectly smooth and free from imperfections, using first the coarse and then the fine emery cloth. Often the shape of the impression is such that it can best be polished with emery and oil used on the end of a stick of wood. The emery will imbed itself in the wood as it does in a lap. The reason for this finish is first, to get a good surface on the forging, and second, to assist the forging to come easily from the die while being worked.

Types and Typing

Frequently it happens that in a drop-forging die there are irregular bosses or ends that cannot be finished on the die-sinking machine, and that are particularly difficult to chip out, scrape and riffle to a finish. Usually these places are deep and narrow, and generally it happens that there are two of these awkward places to cut out, one in each of the two dies. It is customary to take care of such places in dies by means of typing.

A "type" is a punch or small block of steel whose end is shaped exactly like that part of the forging that is difficult to cut in the die. Types are hardened and drawn to a purple temper. The part of the die that is to be typed is milled and chipped out to as near the outline and depth as is considered safe. The face of the type is then rubbed lightly

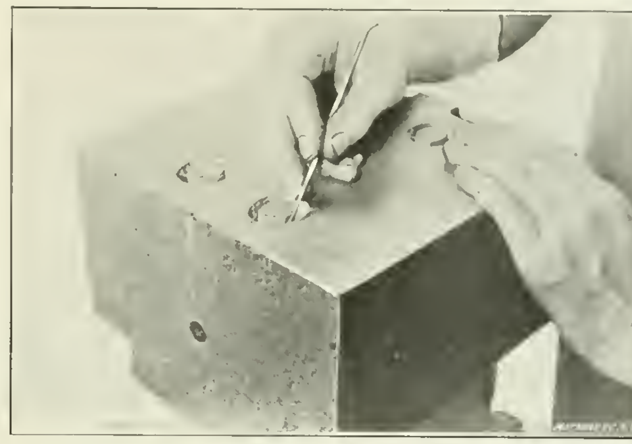

Fig. 19. Using the Riffler—Smoothing the Impression

with Prussian blue, placed in the impression, and with a piece of copper or brass on its top, the type is struck hard into the impression with a hammer. This operation leaves the high places with a blue facing.

These high places are next chipped away, care being taken not to go too deep, and the process is repeated. If properly done, the typed part of the impression will gradually assume the shape of the type and at last, by striking in the type a number of times, the impression will take on the smooth finish of the type and be ready for riffling. If the part of the impression to be typed is cylindrical, the type may be

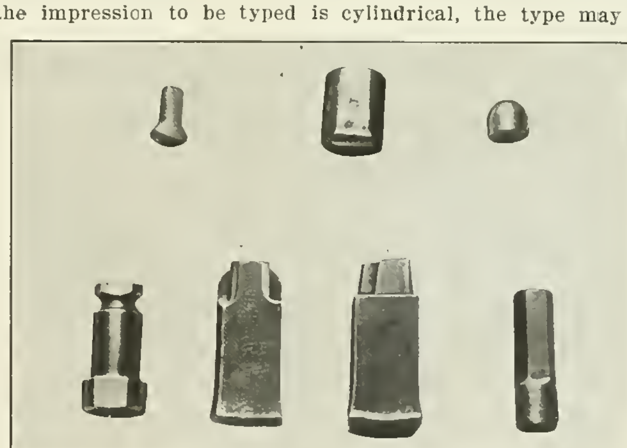

Fig. 20. A Collection of Turned and Milled Typing Toole

turned up in the lathe; but if not, it must be milled and filed to shape. Fig. 20 shows a few types for different die sections, some of which have been turned in the lathe. Turned types are filed with flats on the tops, to assist striking them.

In making types for shaping the impressions in dies for forgings whose ends or hubs are shaped like the forging shown in Fig. 22, there is a very convenient rule to bear in mind. The rule is this: Shape the sides of the type with a

curve whose radius is equal to twice the diameter of the hub. This rule insures the proper amount of draft on the impression, and as this form is very commonly used on bosses and ends of rocker arms, levers, etc., the application of the rule is very frequent.

While speaking of the machine work on the die impression, it was stated that there were exceptions to the rule of doing all machine work on the impression first. In typing, we find one of these exceptions. Let us assume that we have a die to sink for the forging shown in Fig. 23. The impression would consist essentially of a ring with four projecting bosses that must be typed. If the ring were turned first, trouble would be experienced in typing the four bosses, as the type would have a tendency to slide into the ring at every

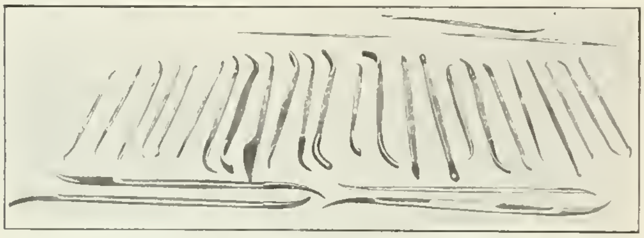

Fig. 21. Die-sinker's Assortment of Rifflers

blow. With such a proposition, it is far better to mill out and type the bosses before doing the lathe work, in order to save time and trouble in the typing.

Lettering

When the forging must show lettering, the dies are usually stamped at the bottom of the impression with the desired letters. This produces raised lettering on the forgings. The stamps used are not the usual sharp-line stamps in common use in the machine shop, but are made deep and with a flat face, so as to give body to the letters on the forging. In putting in the lettering, care must be used in the spacing, for if too closely spaced, there is danger of the stock between the letters breaking out. To space a word properly, the central letter of the word should be stamped lightly in the center of the space to be lettered, and from this central letter the rest of the word is added on either side. If the letters are extra large in size, it is advisable to mill or chip

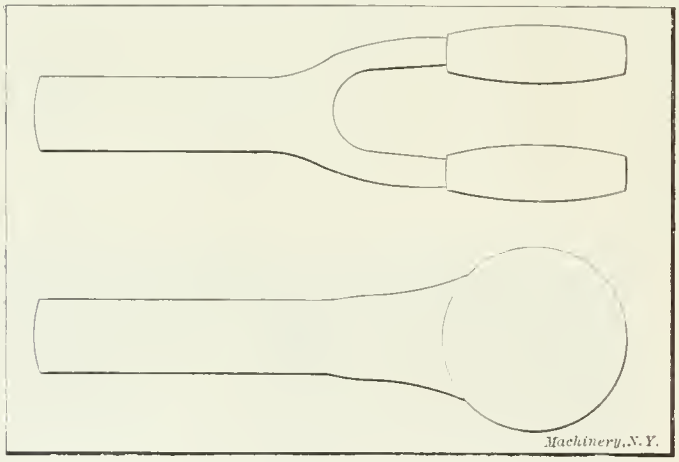

Fig. 22. A Forging to which the Rule for Making the Types applies

out the letters after they have been lightly stamped in the die, after which they may be put in to the full depth without a large displacement of the steel.

The Gate and Sprue

In ninety-nine cases out of one hundred, a drop forging is made complete while still a part of the bar from which it is started and afterwards severed. To hold the forging while being worked, a sprue must be provided. The sprue is the connecting-link between the bar of rough steel and the forging. To form the sprue, a channel is cut from the front end of the impression to the edge of the die-block. The size of the sprue should be governed by the weight of the forging, and in all cases it should be no heavier than is necessary to support the forging while being worked and trimmed.

The gate is an opening in the front of the die to receive the bar stock, and is made large enough to admit the bar without forging or crushing it at all. Fig. 24 shows the operation of cutting the gate, and also illustrates the way in which the matching sides are planed. The second gate in the die is, of course, for the forming impression. The ⅝-inch hole shown in the front of the die-block is for the purpose of lifting the die; by placing therein a short bar of ⅝-inch rod, and another bar in the hole on the opposite side, the block may be handled easily either by hand or with a chain fall.

Taking Leads or Impressions

For the purpose of seeing just how the forging will look when it comes from the dies, as well as to check up the shrinkage allowances and see if there are defective places in the impression, it is customary to take a lead proof from the finishing impressions of the upper and lower dies after they have been completed. Frequently the machinist would like to be able to use a "putting-on" tool in his work, especially after he has read his micrometers; with the die-sinker it is very easy to put on stock if the forging needs it, by simply making the dies a little larger at the desired point. A lead will show up any places on the forging that may need more stock; also, by weighing the lead, a good idea of the weight of the finished forging may be obtained.

Roughly speaking, the finished forging will weigh two-thirds as much as the lead proof. The shrinkage of lead is

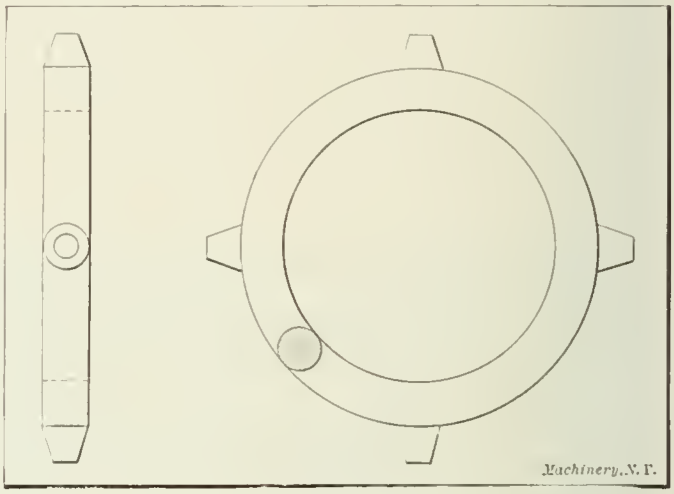

Fig. 23. A Forging for which the Die Impression should be milled and typed before Turning

practically the same as that of steel, so that the finished forging will measure very nearly the same as the lead. In the case of dies for eye-bolts, etc., this rule must be disregarded, because the plugs in such dies that form the central openings, will hold the lead from shrinking naturally, whereas the forging shrinks most after it has been taken from the dies. Fig. 27 shows a group of leads from dies for eye-bolts, hooks, etc.

In taking the lead, the impressions in both upper and lower dies are cleaned out, dusted with powdered chalk, and stood on end, after which the dies are clamped together with a large C-clamp, care being taken to have the matching sides perfectly in line with each other. The lead is now heated, care being taken not to burn it, and is poured slowly and evenly into the dies until it fills the impression and gate. As soon as the lead has cooled, the dies are unclamped, the lead removed and examined. After making any changes that the lead shows to be necessary, another lead should be taken to make sure that the impressions are correct. Fig. 28 illustrates the method of pouring a lead.

The Flash

In theory, the amount of the forging metal in the die impression when struck, should *just* fill the impression—no more and no less. This is, of course, impossible in practice, although the dies are made to come as near to this ideal as possible. As a matter of fact, there is always some stock that must be disposed of, after the impression is full; but if the dies are well planned and the forging is well done, there will be a small amount of extra metal, provided that

the right size of stock is used. This excess stock that is squeezed out is called the "fin."

To take care of this metal that is crowded out of the impression, each die is relieved around the impression by milling a flat, shallow recess, about 1/64 inch deep and 5/8 inch in width all around the impression. These dimensions are for dies of average size; in larger dies, the recess or "flash" as it is called, would be a little deeper and wider. Both upper and lower dies are flashed in this manner. In addition, the upper die is back-flashed; that is to say, there is a deeper recess, sometimes called the "gutter," milled around the impression at a distance of 1/4 inch from the impression at every point. This back-flash is 3/64 inch deep, and acts as a relief for the excess metal after it has squeezed through the flash proper. Only the finishing impression is provided with flash and back-flash. The fin is trimmed from the forging by means of trimming dies, when the forging is either hot or cold, depending on the size and shape. Fig. 25 shows the operation of milling the flash.

The relative positions of the flash and back-flash in regard to the impression itself are clearly shown on the wrench forging in Fig. 29, and the sectional view of a pair of dies in Fig. 30. In Fig. 29, the fin has entirely filled the back-flash, as the two ridges at the sides of the wrench show. This indicates that the stock was a little too full, not being drawn small enough at this part of the forging. Fig. 30 illustrates the appearance of the flash in section, with the back-flash in the upper die. As before stated, the forming impression is not flashed. This set of dies was for forging a plain ring, and although a simple set of drop-forging dies, they illustrate a few points of interest.

The finishing impression is placed as near the center of the blocks as is practical, to secure the best effect of the blow, as well as for strength. The plugs that form the center of the ring are given a 10-degree bevel inside, while the rest of the impression has but 7 degrees. These plugs come within 1/8 inch of meeting, and the forming impression has plugs that are well rounded over, to give them strength for the hard service that they receive, as well as to spread the stock. These plugs barely meet. The edges of this forming impression are also rounded to give strength, and to prevent the formation of cold-shuts. In the finishing impression these corners are made nearly sharp, so as to finish the forging. The opening on the right is the breakdown or edger.

The Breakdown

One of the most baffling points of drop-forge die sinking, to the novice, is the planning and making of the breakdown, edger or side-cut. These three terms are identical in meaning and all three are in common use in various shops. In laying out the breakdown, there are many points to be considered that are obtained only through experience, and appreciation comes only after learning, but we can at least give our attention to a few general principles that should be observed in this part of drop-forge die sinking.

After the face impressions are cut, finished, and the flash, gate and sprue completed, the dies are clamped together just as they were for taking the lead. Next, the rough surfaces of the right-hand sides of the blocks are chalked. The reason for using the right-hand side of the dies for the breakdown, is to make the forging operation easier for the forger, it being much easier to swing the bar on this side. A half-lead, or a templet of the forging, is then laid on the dies and the outline scribed. The location of this templet is important. If the piece is symmetrical, one-half of the outline should be on each die. If not, a parting line must be decided upon and the templet placed with this line even with the parting line of the two dies. A second line is next scribed 1/16 inch inside this outline in all places except the following: First, in all vertical places of the breakdown, the outline is given a draft of 7 degrees, part of which is marked outside the outline, and from that point running to the same distance within the outline at the bottom of the breakdown outline. Second, all right angles or abrupt bends should be well rounded off, so as to prevent the formation of cold-shuts. Fig. 31 illustrates a few templets and the breakdowns for the forgings, showing the points of difference between the templet outline and the breakdown outline.

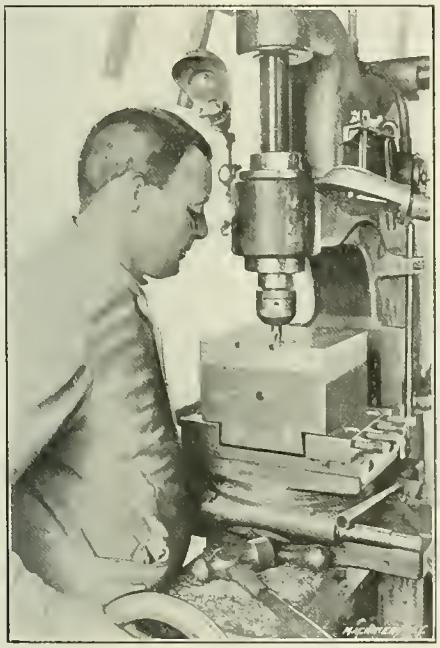

Fig. 24. Milling the Gate

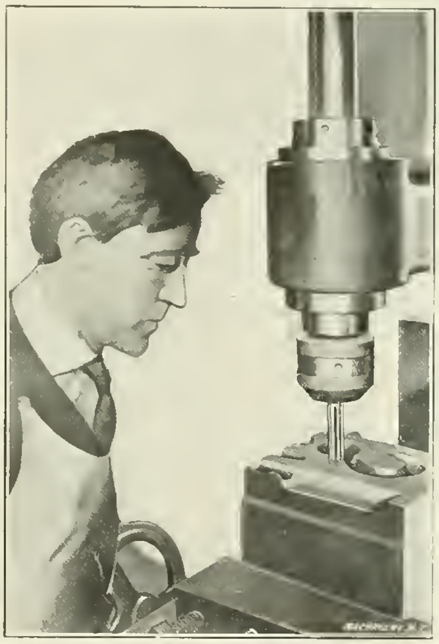

Fig. 25. Milling the Flash

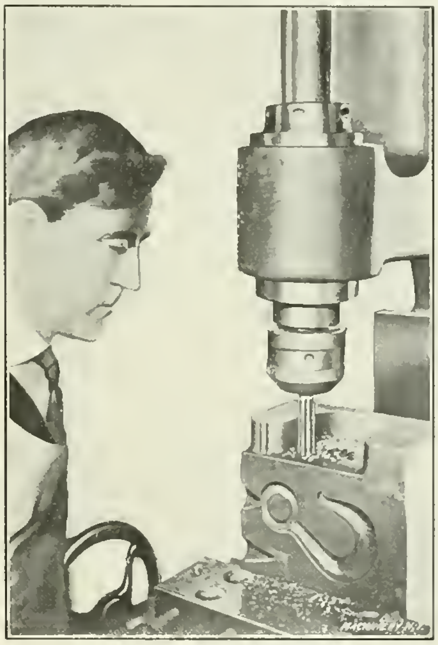

Fig. 26. Milling the Breakdown

The width of the section used as the breakdown should be sufficiently wider than the forging to give plenty of room for the work of forging. For a forging 1 inch thick, the edger should be 1 1/2 inch wide, and about the same proportions should be followed for forgings of other widths. At the rear end of the breakdown, a cut-off is provided to trim off any extra stock that has been drawn out on the anvil. Beyond this cut-off the die is cut away for clearance. The breakdown must be provided with a section that corresponds to the gate and sprue of the die impression, but it must be made slightly longer, so that the forging will not be stretched off when struck in the impression. This may be noticed on the die shown in Fig. 11 (see July number of MACHINERY), at the left-hand side. The breakdown will be at the right when the die is set up in the hammer, as this particular die is a top die.

The breakdown section should be a part of the die-block, and not bolted on the side as is sometimes done. There are cases where the breakdown must be a separate piece, but in nine out of ten dies, it is practical to have the breakdown a part of the die-block. Occasionally it happens that the form of the edger or breakdown must extend above the face of the die-block itself. If the amount of projection is not over 1 inch, the best way to accomplish this result is to

plane away the rest of the face of the die, so as to leave the edger projecting. If the distance is greater than 1 inch, a separate piece may be dovetailed in and held in place by a pin driven through the edger and into the die-block. The inserted piece should be a force fit in the dovetailed recess in the die-block. The breakdown should never be built up with a piece bolted on the side of the block, for the bolts will jar loose or shear off. Generally speaking, it is poor practice to use screws for dies or attachments for a drop hammer on account of the vibration.

Fig. 26 shows the method of setting up the die-block in the die-sinking machine for the purpose of milling the breakdown. After the correct outline for the edger has been determined, the line should be scored plainly with a small chisel. The die-block is then held in the vise of the machine on its side, and with a long straight cutter the breakdown is gradually cut in to the line.

The cut-off connected with the breakdown section of the die should not be confused with the cut-off for severing the forgings from the bar when they are to be cold-trimmed.

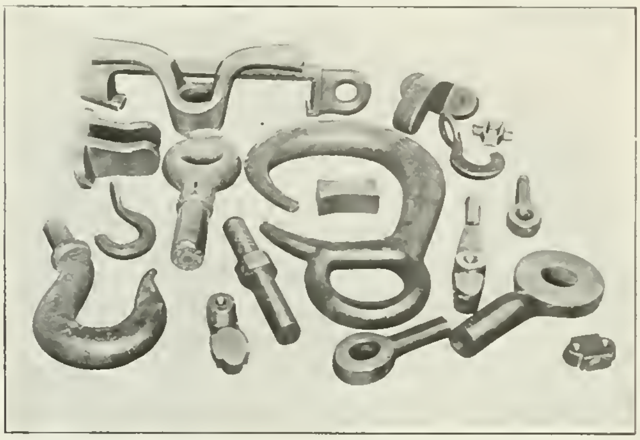

Fig. 27. A Group of Lead Proofs

The cut-off on the breakdown merely cuts the stock to length after being drawn out on the anvil.

The Anvil

There is little to be said in regard to the anvil. The two fullers have slightly crowned faces, and the corners are well rounded. Beyond these fullers, the die is milled away to clear the stock after it has been reduced, and to clear any large parts that must be left. The anvil is placed on the left-hand side of such dies as require it, and as has before been stated, its purpose is to reduce the stock for the thin sections of the forging. If a double-ended

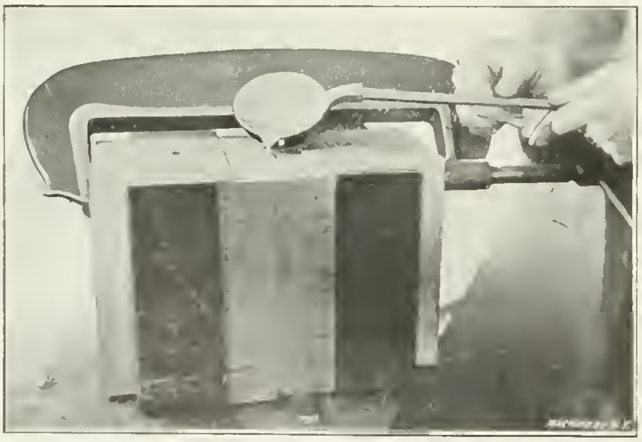

Fig. 28. Pouring a Lead Proof

wrench is to be forged, like the one shown in Fig. 29, an anvil will be necessary to thin out the stock between the thick ends of the wrench, before striking it into the impression or edger of the die. If the thin part of the wrench is ½ inch by 2 inches, the fullers would be left just 1 inch apart; that is, each face would be ½ inch under the face of the die itself. Thus it will be seen that the fullers are to square the stock to the dimensions that will "fill" the die when struck in the impression. The forger draws out the stock under the anvil just as the blacksmith would under a trip hammer. About one-half of the drop-forging dies made require anvils in their make-up.

The Cut-off

Dies that are made for cold-trimmed forgings require a cut-off to cut the forgings from the bar after completion. This part of the die is usually placed across one of the two rear

Fig. 29. A Forging showing the Effect of Flash and Back-flash

corners—wherever there is the most room. The cut-off is made by milling away the stock, so as to leave on each die corresponding chisel-like projections. These edges are not brought up sharp, but are left with a face of ⅛ inch so as to hold up well in use. Only forgings that are to be cold-trimmed require this method of cutting off, but as most small forgings are cold-trimmed, the cut-off is very commonly found on drop-forging dies.

Some die-sinkers prefer to cut a vertical channel into the sides of the dies, and set in steel sections that reach to the die-shoe flush with the bottom of the die-block. In such cases these blades project from the sides of the dies for three or four inches. This method has the advantage of permitting

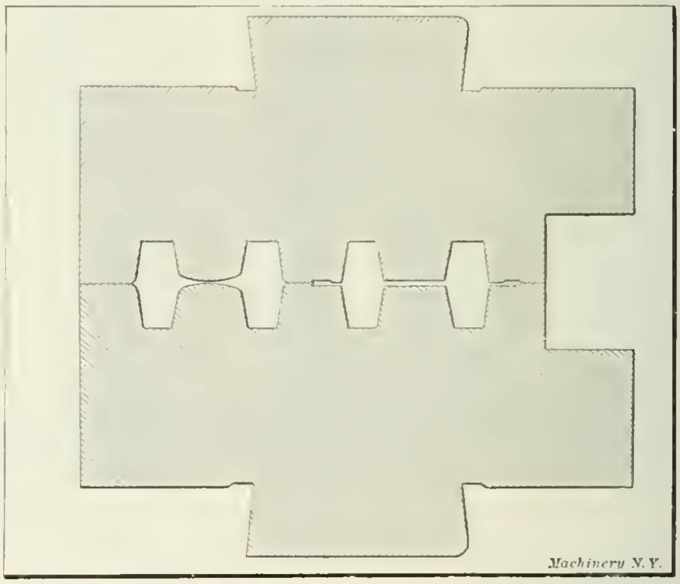

Fig. 30. Sectional View of a Pair of Drop-forge Dies, showing the Flash

new chisels to be inserted, in case of breakage—an advantage that obviates annealing, re-milling and then hardening the dies in case the cut-off gives out.

Hardening Drop-forge Dies

The hardening of drop-forge dies is an important part of the die making, and in small shops, it often falls to the lot of the die-sinker himself to attend to the hardening, or at least to oversee it. Dies that contain less than 60-points carbon must be packed in boxes with granulated raw bone, sealed air-tight and carbonized before hardening. Those open-hearth steel dies containing 60-point carbon or over, or those of tool steel, will harden without such preliminary treatment.

The Hardening Equipment

A good furnace for the hardening of drop-forge dies is the No. 2 Brown & Sharpe hardening and annealing furnace. Other makes may be just as efficient, but so many shops use this particular furnace for the work, that there is no doubt in this case.

The hardening tank should be about 4 feet square and 3 feet deep. The water supply should come in at the bottom, and the supply pipe should discharge upwards, so as to send a strong current toward the top of the tank. The overflow

should be a 6-inch pipe opening from a point near the top of the tank. If dies must be hardened in a tank without circulation, a large wooden paddle must be used to agitate the brine during the hardening. The best method of securing a good supply of cold brine, is to have a small reservoir out-of-doors that is covered over and yet exposed to the air. From this cooling tank, the brine may be pumped to the hardening room, returning by the overflow to be cooled. Across the tank, about 12 inches from the top, two bars should be suspended, forming a support upon which to rest the dies while being hardened. The brine should be a 40 per cent solution, and in the absence of a hydrometer, salt should be added to the water until the brine will float a raw potato.

Packing and Heating

For heating, the dies are placed in cast-iron boxes, in the bottom of which two inches of burnt granulated bone has been placed. Cast-iron boxes are used because cast iron stands the heat well, and the boxes are easily made. The walls should be at least ½ inch thick. Burnt granulated bone is merely the raw bone after it has been used for pack-

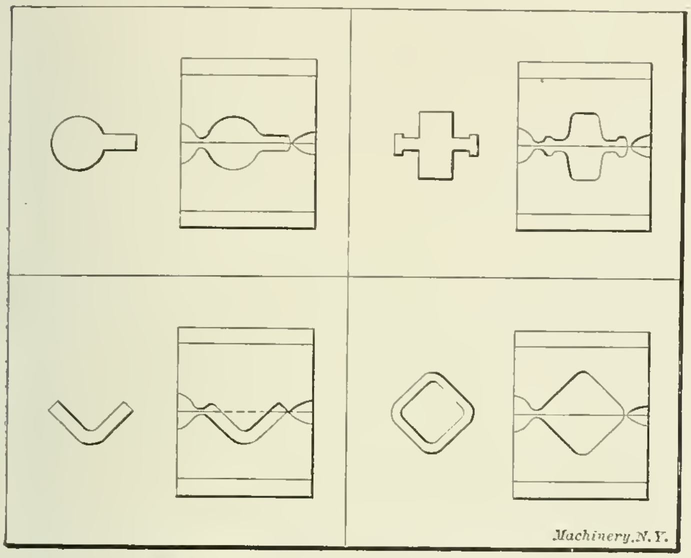

Fig. 31. Specimen Breakdown Lay-outs compared with their Templete

hardening a number of times. Upon this 2-inch layer of burnt bone, the die is laid face down, and settled down so that the bone fills the impression and the entire top face. This layer of bone serves a double purpose, in that it prevents the formation of scale on the face of the die, and also does not allow the steel to decarbonize. Steel heated in the open for any length of time will lose its carbon or a good part of it.

With the face of the die thus protected, the box, die and all are placed into the furnace and heated slowly and evenly. This heating takes from six to eight hours, according to the size of the die-block. The proper heat for quenching a 60-point carbon die lies between 1425 F. and 1450 F. As the die is but partly covered, the heat may be seen at all times.

Quenching the Die

When the die has reached the hardening heat, the cast-iron box, with the die therein, should be taken to the hardening tank. Here the die is held by the shank and placed upon the spider within the tank. The water is turned on full force, striking against the face of the die and driving away any steam that would "pocket" in the impression if it were not for the force of the stream. If the steam were allowed to pocket in the impression, soft spots would be found on the face that would be detrimental to the life of the die. The supply valve is left wide open until the brine reaches half way to the top of the die; at this time the valve should be closed enough to keep the level of the brine at this point. As soon as the die has cooled sufficiently to allow the water to cling or remain at the corners of the top of the die, the shank of which has at this time changed to a dull red color, the die should be placed in a tank of oil and remain there until cold.

A kink in hardening that is worth noting is the method of keeping the die flat when it tends to "hump" up at the shank. The hardener has a short straightedge that he keeps laying on the shank to see if a hump is forming, and such a condition is very apt to arise when hardening large dies. As soon as he notices a perceptible hump, he takes a small hose and plays a stream of water upon the bulging point until it goes back into shape. Care must be taken not to continue this small stream too long, or the hump will be driven to the face. A slight hump on the shank (not over 1/32-inch) will not be objectionable, as this will leave the face of the die comparatively flat. This slight bulging shank may be surfaced or ground flat after the die is cold.

Tempering the Die

The operation of tempering the die is accomplished by drawing the die in a tank of oil. The oil should be brought to a temperature of 450 degrees F. and kept there long enough to insure the heat penetrating through the die. After removing from the oil, the corners of the die and the cut-off must be drawn to a purple color with the aid of a blow torch. The quickest way to do this part of the tempering is to polish off these places as soon as the die is taken from the oil tempering tank, and then apply the blow torch, making use of the heat that is already in the die. After the die is cold, the oil should be cleaned off as much as possible, and the impression polished out with emery and oil on the end of a stick. This final polishing completes the work of making the drop-forging die.

* * *

THREAD ROLLING

By CORRESPONDENT

In performing thread rolling operations, it is essential to have the roll large enough in diameter to roll freely on the pin in the holder on which it is mounted. The thread on the roll should be the opposite hand to that which is to be produced on the work. For example, if the thread required on the work is right-hand, then the roll should be left-hand and *vice versa*. The diameter of the roll should always be made an exact multiple of the diameter of the work on which it is to roll. When the work is smaller than ⅝ inch in diameter, it is advisable to make the roll twice the diameter of the work, which will necessitate cutting a double thread on the roll so that the pitch angle of the thread will be the same as that required on the piece. The work to be threaded—when cutting a right-hand thread—should revolve in the same direction as when a thread is cut in the lathe. The work should also be well supported, and the roll, whenever practicable, should pass under the work. The roll-holder should be mounted on the cross-slide of the screw machine, and should be provided with up and down adjustment, so that the roll can be set to the correct height.

In forming a thread by rolling, the material is displaced, part of the thread being formed by raising a certain amount of the material above the circumference of the work. This necessitates turning the work to a smaller diameter than the finished diameter of the screw. For information pertaining to the diameter of the blank, see the article entitled "Calculating the Size of Blank for Rolling Screw Threads," in the November, 1909, number of MACHINERY, engineering edition, and also "Thread Rolling" in the February, 1910, number of MACHINERY.

The roll and the work to be rolled must travel at the same rate of speed, which, of course, cannot take place except when the roll is rolling the full thread; consequently an incorrect thread is produced when starting the roll. The thread on the piece will, however, be more and more nearly correct as the roll is finishing the thread, and when at the full depth it will be an absolute reproduction as far as the form of the thread is concerned. The roll and threaded piece will then rotate at absolutely the same speed. The slot in the roll holder, in which the roll fits should be slightly wider (about 1/64 inch) than the thickness of the roll, so as to allow the roll to move freely and keep in step with the thread on the work.

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD
NEW YORK CITY

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.
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AUGUST, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

COOPERATION BETWEEN DEPARTMENTS

It is not unusual to find that different departments in a manufacturing plant or machine shop are actually antagonizing one another, instead of working in thorough cooperation and harmony, as the best interests of the business demand. Sometimes each department considers itself independent of the remainder of the works; and many a shop foreman appears to be interested only in getting the work through his department at a given speed and under advantageous conditions, regardless of coordination with the rest of the works and of the effect on the organization as a whole.

The drafting-room and the manufacturing departments especially are often at odds; and frequently the shop man seems to delight in having a piece made wrong, provided he can show that the error was due to a mistake in the drawing.

This is an expensive condition for the employer, and it is well worth while for every manager to find out if such conditions exist in his works, so that if necessary he can locate the causes and eliminate them. Sometimes they originate from a policy which discourages any personal interest by the employes in the business. The first essential is for each employe to attend to his duties as a part of the organization and to carry out faithfully the work assigned to him; but if the management too clearly defines a "mind-your-own-business" attitude toward the employes, it may readily come about that the latter will give no thought to the interests of the company, and few enterprises can make headway under such conditions against the strong competition which exists today.

Sometimes lack of cooperation is due to the presence in the organization of individuals whose habits and mental attitude toward their fellow-workmen breed discord. Every organization is better off without such men, no matter what their mechanical ability may be. In the long run, the cooperation of a large number of average men will easily outweigh the greater ability of any individual whose presence causes trouble.

In general, the means for securing thorough cooperation by the different parts of an organization lie with the manager himself; and through him with the men whom he selects as heads of his departments. The ideals and methods of the leaders are quickly reflected in the attitude of those who fill subordinate places.

* * *

SELLING MACHINERY ON TRIAL

Until a new machine has been tried out by the average run of workmen, more or less unfamiliar with its operation, there is always doubt of its ability to do the work for which it was designed, and no matter what means the manufacturer uses to discover all the weak points, he cannot put himself in the place of the men who are to use it on everyday work; hence the desirability of acquiring experience that will enable him to improve the efficiency and durability of his machine—at the expense of the users. This is one strong argument for the propriety of selling a newly designed machine on trial. If it proves unsatisfactory, both parties have lost by the transaction, but if the trial is a fair one the maker has gained experience that will help him to perfect the weak points that have been discovered; and selling machinery on trial to gain this experience is justifiable from the maker's standpoint.

But to sell machinery that has been fully tried out on trial is poor business policy, and so far as we know, is seldom resorted to by established concerns. It implies weakness on the part of the manufacturer, places him at a disadvantage with his competitors, and an unscrupulous user sometimes does not hesitate to make claims for which the operator rather than the machine is responsible.

A manufacturer who has been more than ordinarily successful in marketing his product, and to whom we submitted this question, replied:

"Sometimes I think it requires greater art to sell on trial than to sell outright subject to no conditions. Corliss worked out a success for himself and his engine by selling on trial, usually with a guarantee to save a fixed amount per month or per annum. In a smaller way I worked out the same thing in the introduction of our machine by guaranteeing in some cases to save over $100 per month and permitting the customer to pay in that amount; also agreeing to take out the machine and stand the expense of demonstration, provided the customer was not satisfied.

"Of course at that time the machine was what we would ordinarily call a new machine, but there is no chance of making any sharp distinction between an old machine and a new one; all machines of progressive companies are in a sense new machines. If they are old ones, they may be new to the work, or to the environment in which they are placed.

"So far as the manufacturer is concerned it seems absolutely necessary that the machine should operate satisfactorily; but ordinarily the machine should not be sold on trial on account of the risk of implying the possibility of its not being satisfactory."

The better method, and one that is adopted by most experienced manufacturers of special machines, is to guarantee the character of the work and the output. The carrying out of the guarantee often costs the services and expenses of the maker's expert for several days, and sometimes the sale may net a loss; but the *machine stays sold*, and the first sale paves the way for more, which cannot be said when a machine is sold on trial and taken out because it is unsatisfactory. In the latter case, the buyer must make good; in the former, the manufacturer has that responsibility and opportunity.

* * *

STARTING SMALL SHOPS

A machine tool dealer in the West recently brought to the writer's attention a number of cases in which the apparent misfortune of losing a job had been the cause of starting a good mechanic in a little business of his own, which was an advantage for several parties—the mechanic, the dealer and the manufacturers whose tools he sold.

The time when such a man can start a machine shop in a small way and progress to greater things is not yet past—at least not in the Middle West. The dealer cited several cases where good mechanics had been laid off during dull times, and rather than go idle had put their savings into a limited machine shop equipment, beginning as a rule with jobbing work and gradually working into some regular line of manufacture. Nearly all the small plants in the Middle West, this dealer said, had started in this manner; and what

is quite remarkable, among those that have been so started, a comparatively large proportion, estimated at 75 per cent, have succeeded.

One reason why small tool shops are generally busy in dull times when larger plants are almost idle, according to our friend the dealer, is because in good times more firms make some of their own small tools. They require a few tool makers anyway, and keep them busy at odd moments making standard tools. They can get along with an old lathe almost indefinitely, but not very well with a broken tap, or a reamer worn under size. When trade falls off, these high-priced men often have to go first in order to cut expenses, the firm preferring to buy what small tools are necessary.

It is of particular interest to note that it often requires a sudden break, or an occurrence entirely out of the ordinary to awaken the dormant capacity in some men. Many of those referred to, if they had not lost their jobs, would still be working as employes, probably in some inferior capacities, with no immediate prospect of any change or improvement. They only needed a "jolt" to demonstrate that they had the courage to start for themselves.

* * *

SOFT IRON VS. HARD IRON FOR MACHINE TOOLS

The cast iron produced in America generally is somewhat softer than the irons of England and the Continent, and American machine tools have been adversely criticized because of the consequent softness of the bearings, ways, slides, etc., and their supposed greater rapidity of wear.

Although our cast irons are softer than European irons, experience shows that they do not wear as rapidly as the harder irons, strange as it may appear. A reason assigned is that the hard iron is very close-grained and "dry," having little or no oil-absorbing quality; American iron being more open-grained or porous, absorbs a small amount of oil when lubricated and feeds it out as the slides become dry. The slides or bearings are not readily cut or scratched even when neglected. It is alleged that a certain European imitator of American machinery has found it necessary to increase the area of ways fifty per cent in order to secure the durability of wearing surface of an imitated American machine.

Another important advantage of the soft American iron is the lessened liability of breakage under shock. Walls one-half inch thick on American machines must be replaced by three-fourths or one-inch walls when made of the European cast iron. These considerations are important. Coupled with the novelty of design that characterizes American machine tools generally, is a natural advantage in the quality of the material, due to our native ores.

However, there are two sides to this question, the same as to all others, and the opinions expressed by a number of German users and makers of machinery in the article by Dr. Grimshaw in another part of this number are of general interest to American machinery builders.

* * *

THE HOBBING PROCESS OF CUTTING GEARS

The value of the hobbing process of cutting spur gears seems uncertain to a number of gear-cutting experts and users of gearing. While some concede that hobbing is unrivalled in speed of production, they insist that hobbed gears are of little value except for low-grade work in which the peripheral speeds are less than 400 feet per minute. Others claim that the hobbing process has produced bad work only in certain cases because of the inexperience and ignorance of the operators of the machine. The defective design of certain hobbing machines and hobs is also given as the cause of bad work.

Although the hobbing process has certain defects and limitations, to us it seems to have large possibilities. The milling machine type of gear-cutter on which gears are cut by successive indexings certainly has limitations and defects, three of which, likely to result in bad gears, are: end play in cutter spindle, creeping on arbor caused by local heating of gear rim, resulting in a thick or thin tooth, and inaccurate index wheels. Notwithstanding these and other possibilities of producing poor work, accurate smooth-running gears are the rule where proper care is taken, especially to insure concentricity of the bore and pitch circle. There are those who assert that lack of concentricity is the cause of more noisy gears than all other causes put together.

Many users of hobbing machines, familiar only with the formed cutter type of gear-cutting machine, have not realized the need for being scrupulously careful in setting the hob at exactly the right angle—not in degrees merely, but in *degrees and minutes*. Moreover, the angle of setting is not fixed. As a hob is ground, its diameter decreases, and a decrease of diameter changes the setting angle. Another cause of trouble is lack of care in setting for depth. A hob gear cutter, the same as a milling gear cutter, should be set so as to produce teeth of the correct thickness on the pitch line, if the best work is required. It is better to spend some time in experimenting, and spoil a few gear blanks in determining the best setting, if perfect gears are thereby afterward made, than to turn out a lot of indifferent or positively defective gears because the setting of the hob is inaccurate. But whether milled, shaped, planed or hobbed, the bore must be truly concentric with the pitch circle if quiet-running gearing is to be produced.

* * *

ESTIMATING STOCK FOR SCREW MACHINE PRODUCTS*

By S. M. HOVIS

In the Data Sheet Supplement is given the amount of stock necessary for the production of 1000 pieces on the automatic screw machine, when the length of the finished piece and the thickness of the cut-off tools are known. In using this table, when the foreman wishes to place an order on the store-room for stock, it is only necessary for him to add to the length of the piece, the width of the cut-off tool blade used, and the number of feet of material required for 1000 pieces will be found in the table.

Screw machine stock usually comes in bars of 10 feet lengths, and in making up this table an allowance is made for chucking on each bar. The amount to add to the length of the piece for the cut-off tool is given in the following; this is the standard in a large number of shops:

Diameter of Stock in Inches	Width of Cut-off Tool Blade in Inches
0.000—0.250	0.045
0.251—0.375	0.062
0.376—0.625	0.093
0.626—1.000	0.125
1.000—1.500	0.156

The table can be extended to take in other lengths not shown in it by using the following formula:

$$F = (L + W) \times 84.0336$$

where

F = number of feet required for 1000 pieces,
L = length of piece,
W = width of cut-off tool blade.

It is also sometimes convenient to know the weight of a certain number of pieces, when estimating the price. The weight of round bar stock can easily be found by means of the following formulas:

For brass stock

$$W = D^2 \times 2.8584 \times F$$

For steel stock

$$W = D^2 \times 2.6748 \times F$$

For iron stock

$$W = D^2 \times 2.6508 \times F.$$

where

W = weight in pounds,
D = diameter of stock,
F = length in feet.

* * *

A few shop kinks and wrinkles are a sign of resourcefulness. Too many indicate the despoilation of untrained genius.

* With Data Sheet Supplement.

THE MANUFACTURE OF A DIRECT-CURRENT MOTOR*

By A. M. MACFARLAND†

The subject of electric drive, whether in the individual or group form, is occupying such a prominent place in the minds of many of those who are concerned with the matter of shop operation, that an article on the manufacture of a standard motor should prove acceptable. Especially is this true when it is considered that in every walk of life, electrical power enters more or less in some form or other.

It can readily be appreciated that in such a mechanism as a motor, the parts of which bear a great similarity to each other, in machines of varying powers and different purposes, many special methods of production have been devised. In fact, while most of the operations might be performed on standard equipment, it has been found profitable, and for the matter of competitive production, a necessity, to use special machinery. It will be noted, however, that nearly all the special machinery employed is of a very simple character, capable of being operated for the most part by unskilled labor, specially trained for some particular operation.

In the selection of a typical machine for descriptive purposes, it is advisable that one which is well known be chosen. For this purpose, the type L, Crocker-Wheeler motor was considered to be representative, and an idea of the extent to which it is used may be gained by the statement that over a million dollars' worth is in use, not only in America, but abroad as well. This type of motor is made in all sizes from 1/20 to 7 1/2 horsepower, so it may be considered as representative of the smaller class of motors such as are commonly used for individual drive. The method of manufacture is typical of that used in the production of small direct-current motors, in general, a number of the processes, however, being peculiar to the Crocker-Wheeler shop.

As before mentioned, much special machinery is employed in the manufacture of motors. In this particular, the policy of the Crocker-Wheeler Co. differs slightly from that of many electrical concerns, for this company believes that if a machine is built so that it can only produce a certain piece in a certain way, and is not capable of a slight change, the making of improvements is discouraged, for any improvements changing the design of the part will necessitate discarding the whole machine. Thus a compromise is made by having the manufacturing equipment so elastic that slight changes in any part of the construction from time to time, such as experience in the art of motor-making may dictate, can be made.

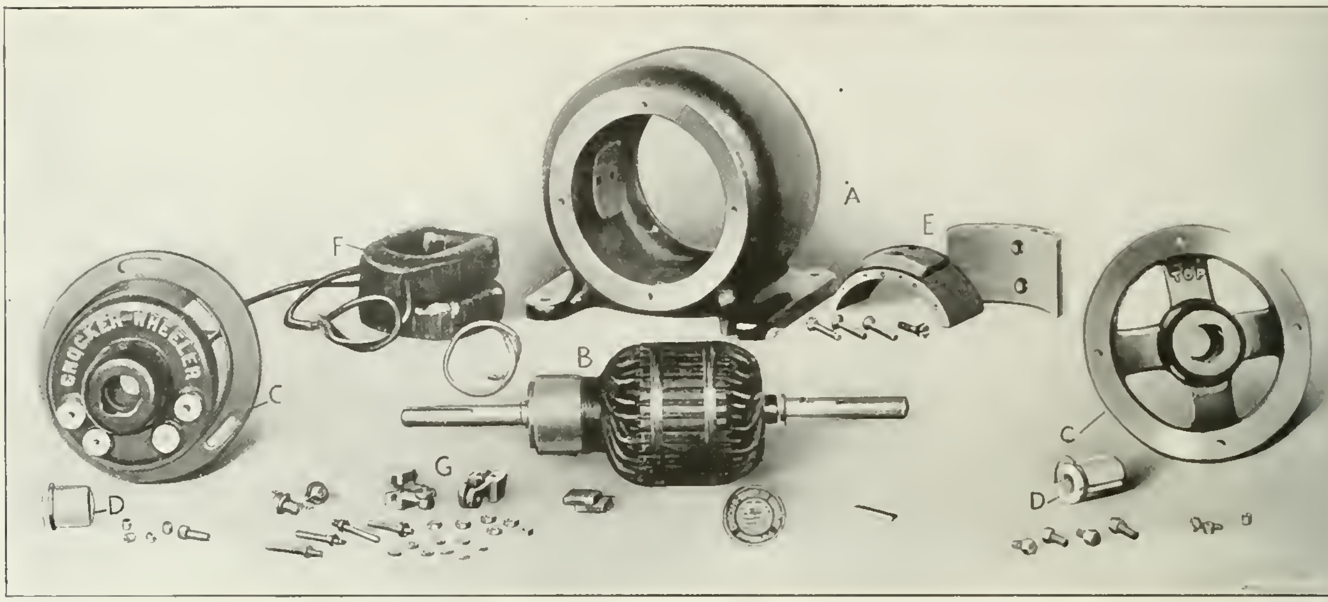


Fig. 1. Component Parts of Small Direct-current Motor of the Partially-enclosed Type

Consistent with the principles of modern machine design, the parts are made absolutely interchangeable throughout, and the wearing parts are reduced to the smallest possible number. The parts themselves and the actual processes through which they pass in the manufacturing will next be considered.

General Description

The type L motor is of the partially enclosed type in which none of the parts are exposed or subject to injury from knocks. Fig. 1 shows all the individual parts of the motor dismantled. *A* is the magnetic frame, the main portion of the motor; *B*, the armature; *C*, the two motor-heads which carry the oil-ring journal boxes *D*; *E*, one of the laminated pole shoes which are bolted to the inside of the magnetic frame; *F*, the field coils; and *G*, the brush holders and the accompanying parts which are held in the porcelain bushings shown in the motor-heads to the left. The other small parts fulfill minor requirements. It can be seen that while the motor, as it normally stands, appears to comprise very few parts, when they are

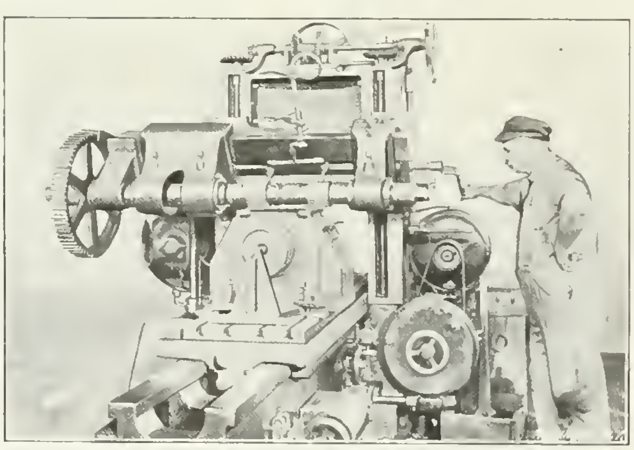


Fig. 2. Horizontal Milling Machine set up to mill the Feet of Motor Frames

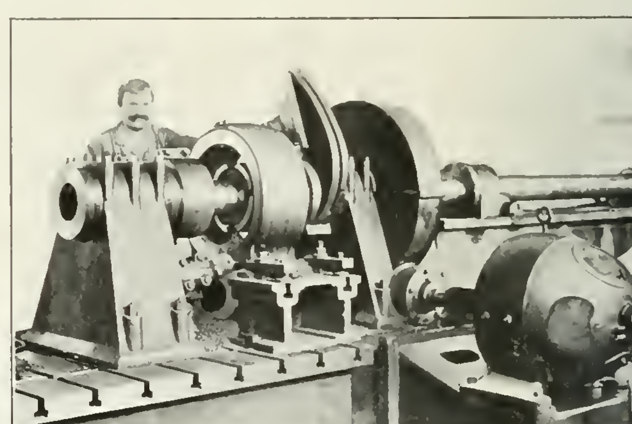


Fig. 3. Boring and facing the Frame on a Special Horizontal Boring Mill

* For additional information on this and allied subjects, see the following articles previously published in MACHINERY: "Pole Piece Design for Dynamos," May, 1908; "Mechanical Calculations and Data for Dynamo Design," January, 1907, and "Winding of Direct-Current Armatures," March, 1906.

† Advertising Manager, Crocker-Wheeler Co., Ampere, N. J.

grouped together as shown they make a goodly number. It will be observed, as the description progresses, that the parts before assembling into the units shown are many more than indicated in the illustration.

Magnetic Frames

The magnetic frame shown at *A*, Fig. 1, will be considered first in the course of machining. In accordance with good practice, this part, as well as all the other parts, is made with just as little metal to be removed as possible, so that the machining operation is light. Fig. 2 shows the first operation in this machining process; the feet of the frame casting are milled in a horizontal milling machine, being held in a special chuck. It will be noticed by referring to Fig. 1 that this magnetic frame has two pole pieces and also two circular ends. In this jig, two jaws center the casting on the pole faces, while two other jaws center it on one of the ends, thus locating the casting centrally and making it possible to cut down the subsequent boring to a very small amount. As all the parts are interchangeable, it is absolutely necessary that the height from the feet to the center of the machine be absolutely uniform in all.

As just mentioned, the milled feet of the frame furnish an accurate attachment to the bedplate of the boring and facing machine shown in Fig. 3. The type of boring mill shown, especially adapted to this class of work, will take the three cuts at the same time, facing off the ends and boring out the pole faces. In order to set up quickly and have the central distance always uniform from the feet, special parallel blocks are provided, such as indicated. The clamping bolt shown is unique in its construction and might be advantageously used in many plants.

The casting thus far machined is removed to the drill press where the feet and poles are drilled and the necessary holes threaded. The holes for the attaching of the pole pieces are drilled and tapped from the outside, this being the most convenient method. In order that these holes will not be visible on the exterior of the casting, they are plugged up, leaving the casting with a smooth surface. For this drilling operation, jigs are used throughout, the interchangeable feature being kept constantly in mind.

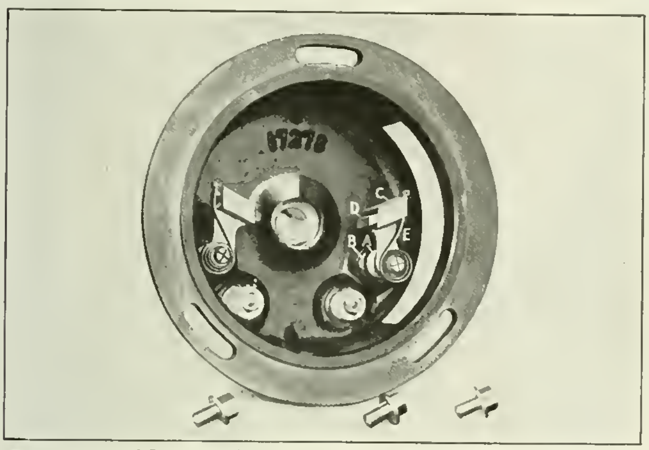


Fig. 4 Enlarged Interior View of Motor-head, showing Brush Construction and Method of Securing

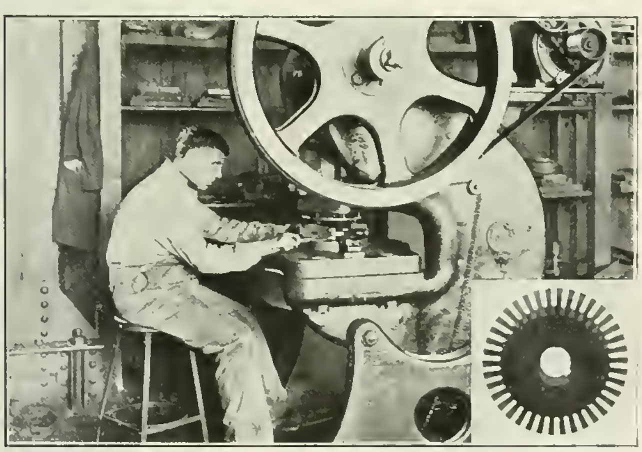


Fig. 6. Punch Press forming Core Lamination with Enlarged View of Lamination in Lower Corner

Motor-heads

The next operation is the machining of the motor-heads which are shown at *C*, Fig. 1. Fig. 4 shows an enlarged view of the motor-head which carries the brushes. In the machining and designing of these heads, great care must be taken that the bearings remain in true alignment. The first step in machining is to rough bore the hole for the journal box, after which the head is forced on a mandrel, the rim faced, and the flanges turned to fit on the end of the motor frame. After this, the heads are removed from the mandrel and bolted to the motor frame, where a finishing cut is taken from the bearings, removing 0.004 inch, left for that purpose. This is accomplished by the use of a pilot reamer which fits one of the ends, while the other end is being reamed to the exact size of the journal box. The journal box is then put in place, this, in turn, acting as a guide for the boring-bar, while the other end is being finished true to size. This method insures the bearings being in exact alignment.

These journal boxes, which are shown to best advantage in Fig. 5, are made from Lumen metal, die-cast to almost the exact finished dimensions. Their construction is clearly indicated in the illustration. They are provided with ring oilers, as is usual in journals where the shaft revolves at high speed. In the smaller sizes, grease cups are used instead of rings, as shown to the right. It has been found that the metal on the surface of die-castings is considerably harder than that of the interior and furnishes a much better wearing surface; for this reason the inside bearing is cast very slightly smaller than the finished size, and a light finishing cut is taken with the reamer so that the wear-resisting qualities of the die-cast surface are not destroyed. The outside of the journal box is finished in the usual manner by placing on a mandrel. This journal box is provided with a circular groove which is just opposite a corresponding ring on the armature shaft, the purpose of which is to throw off any oil from the shaft which has collected in the groove.

Going back to Fig. 4, it is interesting to note the construction of the brush-holders, which are carried in the head. They are contained, as indicated, in porcelain bushings *A*, which are secured in the head by molten type-metal poured

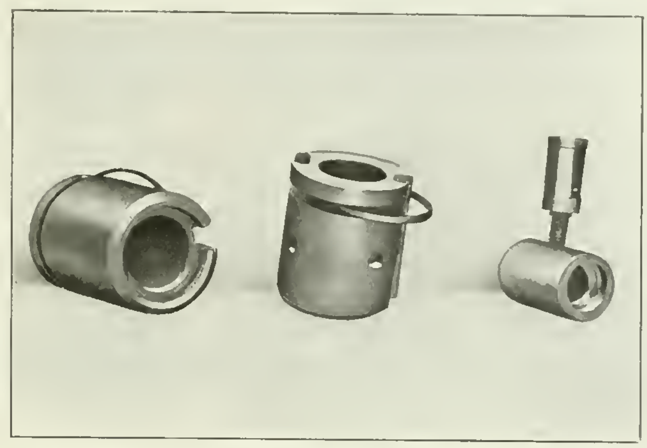


Fig. 5. Three Views of Die-cast Bearing; these Bearings only require Finish Reaming

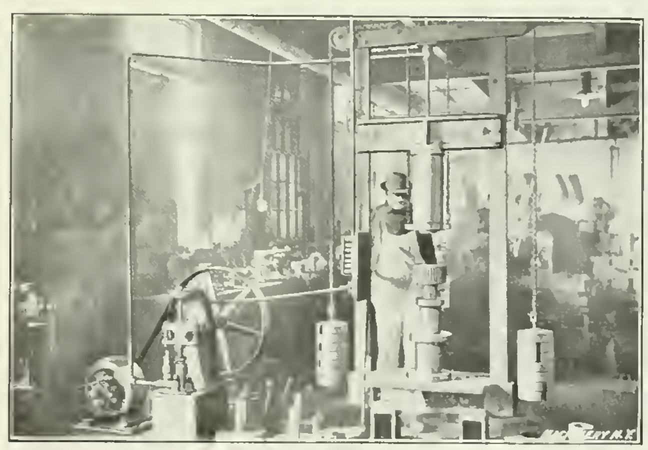


Fig. 7. Building up Core under a Hydraulic Press, showing Pump and Connections

around them, as shown at B, making a rigid connection, instead of swinging around the point of suspension as is usual. It is considered that the latter method of attachment does not give uniform wear at the brushes, the edge nearer to the point of suspension wearing more rapidly; for that reason, the construction shown in the illustration has been followed out very successfully. The brush holder C is rigidly attached to the pin which passes through the bushing A and contains the brush D, this brush being free to slide back and forth in a straight line. The coil spring E, pressing on the upper end of the brush, keeps it in contact with the commutator at all

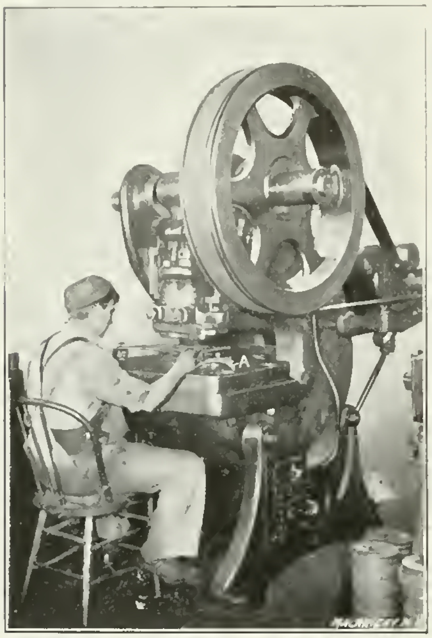


Fig. 8. Punching Pole Laminations

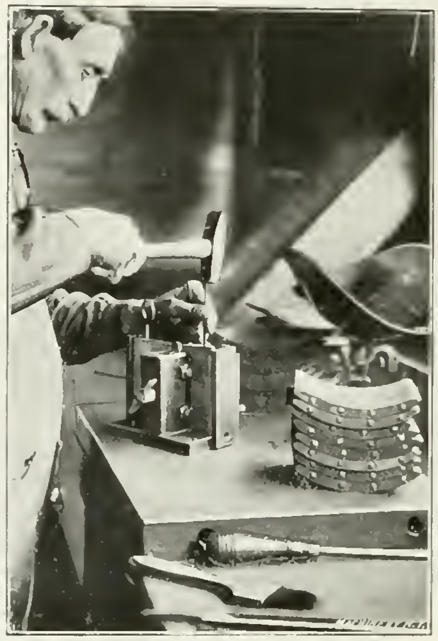


Fig. 9. Riveting together Pole Laminations

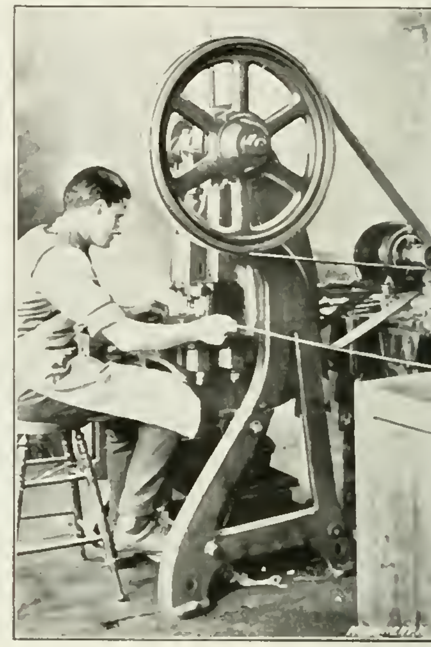


Fig. 10. Punching Commutator Segments

times, so that its path is radial, insuring uniform wear on the end. The leads are brought to binding posts on the outside of the porcelain bushings just described. This method of bringing in the leads is unique and has the decided advantage of keeping the wiring, which is commonly inside the head, entirely on the outside and free from oil which has a tendency to destroy the insulation. This type of construction bears a close analogy to that of the automobile spark plug.

The frame thus far assembled, after having these operations performed upon it, is forwarded to the chipping department

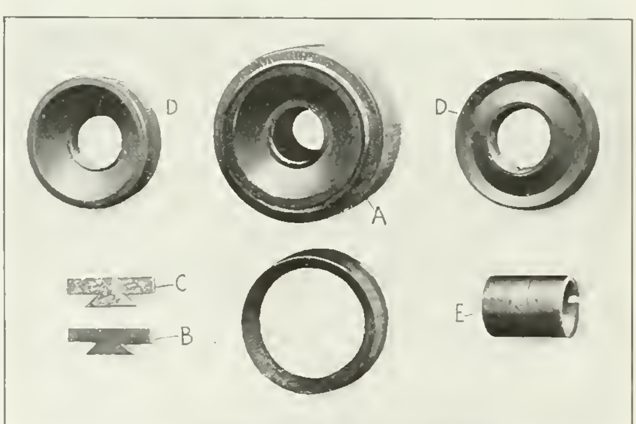


Fig. 11. Component Parts of the Commutator

Fig. 12. Building up a Commutator in a Temporary Clamp

where any rough projections are removed by means of pneumatic tools, followed by sand blast, after which the casting receives the final filing operation. The assembled unit is next treated to a coat of black paint of a special composition, designed to form a foundation for the japanning which follows.

Armature Core

The armature core is made up of a series of thin metal punchings, called "laminations," of the form shown in the lower right-hand corner of Fig. 6. These laminations are made of special "non-aging" metal, provided in sheets of suitable thickness and size to form the required diameter. The main part of Fig. 6 shows the simple punching process by which these laminations are made. It is interesting to note the large sizes that may be made by this punching process; laminations up to three feet in diameter—sometimes larger—may be made at one stroke. For the very large sizes, it is customary to use a notching machine which indexes for each of the separate notches. It is also worthy of note that the punching dies for these laminations must be very carefully made, for any burr would spoil the accuracy of the pile formed by the laminations, preventing them from coming in close contact.

After the punching operation these laminations are carefully heat-treated in annealing furnaces, in order that the iron may be made as soft as possible. This is done in order that the magnetic reluctance may be reduced to a minimum, for it is a well-known fact that the harder the metal, the more difficult it is to rapidly change the direction in which the magnetic lines flow.

Following this annealing process, the laminations are coated with a special insulating varnish and arranged in piles of five. Between each of these units of five a sheet of insulating material is inserted as a means of preventing the generation of eddy currents in the cores. These eddy currents are similar to the currents generated in the cross-bars of a dynamo armature, and have a heating effect on the revolving armature if not destroyed. Breaking the lengthwise electric path by inserting these insulating layers, makes it impossible for the eddy currents to flow.

When a sufficiently large pile of these laminations has been prepared, they are placed under a hydraulic press, such as shown in Fig. 7, where they are compressed into a solid mass, being retained temporarily in that position by small bolts inserted in the grooves, as indicated in the illustration.

The core, now being properly assembled and held together

by the temporary bolts, is forced onto the shaft over a key provided for that purpose, by means of another hydraulic press. It can be seen that these punchings must be very carefully made in order to have them fit the shaft exactly and not be at all eccentric, as this latter consideration is very important if exact balance is to be maintained. The armature assembled on the shaft is removed to a filing machine where the slots are filed to a smooth finish, as no matter how accurately the dies are made, with a series of laminations such as in an armature, the slot surface is bound to be more or less rough.

It will thus be seen that the proper construction of this armature is very important, for much depends upon the proportion of the slots, the material of which it is formed, the manner in which it is insulated, the manner in which it is annealed, and the efficiency of the mechanical means by which it is attached to the shaft.

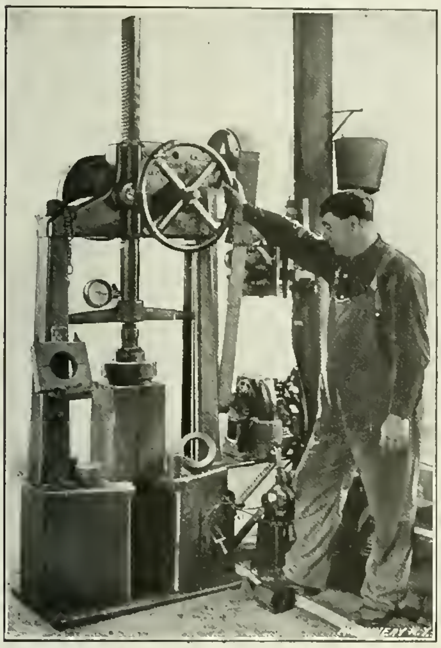


Fig. 13. Forcing Commutator into the Retaining Ring

The armatures for larger machines are constructed in a similar manner with the exception that for ventilation purposes hollow separators are introduced between the laminations at intervals along the length of the core, which keeps the temperature down in the interior of the coil, the centrifugal action of the rapidly revolving armature creating a current of air.

Pole Shoes

A rather unique construction for a motor of this size is the making of laminated pole shoes. These are punched in exactly the same manner as that used in making the armature laminations, the operation being shown in Fig. 8; one of the small laminations is shown at *A* on the press table. Their construction can be more clearly seen in Fig. 9. The material, method of treatment and other particulars enumerated in connection with the armature laminations receive as careful attention for the pole shoe laminations. The idea of using laminated pole shoes instead of a solid casting is to avoid wasteful eddy currents, and it is considered worth the additional expense which this process undoubtedly incurs.

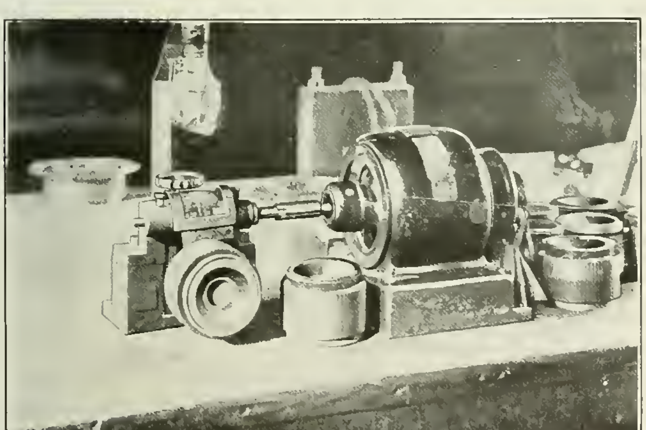


Fig. 14. Slotting the Ends of the Commutator to receive Coil Terminals

The necessary number of these laminations to form a pole shoe are assembled and compressed to a solid condition under a hydraulic press in a manner similar to that previously described. Before the pressure is removed, holding rivets are passed through the holes and solidly headed up on both ends, the methods of lining up for this riveting process being indicated in Fig. 9. A pile of the riveted-up shoes is shown to the right in the illustration.

The pole shoe may now be considered as a solid casting, so rigidly is it constructed. It is drilled and countersunk from the concave side to correspond to the two previously drilled and tapped bolt holes in the poles of the magnetic frame.

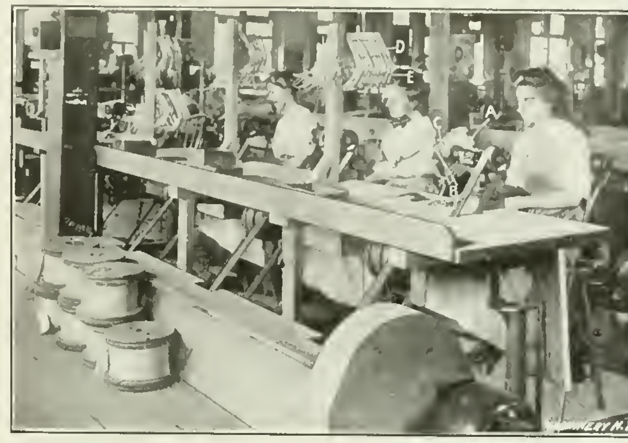


Fig. 15. Forming the Armature Coils

Commutator

The commutator is a very important part of the motor, for by means of this device, the current is given the necessary reversals in direction to rotate the motor. Fig. 11 shows the integral parts. *A* is an assembled view of the commutator; *B*, one of the copper segments of which it is made; *C*, one of the intervening mica segments; and *D*, two end collars threaded respectively right- and left-hand, and drawn together by the corresponding right- and left-hand connection *E*. These end rings *D* fit into the V-part of the copper segments, which are arranged in a circular ring, and compress them when drawn together by the coupling *E*. The compression also tends to draw the segments radially inward. Fig. 10 shows a press at work cutting out copper segments such as that shown at *B*, in Fig. 11. The segment bars are rolled in the form of a sector of a circle, so that when assembled they form a complete ring. The mica strips which are punched in the same way are just thin sheets.

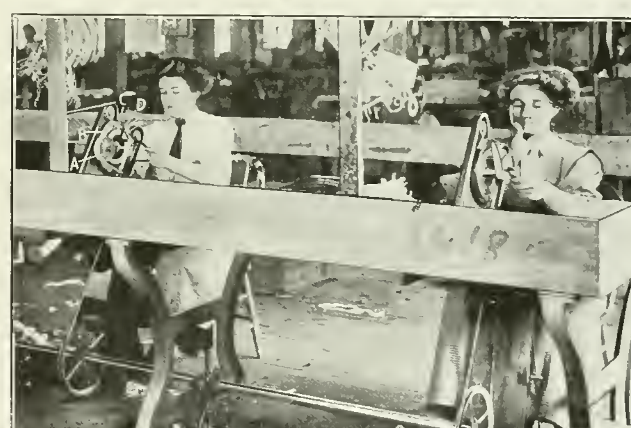


Fig. 16. Taping the Armature Coils

Fig. 12 shows the assembling of the commutator. Alternate pieces of copper and mica are inserted in a clamp form, such as that shown at *A*. When the necessary number has been introduced, the clamp is tightened down and the whole removed to the press shown in Fig. 13. Fig. 12 also shows, on the table, the parts previously illustrated in Fig. 11. The commutator ring, assembled in the clamp, as just mentioned, is placed over a form, the internal diameter of which is slightly smaller than the inside diameter of the clamp, so that the press forces the commutator into this ring, pressing it radially inward by so doing; when entered, the wooden clamp is removed. The commutator in its steel retaining ring, next has the end clamp rings and the center tubular section assembled to it. This tubular piece is formed of cold-drawn steel tubing and is pro-

vided with a notch at one end, as indicated in Fig. 11, which serves as a small keyway. While this piece is a force fit on the shaft, this keyway fitting over a pin in the shaft provides an extra precautionary means for preventing the commutator from slipping. The assembled commutator is next taken to a specially built machine, indicated in Fig. 14, where the inner end of each of the commutator segments is slotted to receive the ends of the connection wires from the armature windings. Just previous to this operation, the assembled commutator is baked in an oven where the temperature is raised to a certain predetermined degree and where the commutator is allowed to remain for a period of several hours. The mica insulation is impregnated with a viscous substance which before being baked may be softened by heat. The object of this baking in the oven is to so harden this viscous substance that the commutator forms a solid unit, in other words a practically solid ring. Before cooling down, the inner tightening ring is screwed up still tighter in order to take up any slack which

Fig. 17. The Varnishing Room where the Coils are Impregnated

may have occurred through the softening of the mica segments. The commutator, now being completely assembled, is forced on the shaft as before mentioned under a hydraulic press.

Armature Coils

The manufacture of the armature coils is possibly the most interesting part of the whole process through which the various parts of the motor go. The wire instead of being directly wound upon the armature, as was originally the method in the early machines, is formed into coils which may be set into the slots of the face of the armature, the connections of the coils being properly connected to the armature segments. Fig. 15 shows a row of special machines used for winding these armature coils. *A* is a form consisting of a member solid with the revolving shaft and an outer removable member, between which the wire is wound. The connecting lead is formed by taking an end of the wire, as at *B*, and temporarily winding

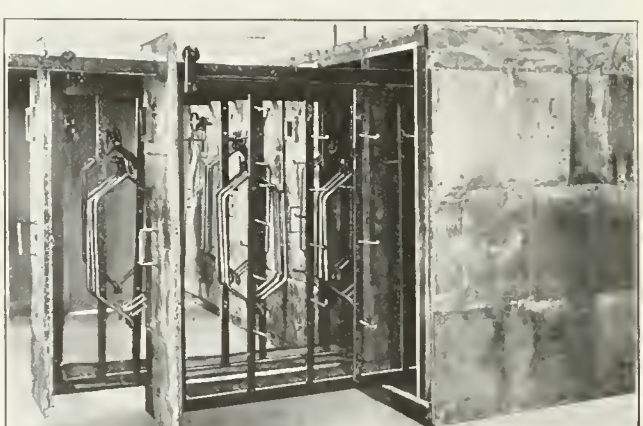


Fig. 18. Baking Ovens where the Varnish has all its Viscosity Baked Out

it around a peg. After a certain definite number of turns have been placed on this form, thin strips of soft metal are slipped under the form in the cut-outs *C* and bent around the form to retain its shape. The removable cover of the form may then be taken off and the coil slipped out. A lot of these coils, as formed, are shown at *D*, the temporary metal-holding clips being shown at *E*. The operators, being constantly engaged on these coils, become very dexterous in their production.

These formed coils must next be insulated. The difference in potential between an individual turn of the coil and the turn next to it is very slight, so the amount of insulation between the different wires does not require to be very great.

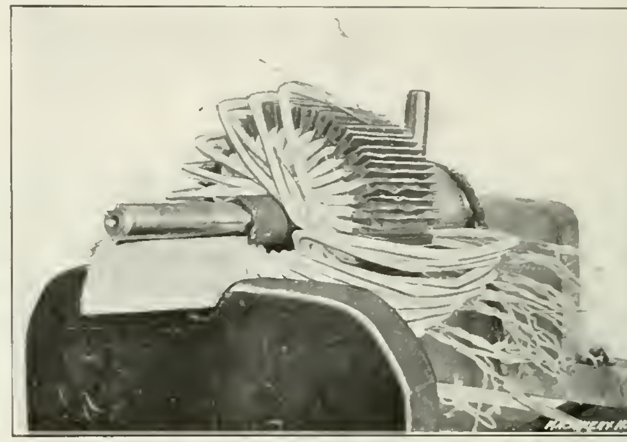


Fig. 19. Placing the Armature Coils in the Slots of the Armature

On the other hand, the difference in potential between the coil as a whole and the armature, is comparatively high so that practically all the insulation must be placed around the coil rather than between the individual wires.

Fig. 16 shows the method of insulating the coils by covering the surface with linen tape. Here special machines are used which, however, are adaptable to coils of all shapes or sizes. A roll of tape *A*, kept under tension by an internal spring, is fastened to a ring *B* which revolves on a projecting shoulder *C* of the frame of the machine. Both revolving ring *B* and projecting ring *C* have a corresponding cut-out *D*, through which a coil may be inserted from the outside. The end of the tape roll is first wound around the coil a couple of turns, when power, which is transmitted to the revolving ring by a belt, causes the roll of tape to revolve with its carrying ring around the coil, taping it from one end to the other. Consid-

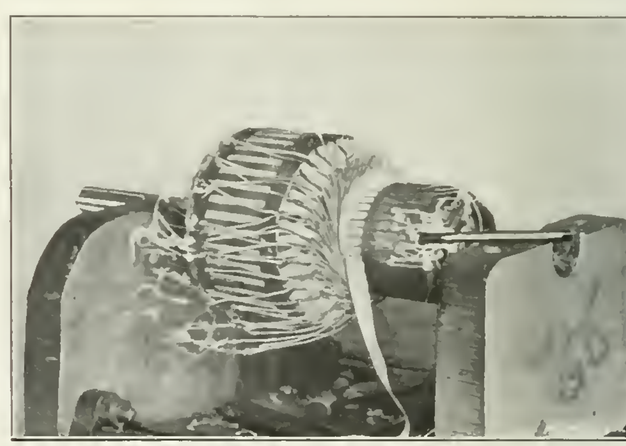


Fig. 20. Connecting the Armature Coil Terminals to their Respective Commutator Segments

erable practice on the part of the operator is required to produce an even, uniformly overlapped tape surface, and it is remarkable how efficient operators become and how rapidly the coils can be produced.

The varnishing of these coils is interesting: After the coils are formed on the winding machines illustrated in Fig. 15, the coils are taken to the varnishing room shown in Fig. 17, where they are immersed in big tanks of special varnish, such as that shown at *A*. A bunch of them is shown at *B*, being held by the leads. The coils are placed in racks, as at *C*, and lowered into the compound. The rack *C*, as shown, is being used for immersing field coils, a description of which will be given later in the article. The armature coils, after the dipping process, are placed on racks *D* where they are allowed to drain for awhile, after which they are taken to the oven to be baked. The larger coils are subjected to a little different treatment, going through a vacuum impregnation in the tank *E*, the cover of which is swung back. The coils are placed in big racks and

lowered into this tank, following which the cover is tightened down and the air exhausted from the tank; the varnishing compound is then introduced under high pressure. The vacuum makes it possible for the compound to penetrate to the inmost parts of the coil leaving no crevice unprotected. The smaller coils, however, are ordinarily treated by the dipping process just outlined.

In baking, the coils are hung on racks in ovens such as shown in Fig. 18. When a sufficient quantity has been introduced into the oven, the rack, which is shown opened, is shoved into the oven and the heat turned on to a definite temperature for a period sufficiently long to thoroughly bake the varnish, making it no longer viscous. After this process, the retaining bands, which were put on when the coils were formed, are removed, for the baked varnish is sufficient to hold the coils in shape. It is after this that the coils are taken to the taping machines where they are completely taped as described, after which they undergo another varnishing process. In some cases the coils are first varnished and baked several times in succession in order to get a good heavy coat of varnish outside the linen tape. For the very highest voltages, coils may be taped upward of a dozen times, each tape being varnished several times. For the coils in question, however, it is sufficient to merely tape them once.

These particular coils are of a very simple construction, as will be seen, and they are so constructed that they may be easily replaced in case of burn-out or direct injury to the machine, for, by merely placing four nails in a board a wire may be wound around it so as to form a perfect coil. The shape of some of the larger coils is well illustrated by Fig. 18, which shows some of the largest size of coils in the oven.

Winding the Armature

Fig. 19 shows one of the armatures undergoing the process of winding. The coils, it will be noticed, are formed of just the right length to stretch between two predetermined slots. In the bottom of the slot fiber strips are placed, which makes an additional insulation between the coil and the armature laminations. One side of each of a number of coils corresponding to the number of slots in the armature is placed in the bottom of a slot all the way around. Then the other side of each coil is placed in on top of the first-entered sides of the coils with a piece of fiber between as insulation. When all are arranged in this manner, the radially projecting pieces of fiber, which go down under the bottom part of the coil at the bottom of the slot, are trimmed off and two pieces of electric tape wound around the outside to hold them in position temporarily, as indicated in Fig. 20. The next step in the operation is to connect up the two terminals of each coil to the proper commutator segments. These are inserted in the manner indicated in Fig. 20, the proper slot being determined from the wiring diagram, and the wire is forced into the slot formed, as was previously mentioned. A piece of tape is wound above and below each alternate wire, as indicated, and after all the ends have been placed in their separate slots, the slots are soldered, making a solid connection to the individual commutator segments. The projecting ends of the wire are then clipped flush with the commutator surface.

The next operation is that of putting the binding wire around the outside of the coils, as indicated in Fig. 21, the manner in which it is being wound on being clearly illustrated in the engraving. This binding wire, which fits in the recesses of the armature, is anchored at different points around the circumference, and when completely secured makes a very solid armature. These recesses in the armature for the binding wire are provided in the laminations by making a certain number of laminations of smaller diameter, as can be clearly seen in the engraving.

After all these various operations have been performed, the completed armature is sent to the dipping room where it is submerged for a period in a tank of special insulation varnish, which impregnates all crevices, thoroughly insulating it at the same time, and leaving it completely waterproof. It is then placed in an oven and subjected to a thorough baking. In this particular, precautionary steps must be taken not to disturb the balance of the motor. This is accomplished by placing the armature vertically on its shaft in the oven. If placed horizontally, the melted varnish would accumulate on the lower part of the circumference, and while comparatively insignificant in itself, at the high rates of speed at which the armature operates, it would materially disturb the operation of the machine, causing considerable vibration

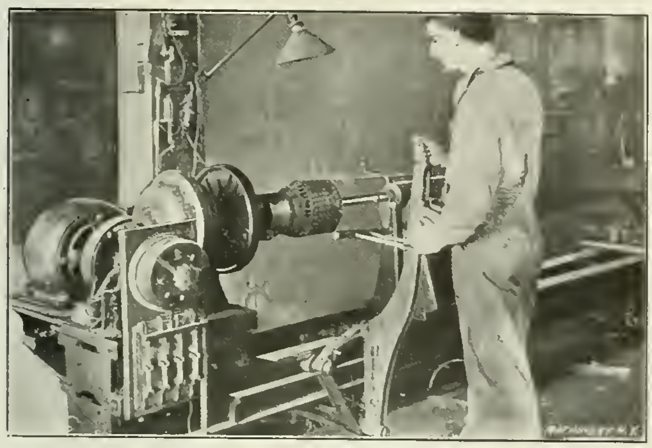


Fig. 21. Winding the Retaining Wire on the Armature

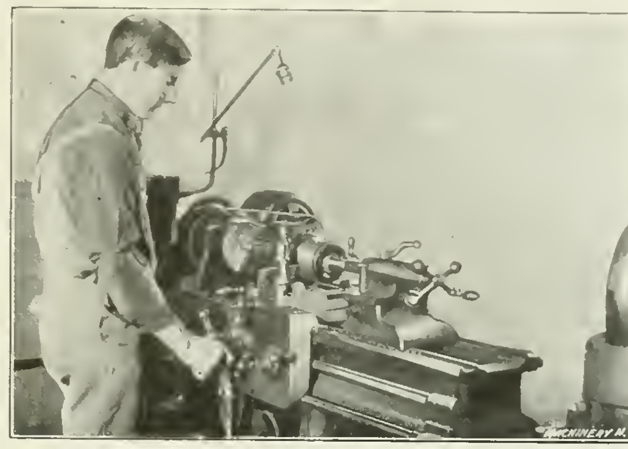


Fig. 22. Truing up the Commutator in the Lathe

Fig. 23. Machine for Winding the Field Coils

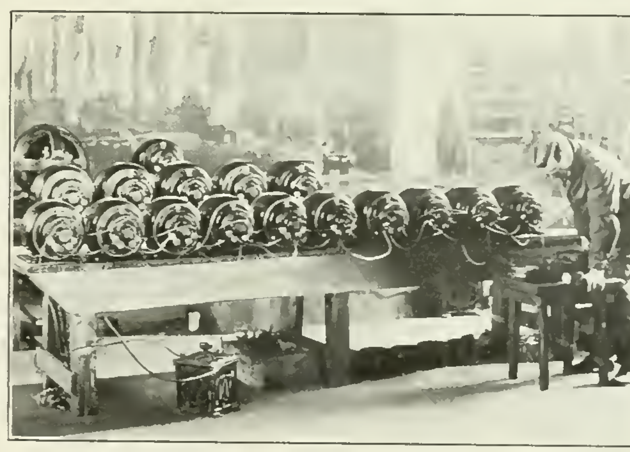


Fig. 24. Row of Type L Motors on the Testing Stand

As a final operation, the armature is placed in a lathe, as in Fig. 22, and a light cut taken from the commutator. In this operation, the tool must have a very keen edge so that none of the copper will tend to drag across the separating strips of mica. Not even very fine hairs should be permitted to draw across, as they will tend to cause short-circuits in the armature on account of the easier path the current would have between the adjacent commutator segments, than through the armature coil. This turning operation incidentally removes any solder that may be left on the inner ends of the commutator where the connections were made. The completed armature, after being tested for electrical defects such as short circuits, is sent to the stock-room.

Field Coils

The field coils are wound on a machine such as that shown in Fig. 23. The device consists of a type of faceplate *A* on the end of a motor spindle, with a removable faceplate *B* attached. Between the two is a form of the shape of the pole pieces for which the coil is being made. On this form are placed layers of insulating material *C*, over which the wire is wound, the necessary number of turns being recorded by a revolution counter. The wire used is very small in diameter, and if its leads were of that size, they would be readily broken off; for that reason, the inner lead is made of a heavier gage, wound on the form for several revolutions with the small wire connected to it. The outer lead is formed in the same way so that the two leads are strong enough to withstand rough handling. When completed, the outer lead is wound around the coil as at *D*. Previous to the winding operation, bands *E* of insulating tape are placed in the form and around the end plates so that when all the necessary wire has been wound on the form, it may be cut on the outside and tied around the coil holding it in shape.

The next operation on the field coil is to tape it and afterward form it to conform with the shape of the pole faces. It is then dipped in varnish and baked in a manner similar to the process outlined for the armature coils, when the field coil is completed.

Assembling and Testing

The various assembled units that enter into the construction of the motor, and which have been sent to the stock-room on the completion of the individual operations connected with each, are brought from that room to the assembling floor where they are assembled. As there is nothing unusual in this operation, it will be passed over.

The assembled motors are then sent to the final testing room, which is illustrated in Fig. 24. Here they are subjected to a very severe test which has for its aim the development of any possible defects in the electrical or operating details. They are subjected to a five-hour loading and heating test, these tests being carried considerably beyond the requirements of the American standard. If any defects in insulating or operating characteristics can be detected, the motor must be retested until no possible faults can be found in its construction or operation.

* * *

PRECAUTION IN MAKING LITHARGE-GLYCERINE CEMENT

One of the most useful of the common cements is the well-known litharge-glycerine cement, which when properly made is waterproof and very strong. Precaution should be taken that the ingredients are free from water, however, to insure success. Before mixing a batch, mix up a small pellet and lay it aside to harden. If it does not harden in fifteen to twenty minutes, the probability is that the litharge is damp or the glycerine contains some free water, or both. The litharge should be carefully dried at a low temperature and the glycerine heated over a slow fire until the water is driven off. The litharge and glycerine should be thoroughly mixed, using as little glycerine as possible to thoroughly incorporate, and then add glycerine until the required plasticity is attained.

* * *

The man with a hammer is a knocker with a purpose, and his noise means something even though it is simply a by-product.

MAKING DUPLICATE DROP-FORGING DIES*

By C. H. WILCOX†

When the locating points of jigs and fixtures are not adjustable, but stationary, it is necessary, if these jigs are to be used for machining drop-forgings, that the variations in the size of the forgings be slight. This is especially true when duplicating a drop-forging die which has become worn out or broken. If the new drop-forging die is not made to exactly the same dimensions as the old one, and if stationary stops or locating points are provided for in the jigs and fixtures, the drop-forging produced in the new die will not be of the required size, thus causing considerable trouble.

In order to duplicate drop-forging dies in our works, we have developed a system for making these dies by means of former-plates or templets. For the small dies, we use a frame, as shown in Fig. 2, to which the former-plates are

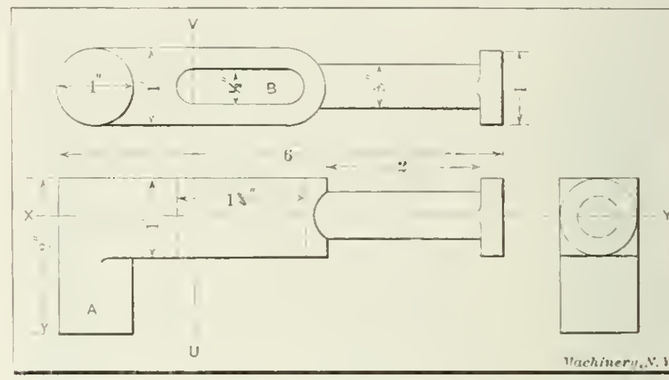


Fig. 1. Drop-forging to be made

attached by screws. For the larger dies, the former-plates or templets are screwed directly to the die itself. These former-plates or templets are made from 1/8-inch sheet tool steel, one side of which is stamped "T" and the other "B," these letters designating that the side marked "T" should be up when machining the top part of the die, and that the side marked "B" should be up when machining the bottom or lower portion of the drop-forging die.

To illustrate the application of these former-plates for making drop-forging dies, we will take a practical example: Assume that it is necessary to produce a forging having the dimensions shown in Fig 1. These dimensions give the size of the finished forging after machining. The necessary allowances for shrinkage, draft and machining must be

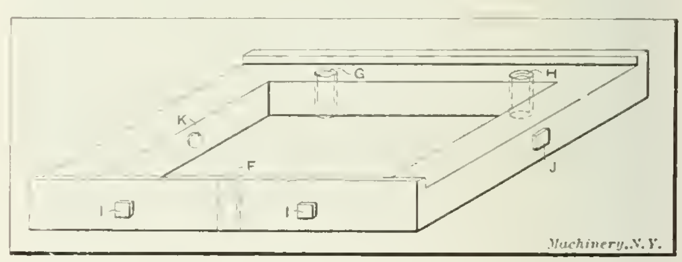


Fig. 2. Frame used for Holding Small Drop-forging Dies

added to the finished dimensions, for laying out the templet. The amount usually allowed for shrinkage is 0.015 inch per inch; for finish, 0.025 inch, all over; and for draft, about 5 degrees.

Referring to the forging, Fig. 1, it will be seen that the boss *A* is 1 inch in diameter. As this boss is $1\frac{1}{2}$ inch from the center line *X-Y* (where the dies are parted) and the draft is to be 5 degrees, the hole *A* in the templet, Fig. 3, will have to be 1 inch plus the following amounts: For draft, $0.087 \times 1\frac{1}{2} \times 2 = 0.261$; for shrinkage, 0.015 inch; and for finishing, $0.025 \times 2 = 0.050$ inch. This gives a total for the diameter of the boss of 1.326 inch; the other dimensions for the templet are obtained in a similar manner.

To obtain the shape of the projection in the die for forming the hole *B* in the forging, Fig. 1, a templet-plate or patch *B*, Fig. 3, is located and fastened by screws, as shown on the

* For additional information on this subject, see "Drop-forge Die-sinking—1," July, 1911, and other articles there referred to.

† Address: 37 Parkwood St., Springfield, Mass.

forming-plate. This plate *B* is used as a guide for the milling cutter, and after one side of the form is milled, the plate is removed from the screws *C* and placed on the screws *D*, when the other side is milled. The method of milling this projection in the die for forming the hole in the forging is shown in Fig. 4 where a cross-section of the die and former-plates (taken at *U-V*, Fig. 1) is shown. Here it can be seen that the draft in the die is accomplished by using a milling cutter of the correct angle. The screw hole *F* in Fig. 2 must be directly in the center of the block, while the screw holes *G* and *H* must be equidistant from the ends, so that the former-plate can be reversed for the other half of the die. This frame, shown in Fig. 2, is held on top of the die by set-screws, as shown in Fig. 4. The set-screws *I* and *J* (Fig. 2) are used for holding the frame on the top part of the die, while the set-screws *I* and *K* are used for holding the frame on the lower part of the die. This is to bring the impressions in the dies in line, and have the matching sides come flush with each other.

In Fig. 5 is shown a sectional view of the top and lower dies (taken at *X-Y*, in Fig. 1), where it can be seen that a web is left in the hole *B*, Fig. 1, which has to be trimmed, when the flash formed at *E* is also trimmed. *C* shows the cut-away portion for the bar, while *B* is the lower member and *A* the upper member of the die; *D* is an inserted steel pin for ejecting the forging.

For obtaining the depth of the impression in the die, the stop shown in Fig. 6 is employed. This consists of a piece of 1/16-inch sheet steel, made of the shape shown. The dimension *A* is made equal to the dimension *B*. The end *C* of the gage is used for setting the stop on the elevating screw. To accomplish this, the end *C* is placed between the boss of the machine and the stop washer on the elevating screw, and the profiling cutter is then passed down through the hole *E* in the plate, Fig. 3, until it touches the top face of the die.

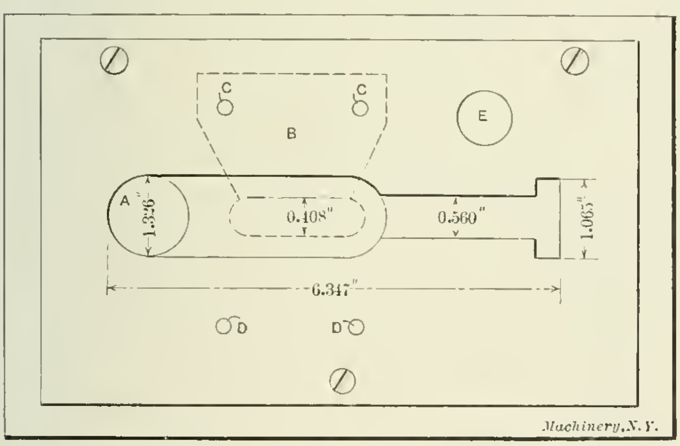


Fig. 3. Former-plate and Method of Milling Projections by Means of a Templet

The stop washer is then brought to bear against the end *C* and locked. When this washer comes in contact with the boss on the machine, it is evident that the impression will be sunk to the correct depth.

The part *D* is used for gaging the depth of the impression, and the height *B* of this lug is made equal to the dimen-

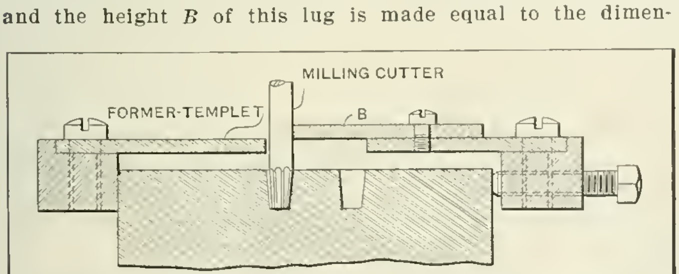


Fig. 4. Sectional View of Drop-forging Die, showing Application of Templets

sion *A*. To obtain the height of this lug the measuring device shown in Fig. 7 is used. This consists of a micrometer spindle *E* equipped with a quill *F*, this quill fitting over the sleeve as shown. The faces *G* of the quill are made flush with the face of the micrometer spindle when the thimble is set at the zero mark. It can therefore be seen that this device will be found useful for measuring the height of the projection *D* on the gage, as a direct reading can thus be obtained. All the other depths or impressions in the die are measured in a similar manner, projections being made on the gage for each depth, and when a large number of varying depths are to be measured, different gages are made.

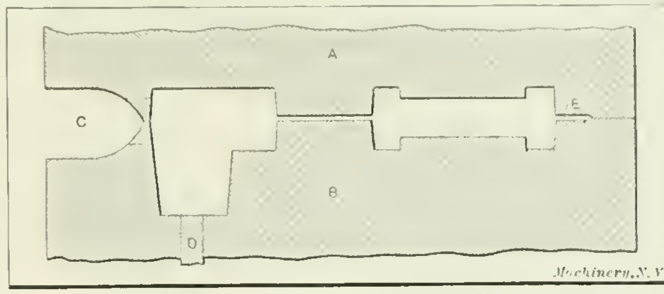


Fig. 5. Sectional View of Upper and Lower Dies

There are a few points which should be followed in connection with the making of dies for drop-forging, which to a considerable extent govern the satisfactory working of the die as well as the accuracy of the product. Large forgings should be trimmed hot, then dropped in the die and trimmed again. The allowance for machining varies from 0.010 to

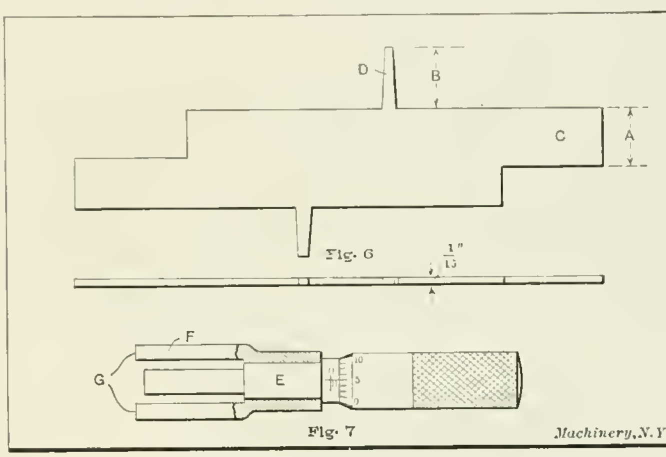


Fig. 6. Gage used in Setting the Stop on the Elevating Screw, and Measuring Depth of Impression. Fig. 7. Micrometer Sleeve for Measuring Projections on Gages

0.050 inch on each face, depending on the size of the forging and the character of the machining operation. The draft is from 3 to 7 degrees, but 5 degrees is generally used. The depth of the impression governs to a large extent the draft to be given, a deep impression being more likely to stick than a shallow one. The shrinkage to be allowed varies from 0.010 to 0.015 inch per inch. A long thin forging shrinks considerably more than a thick one, and the temperature of the work when being struck also governs the shrinkage to a large extent. Deep bosses at the end of the forging assist in preventing shrinkage.

* * *

LARGE CAPACITY DYNAMOMETER CAR

A large dynamometer car especially designed for testing powerful Mallet compound locomotives has recently been built by the Chicago, Milwaukee and St. Paul Railway, and is reported in the *American Engineer and Railroad Journal*. To meet the special services for which it is to be used, it has been made of a much larger capacity than anything heretofore attempted, necessitating a much greater strength of underframe than has been necessary in the past. This car is capable of registering a tractive effort up to 110,000 pounds, while the total movement of the registering device is only 2.17 inches.

While it is customary to use the oil cylinder dynamometer in the construction of such cars, it was considered that this type had but little advantage when used with Mallet locomotives, as the pull is very even and steady and the engine is not subject to any considerable degree of slipping; for that reason a spring dynamometer is used. The complete internal arrangement of the car is such as to provide for the convenient recording of all customary measurements.

DESIGN OF POWER PRESSES AND SHEARS*

By HART PRESTON

It is singular that although manufacturers, when buying milling machines, lathes and other machine tools, investigate minutely their distinctive features and advantages as well as their output and range of work, fully fifty per cent of the manufacturers when buying power presses or shears over-

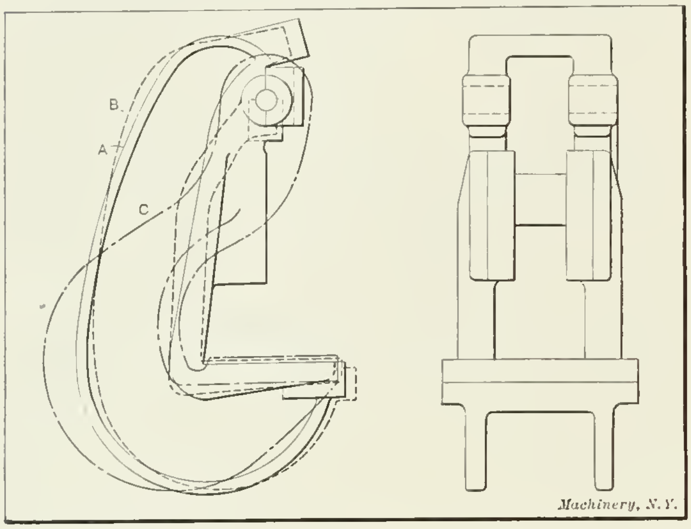


Fig. 1. Frame Design of Three Types of Open-back Inclinable Power Presses

look these same points, and determine the relative worth of the machines by the price asked for them, proportioned upon their weights. This is done in spite of the fact that there are many types of presses of different makes, which while heavier than presses of the same type of other makes, but with the same shaft diameter, will not perform as heavy work, because the extra weight is not properly proportioned and distributed, and the workmanship and materials are inferior. Then, again, there are those manufacturers who are always looking for "lines" in a power press or shear, and, unfortunately, there are also press and shear builders who are equally as notional, as will be seen from the comparative proportions and designs of some of the different types of presses shown in the accompanying illustrations. Along these "lines," the writer would suggest that, when inspecting the various makes of presses, they should be compared with one that is properly proportioned and embodies not so much lines of grace as lines of stiffness and durability, combined with good alignment.

Open-back Gap Presses

Fig. 1 shows the frame designs of three different makes of open-back inclinable power presses, which are all sold to perform the same class of work. The heavy full lines *A* show a frame stiffer than either of the other two, which when assembled and completely fitted, will actually permit of doing heavier work than can be turned out on either of the other two presses. The dotted lines *B* show a frame which is heavier than the first-mentioned, but which, as already stated, will not perform as heavy work, on account of the extra metal in the frame not being properly distributed. In these two frames, first note the difference in the amount of metal at the shaft bearings and arch. It is just as easy to put too much metal at these points as too little, but as the pressure and resistance in press-frames is transmitted in a straight line in the direction of the vertical travel of the slide or ram, this taxes the bearings at times more than any other part of the frame, so that it would be the better practice to take some of the cast iron off the top of the back webs of this frame and, instead, strengthen the arch and shaft bearings, and also increase the thickness of the web and the stiffening rib in the gap or throat of the frame.

The dot-and-dash lines *C* show a third frame weighing about the same as the second frame, but which is weaker than either of the two already described. Particular attention is called to the excessive amount of cast iron in the gap or throat of this frame; of course, in the event of breakage there is a tendency for the frame to give or break at the gap—due to the overhang—but this frame is especially strong at this point. On the other hand, it will be noticed that the shaft bearings, slide-ways and gibs are unusually light in proportion to the stiff gap of this frame.

Attention is also called to what is termed the "solid" shaft bearing in the third frame, the shaft on this machine being inserted through the opening shown in each housing and supported on removable (adjustable) boxes or journals, whereas

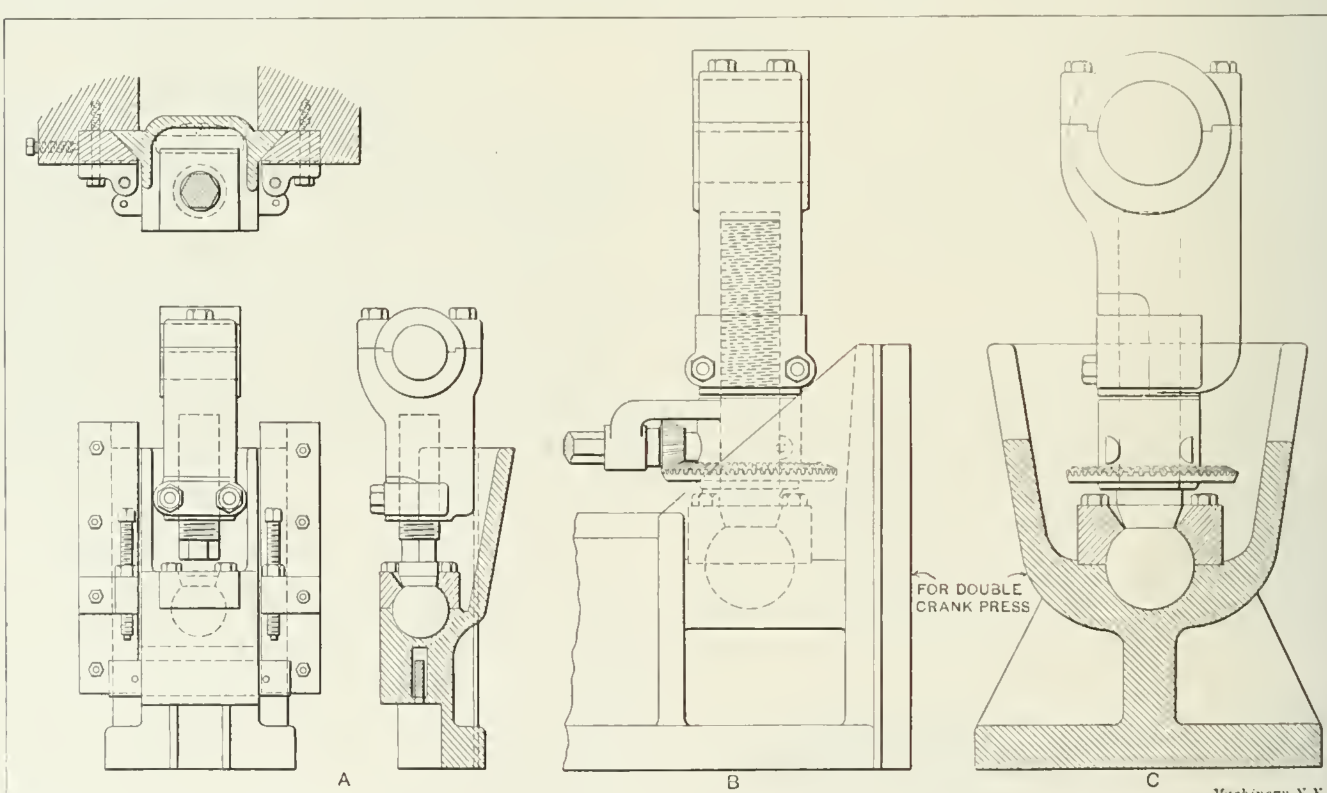


Fig. 2. Screws, Slides and Connections for Power Presses

* For additional information on this and kindred subjects previously published in MACHINERY, see "Power-Press Construction—Uses and Abuses," May, 1911; "Properties of Sections for Punch and Shear Frames," July, 1910, engineering edition, and other articles there referred to; see also: "A German Design of Friction Spindle Press," December, 1908; "Clutches for Power Presses," November, 1908, engineering edition; "Clutches," August, 1908, engineering edition.

the other two frames are fitted with "cap" bearings, having a heavy cap, bolted over and holding the shaft in position in both bearings. The cap bearing, if made heavy enough, of proper proportions and properly aligned and fitted, is equally as solid a bearing as the "solid-cast" bearing, and eliminates the trouble sometimes encountered with the latter, *viz.*. having to stop the press to adjust the journals from time to time, as the boxes or journals if not properly constructed and fitted have a tendency to work loose when operating on heavy work.

Slides and Connections

On account of the high speed at which these presses are operated, too much stress cannot be laid on the length and proportions of the shaft and slide, as well as the fitting of the clutch-wheel and connection bearings. A heavy high-carbon shaft, massive connections, adjusting screw and stiff slide are worthless, unless they are properly supported as well as lubricated. These are vital points to be considered in all

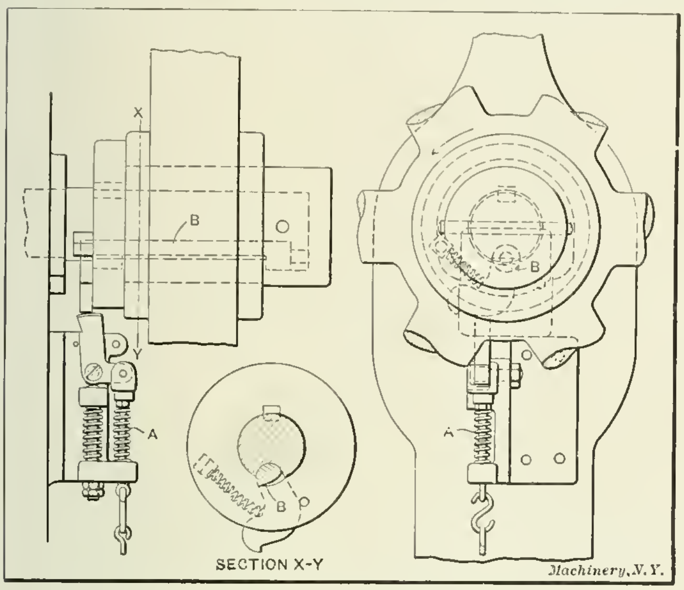


Fig. 3. Type of Rocker-arm Clutch for Power Presses

presses of any type. There are also a great number of different types of connections in use as is the case with the other parts of presses. One of the stiffest, most easily and quickly adjusted connections is that shown at *A* in Fig. 2. This connection has not only simplicity and quick adjustment, but also stiffness, a feature not to be overlooked in view of the fact that between the shaft and slide proper the pressure or strain is diverted directly to the connection and screw at

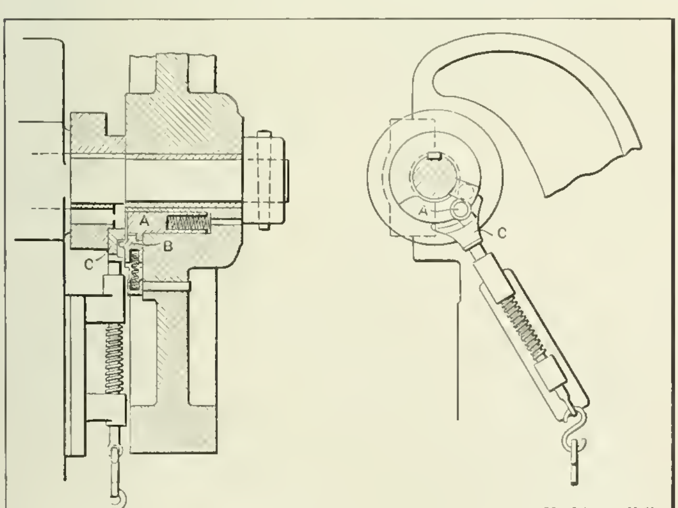


Fig. 4. Sliding-pin Clutch of Improved Design

varying angles, depending upon the length of the stroke of the shaft and the nature of the work.

At *A*, *B* and *C* in Fig. 2 are also shown one of the best constructed connection screws and bearing, as the ball-and-socket joint not only furnishes the greatest possible amount of bearing surface and support, but owing to its constant rocking motion in the prescribed arc of a circle, insures also better wearing qualities than the "cheaper-to-make" type of pivoted wrist-bearing. This connection and screw are applicable to all regular types of power presses.

Clutches

There are about as many different styles of clutches for driving power presses as there are clutches for other power drives. Practically all of the different types of smaller power

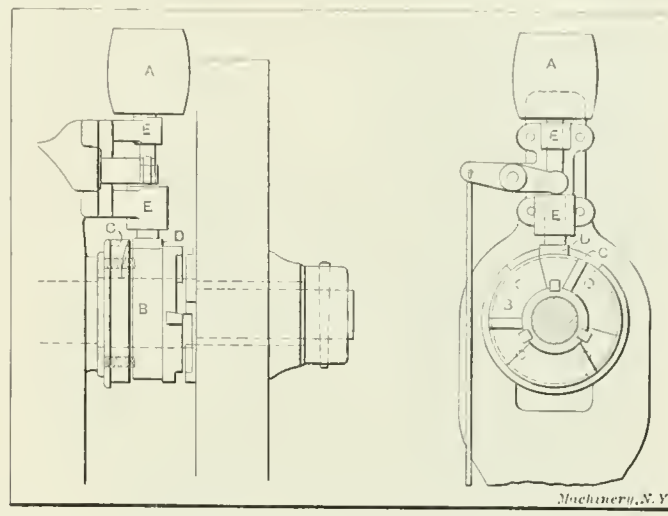


Fig. 5. Strong and Positive Type of Block-clutch

presses of the different makes are operated by "pin-clutches," by means of which the drive is imparted from the belt or clutch-wheel to the shaft through a sliding pin having its normal bearing either in the shaft or in a collar located on the shaft, or in the hub of the wheel. This pin, upon being released, flies out into a recess provided for it either in the shaft-collar or wheel-hub.

Fig. 3 shows what is called the "rocker-arm clutch," which has the advantage of having its bearing close to the axis of

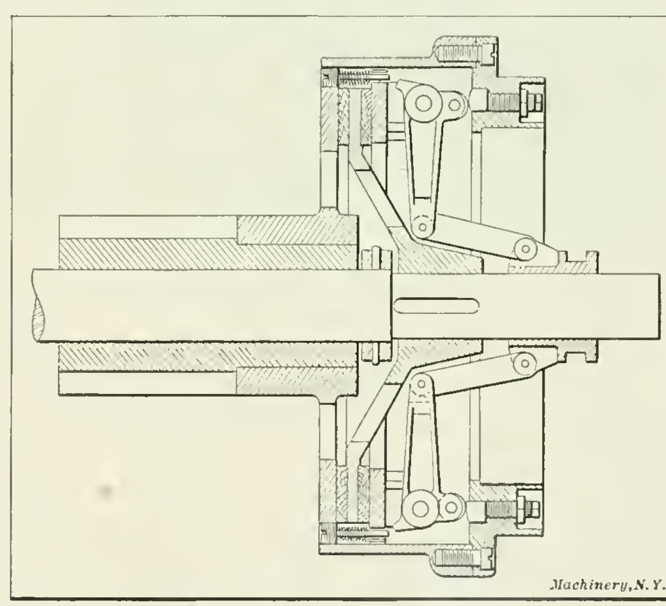


Fig. 6. Friction-clutch used on Wiring and Drawing Presses

the shaft, and thereby reducing to a minimum the resultant strain on the clutch-pin from the leverage and momentum of the clutch-wheel upon engaging with the pin when the latter is released. This style of clutch also provides a positive, efficient drive, but as soon as the spring *A* on the trip or releasing lever loses its tension (a matter which is often almost criminally neglected), thereby permitting the pin to project above its normal bearing and possibly to engage with the clutch-wheel, this clutch often becomes undependable. Another disadvantage from the same cause in this clutch, is that with the clutch-wheel in constant motion over this pin, there is a tendency for the sharp engaging surface of the pin to wear and round off, and thereby not engage at all, or, if it does engage with the wheel, it may stick or bind and cause the press to repeat or make a second stroke instead of coming to a stop after each stroke.

Owing to these objections, sliding pin-clutches of different types are furnished by the majority of press-builders for operating the lighter types of presses. Fig. 4 shows one of the most positive and dependable sliding pin-clutches. This clutch, as will be noted, has its normal bearing in the hub of the wheel, and upon being released, flies out a fixed distance into a recess provided for it in the driving collar, which is keyed to the shaft (the engaging surface being hardened tool steel).

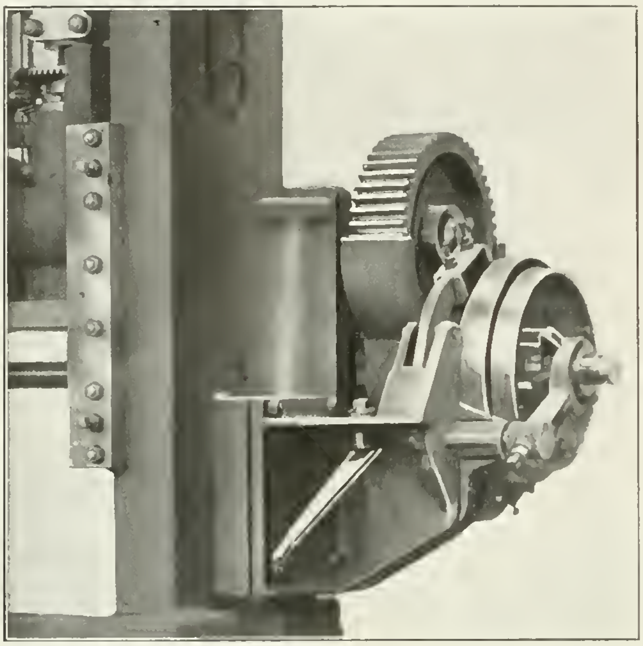


Fig. 7. Clutch in Fig 6 applied to a Power Press

The advantage of having the bearing of the pin in the hub of the wheel instead of in the driving collar on the shaft, as is the case in all other types of sliding pin-clutches, is that the pin is thereby subjected to much less strain from the impact of the revolving wheel. The other types of sliding pin-clutches, when engaging with the wheel, enter the wheel-hub only about one-half the length of that part of the pin A which remains in the hole in the wheel when released. In other words, pin

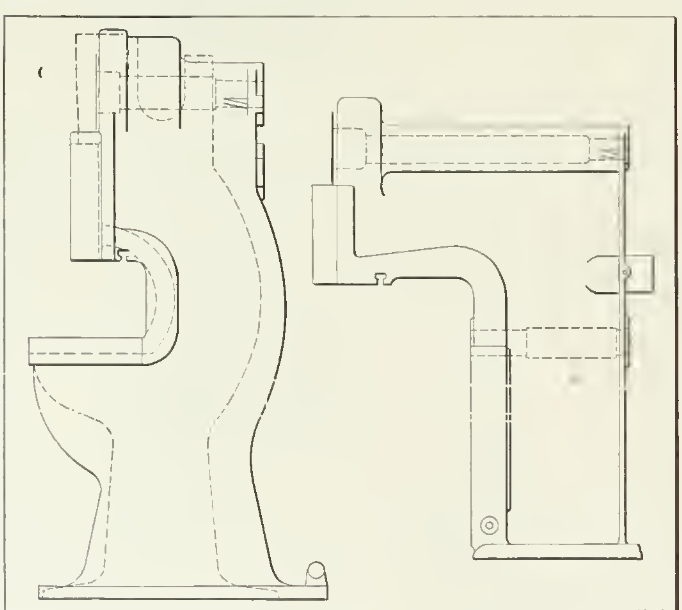


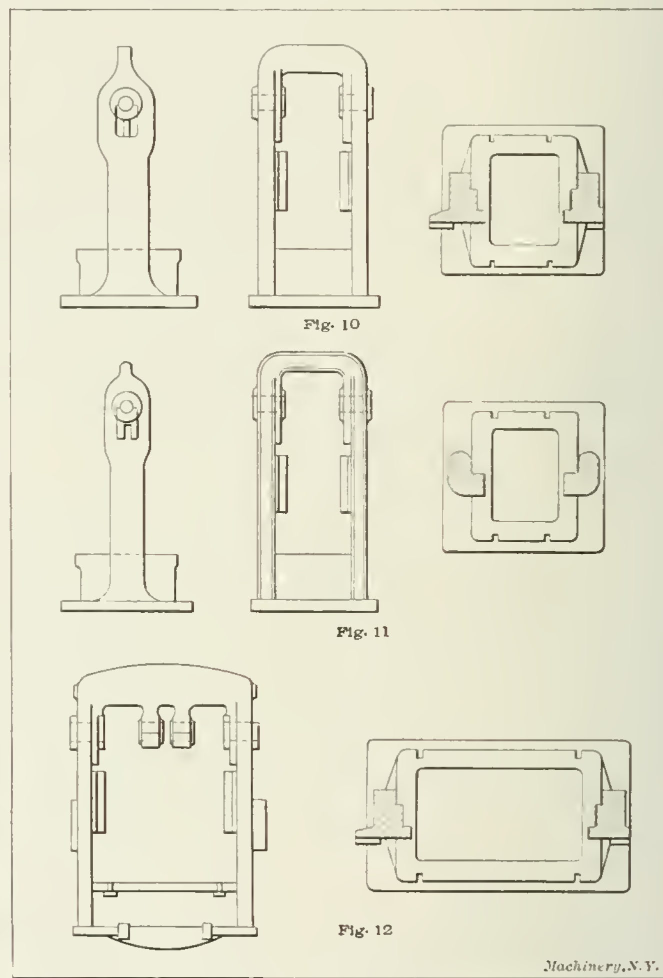
Fig. 8. A Comparison of Two Types of Solid-back Press Frames

Fig. 9. Solid-back Press Frame of the Detachable-bed Type

A in this type of clutch offers about double the resistance to the strain constantly exerted upon it by the velocity and leverage of the wheel when the press is set in motion. Another feature is that the pin clutch-block B holds the pin A in place until the treadle is tripped. Supposing, however, that the block B fails to operate, the pin A will be forced back into the wheel by the block C.

Some press builders (undoubtedly because of their cheaper cost) still advocate the use of pin-clutches for operating large presses. A number of builders, however, have discarded this type of clutch entirely on large presses, and, instead, drive them either with a block- or jaw-clutch, or with a friction-clutch. Figs. 5 and 6 show block- and friction-clutches, respectively. Fig. 5 shows what is perhaps the simplest, strongest, safest and most positive style of block-clutch thus far perfected. The prime features of this clutch are that when it is released, through raising the weight A, the clutch or driving collar B (actuated by powerful springs) is forced out, and engages with the revolving clutch-wheel or gear. Upon withdrawing the foot from the treadle, the weight A again drops down, and as the shaft and collar revolve, the latter, at the end or "top" of the stroke, is automatically disengaged and forced back in place by the cam C. This is accomplished by the cam coming in contact with the roll D attached to the weight A by a shaft operating in bearings in the brackets E.

The only springs used in this clutch are those for throwing the clutch-collar out to engage with the clutch-wheel or gear. Should these springs become weak or refuse to act, the



Figs. 10 and 11. Two Types of Straight-sided Blanking, Forming and Reducing Presses. Fig. 12. A Double Crank Press Frame of the Straight-sided Type

collar will not fly out and engage with the clutch-wheel, and the gravity weight A will drop back into its normal position in the groove in this collar. Owing to this precaution and the fact that the gravity weight positively stops or disengages the clutch after each stroke, it will be seen that this is a most safe and positive "make-and-break" mechanism, and is free from the defects of the majority of pin- and block-clutches.

Friction-clutches are invariably used on drawing, wiring, and other presses for work requiring a long or deep stroke or slide motion, as well as for work requiring a longer pressure or dwell on the dies than can be obtained through any other type of clutch. Figs. 6 and 7 show a friction-clutch having the least possible number of links and other parts, and which is not only simple in design, but is also powerful, quick-acting and easily disengaged. Particular attention is directed to the great efficiency of this clutch, which is obtained through its broad-faced double-friction or engaging disks, as well as through the construction and operation of the brake shoes. Having outlined the features of the operating or mov-

ing parts of presses, let us turn our attention to the frames or bodies for supporting them, and also consider the strains transmitted to the frames when the presses are in operation.

Solid-back Gap Presses

Fully twenty per cent of the stamped sheet-metal work produced to-day is turned out either in open-back inclinable presses or solid-back punching presses, the solid-back press

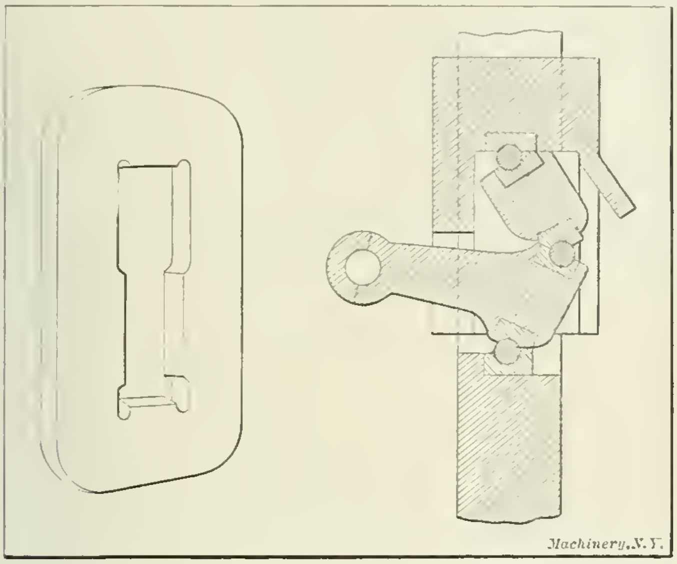


Fig. 13. Slide and Link or Arm Mechanism used on the Presses shown in Figs. 10 to 12 inclusive

being designed and used particularly for heavy punching and forming work not requiring an opening in the back of the press-frame. Upon comparing this type of press with the open-back press, one can readily appreciate the advantages of

Fig. 14. Straight-sided Double-action Cam Drawing Press

the former because of its having a massive single-column frame and continuous one-piece shaft bearing.

The solid lines in Fig. 8 show a well proportioned, rigid, solid-back, press-frame, while the heavy dotted lines show another make of press of the same type and size, but which in reality will not withstand the same pressure. The dotted lines indicate a weak gap, which is principally due to the desire of the builder to furnish to the trade a frame with extra-high die-space, and extra-deep throat or gap (without stiffening the other parts of the frame in proportion). There is also a marked contrast between the continuous shaft bearing in the one frame and the severed or double bearing in the other. The work done in presses of this type is of a nature that at times taxes the shaft to the highest point, and demands not only a stiff shaft of proper diameter, but an equally stiff frame, particularly at the shaft bearing. In case of an overload, if the gap of the frame is heavy enough, the pressure is diverted to the shaft and shaft bearings, and if the shaft will not bend or twist off, the frame bearing often fails on the solid-back frames with the double shaft bearing.

As a further illustration, refer to Fig. 9, which shows another solid-back frame (of the detachable-bed type, for riveting work) in which the depth of the throat or gap has been increased to several times that of the solid-line frame in Fig. 8. This frame, as it is properly reinforced or stiffened

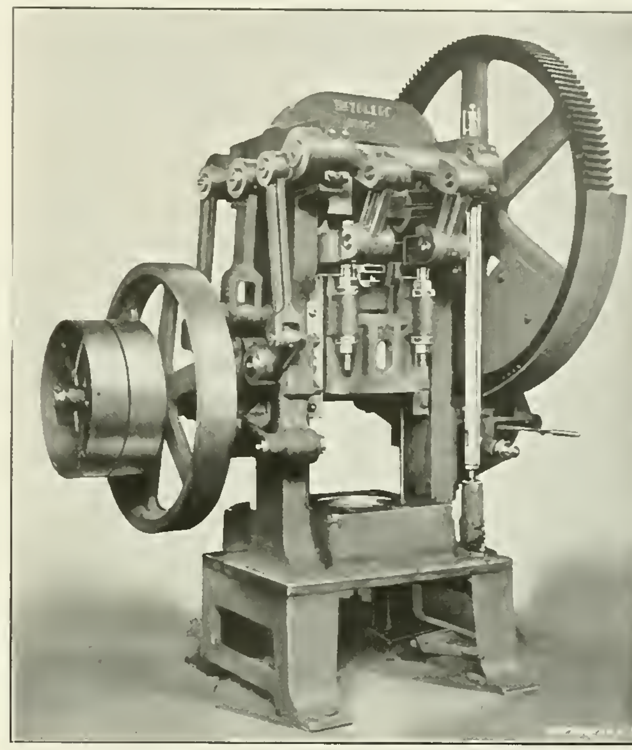


Fig. 15. Toggle Drawing Press of Improved Type

at the shaft bearing and other points will, with the same shaft diameter, perform equally as heavy work.

Straight-sided Presses

Figs. 10, 11, and 12 show various styles of toggle embossing or coining presses, and the regular straight-sided blanking, forming and reducing presses. A number of press builders are manufacturing toggle embossing or coining presses, and while the section of the frame and other proportions throughout are about the same in all the different makes in corresponding sizes, the principal difference is to be found in the construction and operation of the toggle-arms and other moving parts. Embossing or swaging, or "coining" as it is often called, is one of the most severe strains on any machine, and an operation for which it is extremely difficult to determine the exact pressure required. For this reason presses of this type are often abused through ignorance on the part of operators. In this connection it may be interesting to know the pressure in tons required for various American silver coins, as all American coins after being blanked or cut to size are embossed or coined in presses of this type. The pressure required for embossing is as follows: Dimes, 30 tons; quarters, 60 tons; half-dollars, 100 tons; dollars, 160 tons.

Fig. 13 shows the slide and link or arm mechanism of these presses, when designed particularly for coining work. However, for embossing escutcheon plates, hinges and other large work, it is most advantageous to reverse the links, and, instead, have them moved down on the work on a solid bed. This construction also permits attaching bottom knock-outs or other attachments directly on the solid bed. In addition, the press

is more readily accessible with the slide, shafting and gearing operated from above instead of from below. The frames of these presses are usually made of steel castings, as are also the slide and links or arms, while the link-pins and bearings for them should be made of tool steel of suitable area and length, and hardened.

Toggle embossing presses are rapidly replacing hydraulic presses for producing such work, as the former are not only quicker-acting and require less floor space, but are also simpler in construction and cheaper to operate and maintain. Straight-sided crank presses are also often used for the lighter work of this character, and although press builders seem to agree so well on the stiffness of the parts, particularly the frames of toggle embossing presses, it is interesting to note the wide variation of opinion as to the proportions to be maintained in the regular straight-sided crank press frame for this and other forming and shearing work.

Fig. 10 shows one of the best-proportioned straight-sided press-frames now in use, embodying all the requirements for a press for heavy blanking, forming and reducing work. Fig. 11 shows a frame of the same type of another make designed to have "lines"—principally a hobby of the builder. It will be observed that the uprights as well as the arch of the frame in Fig. 11, are materially weaker throughout than in Fig. 10, although the builder of one uses the same shaft diameter as the other. Instead of rounding off the arch and uprights of Fig. 11, a few additional pounds of cast iron could well be used on the frame as an "ounce of prevention." The illustration Fig. 12 shows a double-crank press-frame of the same type and make as Fig. 10, and with the same shaft diameter.

Double-action Presses

The adaptability of double-action cam and toggle drawing presses for deep-drawn work need not be explained here, Figs. 14 and 15 being shown merely to illustrate two presses of the types mentioned, each embodying a number of noteworthy and improved features. Fig. 14 is a straight-sided double-action cam drawing press designed for cutting and drawing computing scale dials and parts, alarm clock cases and a similar line of deep-drawn sheet-metal work. This press is built with either block- or friction-clutch, depending upon the stroke and the nature of the work. The cams are laid out so as to give the maximum dwell on the blank-holder or outer slide while the plunger or inner slide is in action, and also to provide for a quick, positive return for the blank-holder after the work is completed. The blank-holder is returned to its normal position in this press by a pair of yokes or connection-arms of ample proportions, supporting a set of hardended tool-steel rolls. As the shaft revolves, the cams keyed to it bear up against the rolls, the latter automatically lifting up the yokes and the blank-holder which is attached to them by the vertical shafts shown. This is a marked improvement over the old-style method of raising the blank-holder, which was accomplished either by means of heavy springs supported on the back of the arch of the frame, or by various arm movements attached to the left-hand outer end of the shaft.

The illustration Fig. 15 shows a toggle drawing press of improved type, which is built in sixteen different sizes. In this press the old-style outer-slide connection for the toggle movement controlling the blank-holder is replaced by an improved bell-crank and link movement, which provides equally as positive a dwell on the blank-holder as the other, and continues to act during a longer period of travel of the plunger. The advantages of this construction will readily be comprehended by manufacturers of drawn press work. The frame of this press is proportioned similarly to a regular straight-sided single-acting press and with the same shaft diameter but, in addition, the press is reinforced to provide proper support and bearings for the toggle-arms.

Practically all other presses of this type are ordinarily provided with cast-iron toggle-arms and links. The press shown in Fig. 15 is provided with cast-steel arms and links throughout, and forged steel link-pins, each of the latter operating in a bronze-bushed bearing, well lubricated.

Presses of this type should be operated by a friction-clutch, not only to give the proper pressure for performing the work

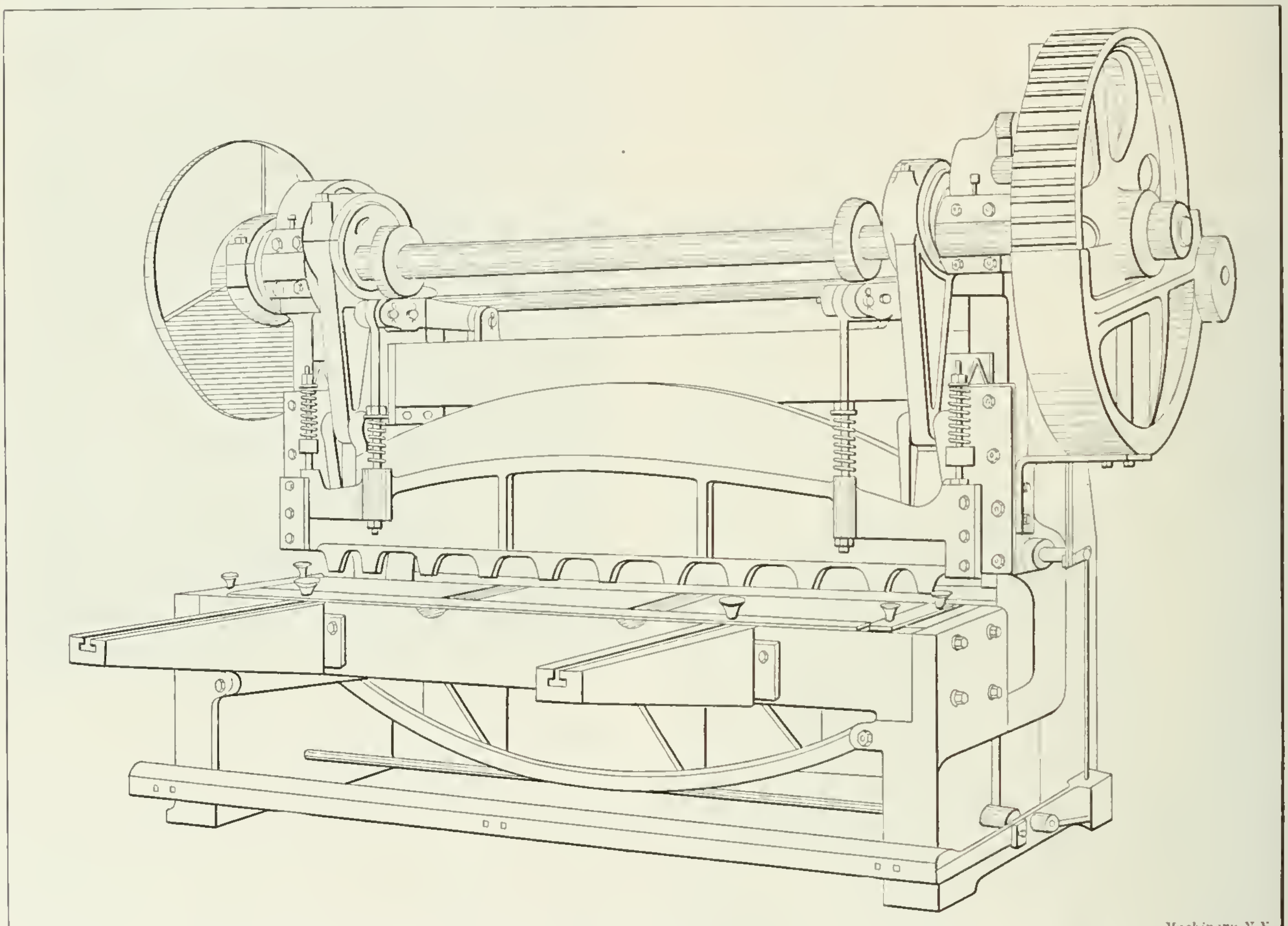


Fig. 16. Massive Gap-shear with a Capacity for Cutting 1-4 inch Steel Plate, 97 inches Wide

for which these presses are designed, but also for use in setting up, adjusting and trying out the dies operated in these presses.

Power Shears

Another peculiarity of the sheet-metal working industry is that while some manufacturers are very particular in their specifications covering power presses, they buy power shears the same as they sell their scrap metal—by the pound—and as shear-building and designing is not as remunerative as regular press building (owing to the limited number of shears sold as compared with presses) most of the squaring- and gap-shears sold by the pound to-day are not worth much more than what is paid for them.

One of the most important things to bear in mind when buying a shear of either type, is the fact that shearing or cutting metal either in the strip or bar form, requires the same pressure in a power shear as in a power press. The buyer of a shear should, accordingly, look for the same "lines" of rigidity, proportions and other essentials as are found in a durable, efficient and reliable press.

Fig. 16 shows a massive gap-shear with a capacity for successfully shearing or splitting at one stroke 1/4-inch steel plate the full width of the blades (97 inches). Before discussing the minute details, suppose we place a sheet of paper of the proper width directly in the center of this illustration, so as to leave visible only the clutch, gearing and pulleys, and the two massive uprights or housings. An examination of these parts will readily enable one to fill in the remaining details to make up with these parts a rigid, though rather odd-looking gap power-press.

The head or gate of a shear corresponds to the slide of a press and should, therefore, be particularly rigid in view of its great length and its limited width. The cross-head on the shear shown is heavily ribbed in the back as a reinforcement, while a heavy cast-iron brace in the rear of the cross-head is securely bolted to each of the uprights and acts as a further stiffener against any tendency to "spring" or give. The bed also should be made amply heavy (note heavy stiffening webs on bed illustrated) as the tendency of cheap, lightly constructed shears to "spring" when operating sometimes on work even below their rated capacity, fully bears out the statement that it is better to have too much rather than too little cast iron properly distributed in the bed, cross-head and uprights.

Another important detail is the hold-down or clamping attachment which descends onto the sheet to be sheared, clamping and holding the sheet until after it has been cut. The hold-down, like the cross-head, must be as narrow as is practicable, to permit shearing the narrowest possible strips, and should, therefore, be stiffened accordingly. A large portion of shear-troubles and breakages are traceable to lightly constructed hold-downs not properly clamping the sheet while being cut and, consequently, permitting it to be drawn down between the bed and cross-head, thereby straining or breaking these or other parts.

* * *

HOW TO BUILD A LOCOMOTIVE

The item of the young lady who visited the Baldwin Locomotive Works, and then told how a locomotive is built, is again going the round of the exchanges—and is worth repeating.

"'You pour a lot of sand into a lot of boxes,' she said, 'and you throw old stove-lids and things into a furnace, and then you empty the molten stream into a hole in the sand, and everybody yells and swears. Then you pour it out, and let it cool, and pound it, and then you put it in a thing that bores holes in it. Then you screw it together and paint it, and put steam in it, and it goes splendidly, and they take it to a drafting room and make a blueprint of it.

"'But one thing I forgot—they have to make a boiler. One man gets inside and one gets outside, and they pound frightfully; and then they tie it to the other thing, and you ought to see it go!'"

* * *

Often a crack-brained idea contains a nugget of gold, but many of them cost too much for reduction to be commercially valuable.

CALCULATING HORSEPOWER FROM DYNAMOMETER TESTS*

When a dynamometer is arranged for obtaining the horsepower transmitted by a shaft, as indicated by the diagrammatic view in the accompanying illustration, the horsepower may be obtained by the formula:

$$\text{H. P.} = \frac{2\pi L P N}{33{,}000}$$

in which

H. P. = horsepower transmitted,

N = number of revolutions per minute,

L = distance (as shown in illustration) from center of pulley to point of action of weight P, in feet,

P = weight hung on brake arm or read on scale.

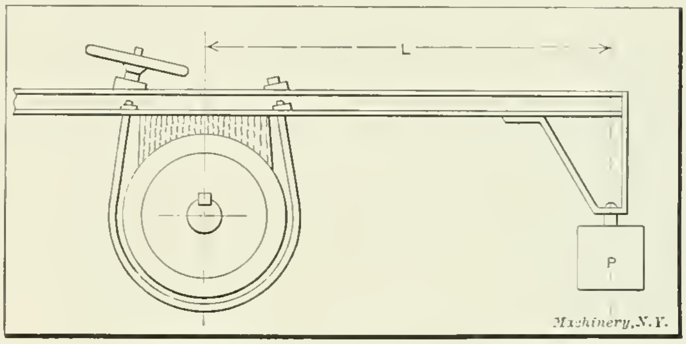
By adopting a length of brake arm equal to 5 feet 3 inches, the formula may be reduced to the simple form:

$$\text{H. P.} = \frac{NP}{1000}$$

If a length of brake arm equal to 2 feet 7½ inches is adopted as a standard, the formula takes the form:

$$\text{H. P.} = \frac{NP}{2000}$$

The tables in the accompanying Data Sheet Supplement are based upon these formulas. They give the brake horsepower for velocities varying from 120 to 800 revolutions per minute. For example, assume that we wish to find the horsepower in a case where the shaft makes 300 revolutions per minute, a 60-pound weight being attached to a lever arm 5 feet 3 inches. Then, according to the simplified formula:



Diagrammatic View showing Arrangement of Dynamometer

$$\text{H. P.} = \frac{NP}{1000} = \frac{300 \times 60}{1000} = 18$$

This value may be found directly from the tables by locating $P = 60$ in the extreme left-hand column, and $N = 300$ at the top of the columns. At the place where the two rows of figures intersect, the horsepower—in this case 18—may be read off.

* * *

The builders of drilling machines have generally followed certain practices in manufacturing out of keeping with the methods employed by the makers of other machine tools of a heavier grade. Babbitting cored holes for shaft boxes with babbitting jigs, is a practice still followed, the impression being general that this method is the best and cheapest for the quality of bearing required. As a matter of fact, it is an expensive practice when the labor, babbitt and quality of work produced are compared with the result that would follow boring the boxes in jigs and running the shafts on the cast iron. The need for babbitt in boxes running at comparatively slow speed and with low unit pressures is imaginary. We know of no change of practice in making drilling machinery that would improve the general conditions as much as this.

* * *

We may cut sentimentality out of business, but when we start in to eliminate sentiment itself we begin trimming at the vitals of business.

* With Data Sheet Supplement.

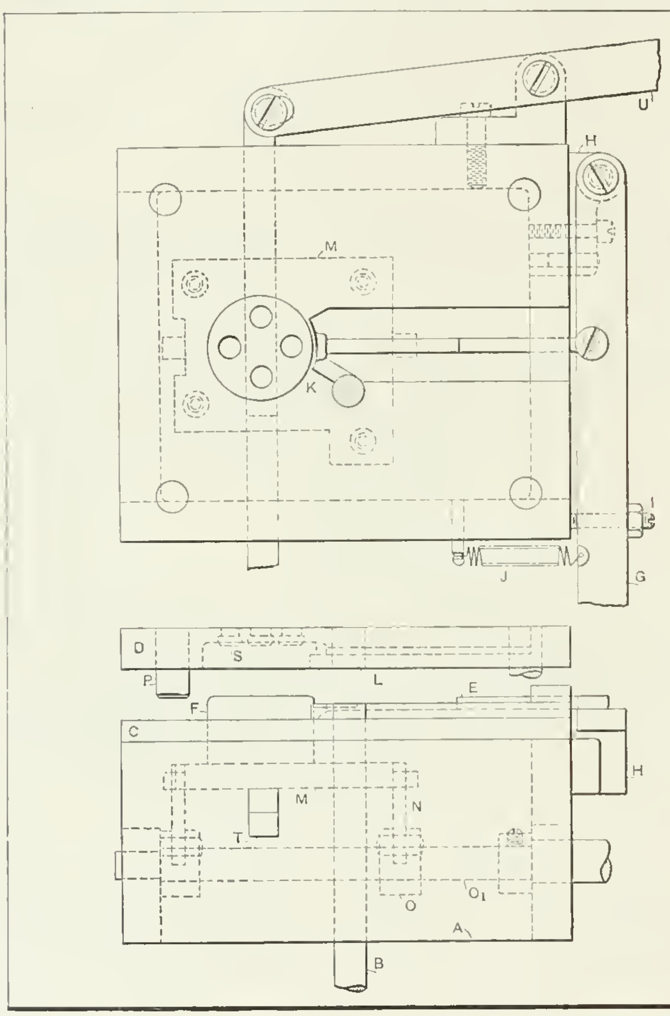
MAKING DIES FOR PRESSURE CASTINGS*

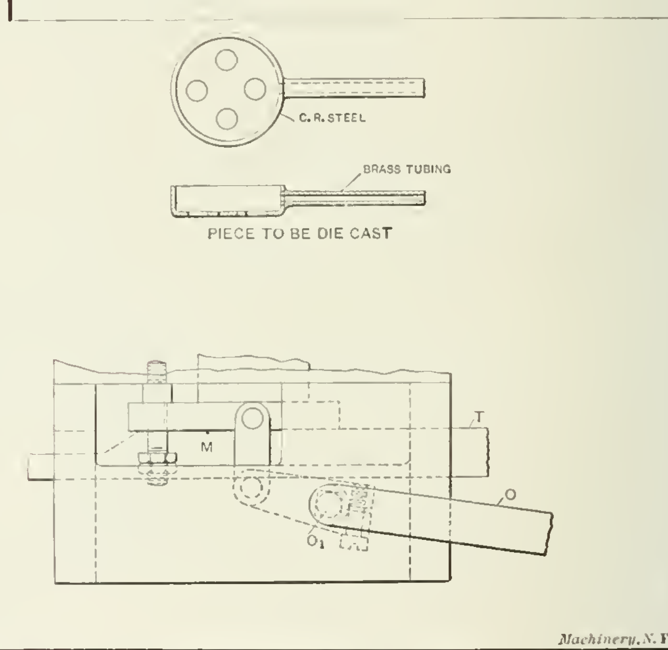
By A. W. CHRISTIANSON†

When making a die for a pressure casting, the piece to be made should first be considered, as the shape of the piece will govern the point at which the dies should be parted. If the dies are not made and parted correctly, and the sprue not put in the proper place, it will be difficult to obtain good castings. It is therefore desirable to take these points into consideration before attempting to lay out a pair of dies for making pressure castings. Care should also be taken when making the dies to have them fit together closely, so that there will be no fin left on the casting; this, however, in some cases is unavoidable.

The next point to take into consideration is the weight and character of the castings. If the casting is a thin shell of an odd shape, particular attention should be given to the position of the sprue cutter, which should be placed so that it will be possible to insure the mold being filled. When the sprue cutter is not located in the proper position, it will be found that the mold will not fill up properly, which will result in poor castings. It is impossible to lay down any hard and fast rule for the shape or position of the sprue, as the work under consideration is the determining factor. It is well, however, to fill the mold from the bottom, as is the rule in iron molding.

Another factor which enters into the problem for making successful pressure castings is the position in which the dies are set in the machine, the design of the machine, and the conditions under which it works. If the machine has a good pressure, the sprue can be made small, but if the pressure is reduced, which results from various causes, the sprue should be designed to compensate for the loss in pressure. The pressure is sometimes decreased by overheating the metal, which expands the cylinder in the machine, so that the metal squirts out around the sides of the plunger.





Work and Dies used for Producing it

The piece shown in the accompanying illustration is made from sheet steel and has a brass tube inserted in it. The cost of making this part was so high that it was decided to make the body from white metal and cast the brass tube in it. The end of the brass tube which fits in the body or cap is knurled, so that the tube is held tightly by the metal when cast around it. The die for casting this piece from white metal was made to cast one piece at a time. Of course, if a large quantity had been required it would have been possible to make the dies to cast more than one piece.

The die shown in the accompanying engraving consists mainly of a cast-iron frame *A* of box-shape construction. On the top face of the box is fastened the lower die *C*, the other half of the impression being formed in the plate or die *D*. *E* is a circular plug which pushes the brass tube up against the core *F*, forming the inside of the casting. A handle *G*, pivoted on the bracket *H* actuates this plunger *E*, and the coil spring *J* connected to the handle *G* keeps the brass tube tightly up against the core *F*, while the piece is being cast. *K* is a gate through which the metal passes into the dies, while the hole *L* is made to fit the sprue cutter *B*, the latter removing the metal passing from the pot to the sprue, after the piece is cast. The gate is broken off after the piece is removed from the dies, which can be accomplished with a slight pressure of the hand. The gate should not be made more than 0.010 to 0.015 inch thick, but the width should be made to suit the piece. A plate *M* is held to the lower die by four studs, and acts as a bearing for the links *N*. The studs in the plate *M* are used for guides as well as stops for the up and down movement of the plate, as is shown in the view to the right. *O* is an arm which is mounted on a squared portion on the shaft O_1, the arm being bent at one end to form a handle. This arm *O* through the links *N* raises and lowers the plate *M*, which, in turn, actuates the core *F*. Dowels *P* are used for lining up the two dies in their relative positions. The dowels should be driven into the thickest die, so that they will be held rigidly.

The holes in the casting are formed by the four core-pins *S*, which are fastened to the upper plate *D*. A slide *T* is pushed in under the plate *M* by means of the lever *U*, and is used to prevent the core from blowing out when the pressure is applied for forcing the metal into the dies. The die *D* is held in the die-casting machine on the plate nearest the nozzle, while the other half of the die is fastened to the rear plate. After the plates are separated in the manner described in the article entitled "Die-casting and Die-casting Machines", in the May number of MACHINERY, engineering edition, the piece is ejected by means of a handle, which is pushed forward, allowing the core *F* to go back flush with the plate *C*, when the piece will fall into the hand if placed under the die.

* For previous information on this and kindred subjects, see "The Design of Die Casting Machines—Alloys for Pressure Castings," July, 1911, and other articles there referred to.

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THREAD ROLLING*

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON†

The production of threads by rolling has for a considerable time been employed in the manufacture of machine and wood screws, the threads being formed by dies which have V-grooves in their opposing faces, cut at an angle equal to the helix of the thread. The operation of rolling a screw in a thread rolling machine consists in passing the screw between two flat dies, one of which is stationary and the other reciprocating. This is the principle on which some of the thread rolling machines on the market work, while others have one stationary hollow cylindrical die and one revolving circular die. However, the principle on which they act is the same; that is, part of the material is raised to form the thread by forming a corresponding depression in the blank. This action makes the diameter of the finished screw larger than the blank.

The adaptation of thread rolling to the automatic screw machine is, however, of comparatively recent application—

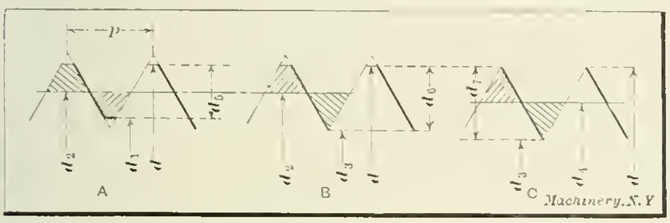
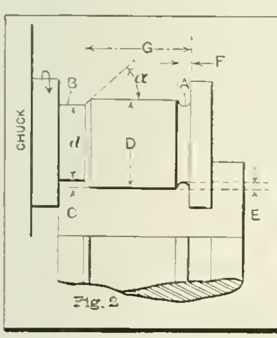


Fig. 1. Thread Forms used in Calculating Diameters of Thread Rolls

hence the scarcity of definite information on the subject. After considerable experimenting with this class of work, the Brown & Sharpe Mfg. Co. has found that the production of rolled threads on steel parts is very unsatisfactory, and thus confines the production of rolled threads to brass and similar materials. In this article, therefore, the information given applies exclusively to the rolling of threads on these materials.

Obtaining the Diameter of the Blank

Producing a thread by means of a roll differs from cutting a thread with a V-tool, in that by the former method no material is cut away, the thread being formed by displacing the



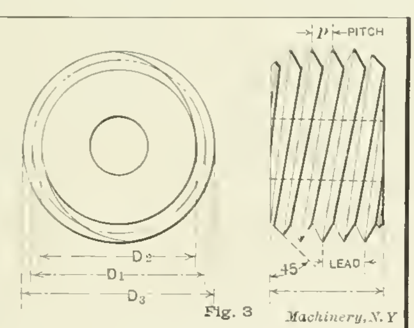


Fig. 2. Preparing a Piece with a Circular Form Tool Fig. 3. Thread Roll with a Double Thread —Note Beveled Edges

material, as stated. Theoretically, in a sharp V-thread the volume of one convolution above the pitch diameter should be greater than that below the pitch diameter, on account of the greater circumference. Therefore, the diameter of the blank before rolling should presumably be greater than the pitch diameter. This, however, is not the case for all materials, brass in particular being an exception. As a rule, the diameter of the blank for brass should be approximately equal to the pitch diameter.

When rolling a U. S. standard thread, the pitch diameter is found to be slightly greater than the required diameter of the blank, because of the impracticability of making the thread roll with a flat top. If a thread roll is not made with a sharp V-thread on the top, it will require a considerably greater pressure to force it into the work, and does not produce as smooth and perfect a thread. Therefore, it has been found advisable to make all thread rolls, whether for forming a sharp vee or a U. S. standard thread, with a sharp vee top and bottom. It is not necessary to make the bottom of the thread on the roll sharp, but there would be no advantage in having it flat, as the outside diameter of the screw is governed by the circular form or other external cutting tool used for forming the blank.

The shape of the thread produced by a thread roll when the U. S. standard form is required is shown at *B* in Fig. 1. Here it can be seen that the pitch diameter d_2 is the same as the pitch diameter of the U. S. standard form shown at *A*. The root diameter d_3, however, is less than the root diameter d_1 of the U. S. standard thread shown at *A*. The pitch diameter d_2 is slightly greater than the required diameter of the blank, which can be found approximately by the following formula:

$$D = d_2 - \frac{d_5}{8} \qquad (1)$$

in which

D = diameter of the blank,
d_2 = pitch diameter of the screw,
d_5 = depth of U. S. standard thread. (See *A* Fig. 1.)

The depth of the thread d_5 can be found by the following formula:

$$d_5 = \tfrac{3}{4} \times p \times \cos 30 \text{ deg.} = 0.6495\, p \qquad (2)$$

where p = the pitch of the thread or

$$\frac{1}{\text{number of threads per inch}}$$

$$d_2 = d - d_5 \qquad (3)$$

where d = the nominal external diameter of the screw.

When rolling a thread having a sharp V-form, the pitch diameter d_4, as shown at *C* in Fig. 1, can be taken for the

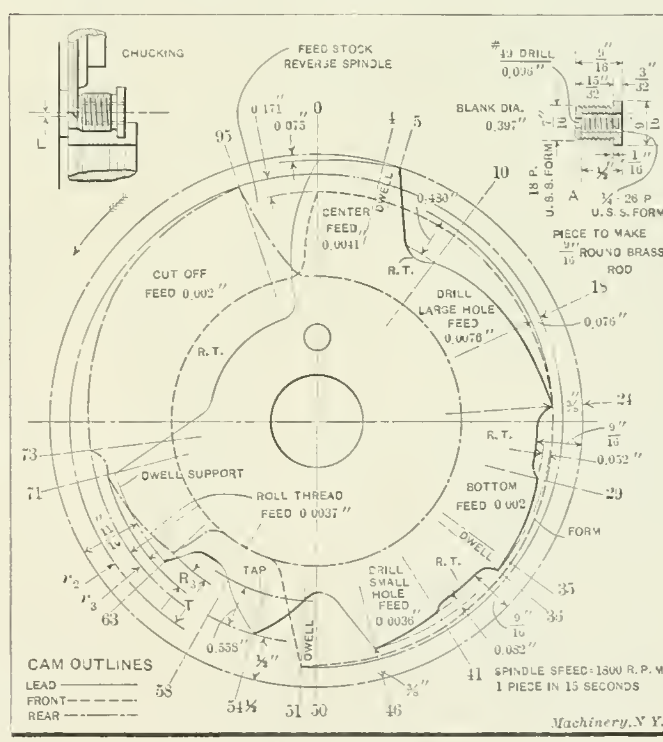


Fig. 4. Lay-out of a Set of Cams for Performing a Thread-rolling Operation

approximate diameter of the blank. The correct diameter of the blank in any case cannot be found by any formula, but by experiment only. It might be possible, however, to derive an empirical formula by making a series of experiments, and in each case determining the hardness of the metal. Then the results could be tabulated and used under similar conditions—where the metal is of the same hardness and the thread of the same shape. It is a simple matter, in the automatic screw machine, to reduce or increase the diameter of the blank, so as to give the correct finished diameter; thus it seems that any elaborate method of obtaining the diameter of the blank accurately is unnecessary.

* For information previously published in MACHINERY on this and kindred subjects, see "Thread Rolling in the Automatic Screw Machines," May, 1910; "Thread Rolling," February, 1910, and "Calculating the Size of Blanks for Rolling Screw Threads," November, 1909, engineering edition.

† Associate Editor of MACHINERY.

Preparing Work for Thread Rolling

In most cases that part of the work on which a thread is to be rolled can be formed by the circular form tool. The thread to be rolled is generally at the rear of a shoulder, so that the thread roll is confined and has to be of a certain width, thus making it necessary to bevel the edges of the roll to prevent the threads at the ends from chipping. It is, therefore, desirable, when the work is to be threaded up to a shoulder, to make the form tool of such a shape that it will neck the work, as shown at *A* in Fig. 2, and also reduce the diameter at *B* where the work is to be cut off.

The angle a should be 45 degrees, and the distance *C* should be equal to at least half the single depth of the thread, so that

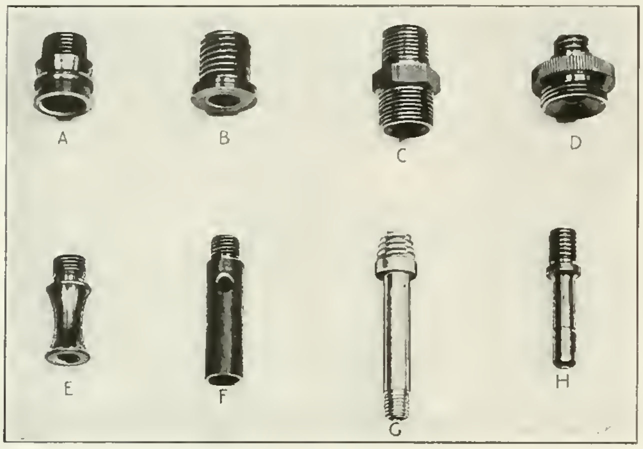


Fig. 5 Samples of Pieces having Rolled Threads

the part *B* will be slightly smaller than the root diameter of the finished piece. The distance *E* should be made equal to *C*, and the distance *F* equal to at least the pitch of the thread. Where it is not necessary to roll the thread up to a shoulder, the work need not be necked. However, better results are obtained in most cases by necking the work, when it would not be seriously weakened thereby.

Making the Thread Roll

The best results are obtained by using a thread roll with a single thread, but when the piece to be rolled is less than ⅝

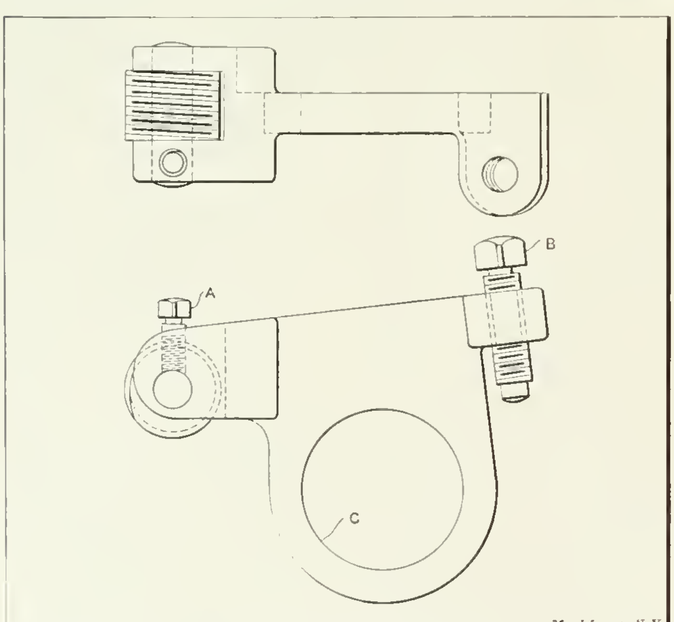


Fig. 6. Top Cross-slide Roll-holder

inch diameter, it is necessary to make the roll with a multiple thread in order to have it of the proper size. The roll should be made the opposite hand to that which it is required to produce; that is to say, for a right-hand thread, the thread roll is cut left-hand.

Owing to the displacement of the metal in forming a thread by rolling, there is no point in the formation of the thread where the contact is perfect. If the pitch diameter of the roll was made an exact multiple of the pitch diameter of the piece to be rolled, the contact would be perfect when the thread was completed, but not at any other point during the formation of the thread, and, therefore, would not allow the metal to flow. The Brown & Sharpe Mfg. Co. has found that the pitch diameter of the roll should not be an exact multiple of the pitch diameter of the finished piece, but should be slightly less. The pitch diameter of the roll for a U. S. standard thread can be found by the following formula:

$$D_1 = N\left(D - \frac{d_6}{3}\right) \qquad (4)$$

in which

D_1 = pitch diameter of roll (see Fig. 3),

N = approximate ratio between pitch diameter of roll and pitch diameter of piece to be threaded,

D = diameter of blank (see Fig. 2),

d_6 = depth of thread (see *B*, Fig. 1).

The depth of a U. S. standard thread as produced by thread rolling can be found by the following formula (for notation see *B*, Fig. 1):

$$d_6 = \tfrac{7}{8} \times p \times \cos 30 \text{ deg.} = 0.7578\,p \qquad (5)$$

where p = the pitch of the thread.

To illustrate clearly the method used in designing a thread roll for producing a U. S. standard thread, as shown at *B* in Fig. 1, take a practical example: Assume that it is necessary to design a thread roll for producing the thread on the piece shown at *A* in Fig. 4. As this is a U. S. standard thread, and it is impracticable to use a roll with a flat top, we use the blank diameter for calculating the pitch diameter of the roll.

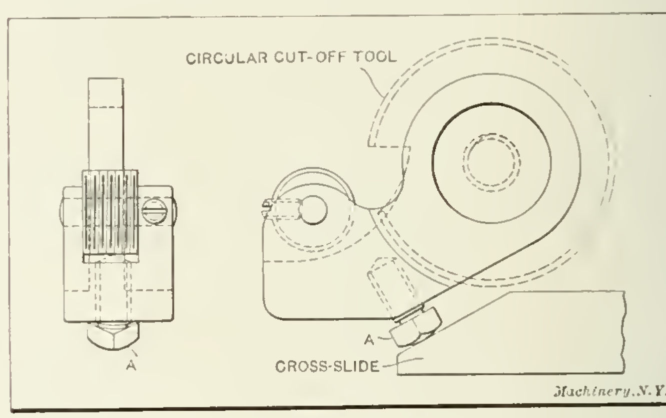


Fig. 7. Holder used when the Roll is passed under the Work

instead of the pitch diameter of the thread, as would be the case with a sharp V-thread. The blank diameter can be found by Formula (1). Before finding the blank diameter, however, it is necessary to find the depth of the thread, which can be found by substituting the known values in Formula (2), as follows:

$$d_5 = 0.6495\,p = 0.6495 \times 0.0555 = 0.0360 \text{ inch.}$$

Then

$$d_2 = d - d_5 = 0.4375 - 0.0360 = 0.4015 \text{ inch (see Figs. 1 and 4);}$$

and

$$D = d_2 - \frac{d_5}{8} = 0.4015 - \frac{0.036}{8} = 0.4015 - 0.0045 = 0.397 \text{ inch.}$$

The pitch diameter of the thread roll can then be found by Formula (4), but before finding the pitch diameter it is necessary to find the depth of the thread d_6 (see *B*, Fig. 1) by inserting the values in Formula (5)

$$d_6 = p \times 0.7578$$
$$= 0.0555 \times 0.7578 = 0.042 \text{ inch}$$

Then

$$D_1 = N\left(D - \frac{d_6}{3}\right)$$
$$= 2\left(0.397 - \frac{0.042}{3}\right) = 0.766 \text{ inch.}$$

The root diameter D_2 and the outside diameter D_3 of the thread roll (see Fig. 3) can be found by the following formulas:

$$D_2 = D_1 - d_7 \quad \text{(See C, Fig. 1)} \qquad (6)$$
$$D_3 = D_1 + d_7 \qquad (7)$$

Inserting the values already found, we have:

$$D_2 = 0.766 - 0.048 = 0.718 \text{ inch,}$$

and

$$D_3 = 0.766 + 0.048 = 0.814 \text{ inch.}$$

The same method as that given for the U. S. standard form of thread is used for the A. S. M. E. form when designing a thread roll. A thread roll for a sharp V-thread, however, is calculated from the pitch diameter, which is also used as the approximate diameter of the blank. For a sharp V-thread the root, pitch and outside diameters of the roll are found by the following formulas:

$$D_1 = N\left(d_4 - \frac{d_7}{3}\right) \qquad (8)$$

$$D_2 = D_1 - d_7 \qquad (9)$$

$$D_3 = D_1 + d_7 \qquad (10)$$

in which

D_1 = pitch diameter of thread roll,
D_2 = root diameter of thread roll (see Fig. 3),
D_3 = outside diameter of thread roll,
N = approximate ratio between pitch diameter of roll and pitch diameter of piece to be threaded,
d_4 = pitch diameter of piece or diameter of blank,
$d_7 = 0.866\ p$ (see C Fig. 1).

In making a thread roll the outside diameter is turned to

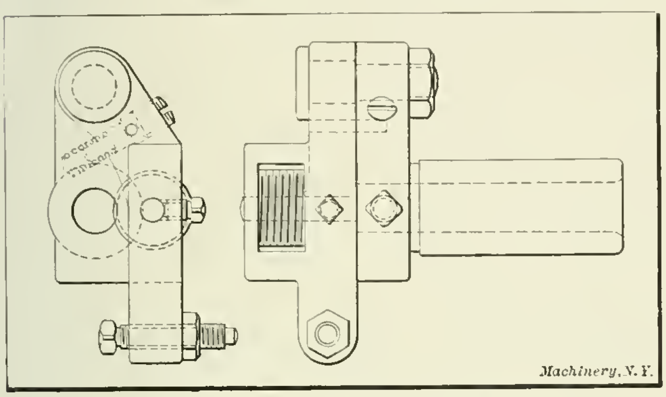


Fig. 8. Swing Holder for Holding a Thread Roll

the size required, and the ends are beveled at an angle of 45 degrees, as shown in Fig. 3, to prevent the threads on the ends of the roll from chipping. If the roll is to be made with a multiple thread, as would be the case in the example previously given, which was 18-pitch double thread, the lathe is geared to cut 9 threads per inch. Before cutting the thread it is preferable to bevel the edges at an angle of 30 degrees, or equal to the angle of one side of the thread. This facilitates the starting of the thread tool. After the threads have been cut the roll should again be beveled, but at an angle of 45 degrees.

Thread rolls should be made from steel containing a high percentage of carbon, and as they are not used in this case on steel, it is not advisable to make them from high-speed steel. Styrian steel has been found to give good results, but extra precautions should be taken in hardening, because if the sharp edges become burnt the roll will be useless. Thread rolls, as a rule, are lapped after hardening. This is accomplished by holding them on an arbor in the lathe, and using emery and oil on a piece of hard wood. A thread roll, to give good results, should not be made to fit loosely in the slot in the holder, but should be made a good running fit. If the roll is made to fit loosely in the holder, it will chew up the threads. The hole in the roll should also be made a good running fit on the pin in the holder, and in most cases should not be larger than 5/16 inch, 1/4 inch being usually adopted for rolls 1 inch in diameter or less.

Applying a Thread Roll to the Work

The shape of the work and the character of the operations necessary to produce it govern, to a large extent, the method employed in applying the thread roll. There are, however, other considerations to be observed, some of which are as follows:

1. Diameter of the part to be threaded;
2. Location of the part to be threaded;
3. Length of the part to be threaded;
4. Relation that the thread rolling operation bears to the other operations;
5. Shape of the part to be threaded, whether straight, tapered or otherwise;
6. Method adopted in applying the support.

When the diameter to be rolled is much smaller than the diameter of the shoulder preceding it, a cross-slide knurl-holder should be used. If the part to be threaded is not behind a shoulder, a holder on the swing principle should be used. Where the work is long—greater in length than two-and-one-half times its diameter—a swing roll-holder should be employed, carrying a support. When the work can be cut off directly after the thread is rolled, a cross-slide roll-holder should be used. The method of applying the support to the work also governs to some extent the method of applying the thread roll, but as this depends entirely on the shape of the work, it would be impossible to say what method should be employed, unless the shape of the work were known.

When no other tool is working at the same time as the thread roll, and where there is freedom from chips, the roll can be held more rigidly by passing it under instead of over the work. The reason for this is that in passing the roll over the work, it has a tendency to raise the cross-slide, while, on the other hand, if the roll is passed under the work, the pressure is downward and hence the holder is more rigidly supported. Where the part to be threaded is tapered as shown on the aluminum piece G in Fig. 5, the roll can be best presented to the work by holding it in a cross-slide roll-holder.

Holders for Thread Rolls

As previously mentioned, certain considerations govern the method of applying the thread roll; the holder for the roll, therefore, has to be designed to suit these requirements. There are various types of special holders in use for holding thread rolls, and as it is impossible to show all of them here, only a few of the more common or standard types are described.

In Fig. 6 is shown what is called a "top" roll-holder. This holder is held on a boss turned on the circular cut-off tool, and is clamped by the circular cut-off tool and the screw which

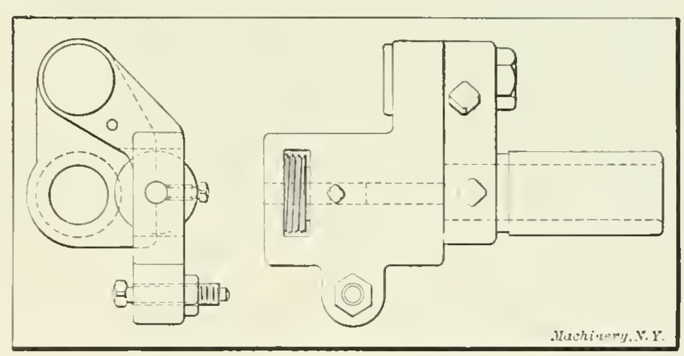


Fig. 9. Another Swing Roll-holder

holds the latter to the toolpost. The thread roll is held in a slot cut in the forward end of the holder on a pin, the latter being driven into the holder, as shown. As considerable pressure is required to force the roll into the work, it has a tendency to turn the pin in the holder; so, to obviate this, a flat is filed on the pin and a set-screw A is provided. The set-screw B is used for setting the roll to the proper depth, and rests on the toolpost. By making the hole C in the holder to fit the screw in the toolpost, this holder could be held on the outside of the toolpost, instead of fitting on the circular cut-off tool. This thread-roll holder can be used for holding rolls for threading pieces such as shown at A, B and C in Fig. 5.

A thread-roll holder which is held on the cross-slide but passes under the work is shown in Fig. 7. This holder is held on a projection on the cut-off tool in a manner similar to that shown in Fig. 6. The support in this case, or to be exact the set-screw A, rests on the cross-slide, and is used for adjusting the roll to the proper depth, as well as for supporting the holder. This holder can be held more rigidly than the top roll-holder shown in Fig. 6; it is used when no other tool is operating on the work at the same time, and also where there is an absence of objectionable chips. Thread-roll holders which are held on the cross-slide can only be used when the work is cut off directly after the thread is rolled, and for this

reason they should be held on the same slide as the cut-off tool. If the roll is brought back over the work, it produces a poor thread.

When it is necessary to bring the cut-off or form tool in more than once for the same piece, a cross-slide holder should not be used. Of course it would be possible to design a holder in which the roll would be held in a member free to oscillate, and held in position by a spring. This type of holder would be objectionable, however, owing to the fact that chips would get in between the movable member and the body, and prevent the part holding the roll from coming back into the same place each time, thus causing an endless amount of trouble.

When the work is of such a shape as to necessitate bringing in the form and cut-off tools more than once for the same piece, a swing holder should be used. Two holders of this type are shown in Figs. 8 and 9. These holders are made on the same principle as the ordinary swing tool, with the exception of the change in the swinging member to hold the roll. A hole is drilled in the shank of the holder and a set-screw provided for holding a support.

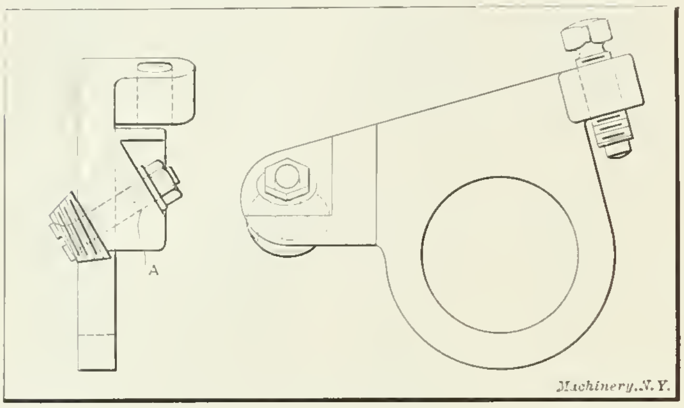


Fig. 10. Cross-slide Holder for applying a Thread Roll to a Beveled Piece

A thread-roll holder which is held on the cross-slide and holds a roll for threading the beveled piece shown at G in Fig. 5, is shown in Fig. 10. This holder is held to the toolpost in a similar manner to those previously described, but the roll in this case is held at an angle on the stud A, a nut and washer being used for holding the latter in the holder.

Rise on Cam when using Cross-slide Roll-holder

In thread rolling, the roll is first brought against the work, then fed at a certain feed per revolution until the center of the roll is in line with the center of the work, and finally removed from the work on the quick rise of the cam. As the roll is removed from the work, the cut-off tool is brought into position. The rise on the cross-slide cam for thread rolling, when using a holder held to the toolpost, can be found by the aid of the following formulas derived from the diagram Fig. 11. This shows the outside circumference of the thread roll touching the circumference of the blank, and a horizontal line is drawn tangent to the root diameter of the finished screw.

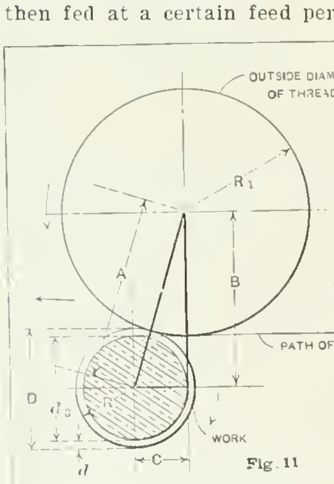


Fig 11. Diagram used in Calculating the Rise on the Cam for Thread Rolling when a Cross-slide Holder is used

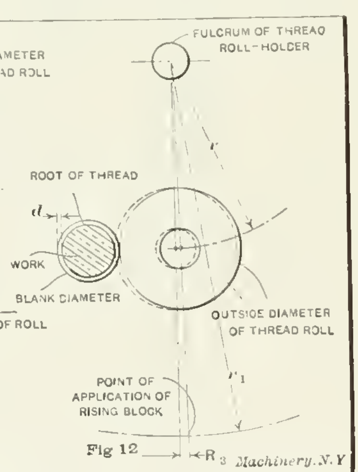


Fig. 12. Diagram used in Finding Rise on Cross-slide Cam when using Roll-holder of the Swing Type

Let D = diameter of blank,

d_3 = theoretical root diameter of screw,

R = blank radius,

R_1 = largest or outside radius of thread roll,

d = difference between radius of blank and radius of root of thread.

Then

$$A = R + R_1 \qquad (11)$$

$$B = R + R_1 - d \qquad (12)$$

$$C = \sqrt{A^2 - B^2} \qquad (13)$$

For example let it be required to find the rise on the cross-slide cam for threading the piece shown at A in Fig. 4. Substituting the known values of the diameter of the roll and the diameter of the blank in the above formulas, we have:

$A = 0.1985 + 0.407 = 0.6055$ inch

$B = 0.1985 + 0.407 - 0.024 = 0.5815$ inch

$C = \sqrt{(0.6055)^2 - (0.5815)^2} = \sqrt{0.02848} = 0.168$ inch

Then the rise on the cam R_3 (see Fig. 4) equals C (Fig. 11) plus from 0.010 to 0.015 inch, depending on the diameter of the roll and work. This calculation was for rolling a U. S. standard thread, but the same method can be used for rolling any other shape, substituting, of course, the correct values.

Total Rise on Cross-slide Cam

As the work is cut off with the same cam, it is necessary to find the total rise on the cam for thread rolling and cutting the piece off; this can be found by the following formulas,

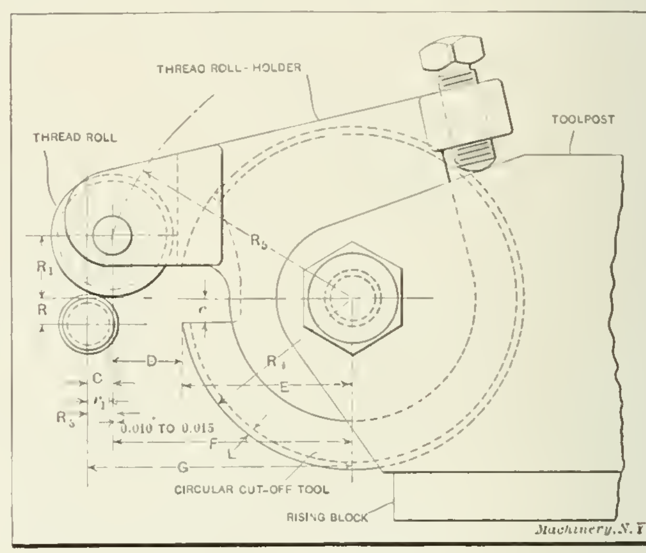


Fig. 13. Diagram used in Finding the Total Rise on the Cam for Thread Rolling and Cutting off

which are derived from the diagram Fig. 13. Here the thread roll is shown touching the circumference of the blank, and the circular cut-off tool and thread-roll holder are shown in their relative positions.

Let T = total rise on cam (see Fig. 4),

C = distance from center of roll to center of work,

R_3 = actual rise required to roll thread, which equals C + from 0.010 to 0.015 inch,

R = radius of theoretical root of thread on piece,

r_1 = radius of work turned down with circular form tool, or $\frac{d}{2}$ (see Fig. 2),

r_2 = actual rise on cam to cut off piece, which equals $r_1 + L + 0.010$ inch (to approach) + 0.005 inch (to pass center),

L = distance of bevel on cut-off tool (see Fig. 4),

R_1 = outside radius of thread roll,

R_4 = largest radius of circular cut-off tool,

R_5 = radius of thread-roll holder,

c = distance that cut-off tool is cut below center,

E = distance from center of circular tool to edge, when tool is cut down below center,

F = distance from center of cut-off to center of roll, when it is touching piece as shown,

G = distance from center of cut-off tool to center of work, when roll is touching circumference as shown, which is equal to $F + C$.

Then

$$E = \sqrt{R_4^2 - c^2} \qquad (14)$$

$$F = \sqrt{R_5^2 - (R_1 + R)^2} \qquad (15)$$

Proceeding with the examples given in Fig. 4 and assuming the following numerical values: $R_4 = 1.125$ inch, $R_5 = 1.625$ inch, $c = 0.15625$ inch, $R_1 = 0.407$ inch, $R = 0.178$ inch, $r_1 = 0.165$ inch, $L = 0.020$ inch, we get:

$E = \sqrt{(1.125)^2 - (0.15625)^2} = 1.114$ inch.

$F = \sqrt{(1.625)^2 - (0.407 + 0.178)^2} = 1.516$ inch,

$r_2 = 0.165 + 0.020 + 0.010 + 0.005 = 0.200$ inch,

$R_3 = 0.168 + 0.010 = 0.178$ inch.

The distance G, in Fig. 13, will be greater, however, in practice than $F + C$, as from 0.010 to 0.015 inch must be added to the distance C to make allowance for the roll to approach the work. The distance D, which equals $F - E$ as shown in the illustration, is the relative difference between the edge of the circular cut-off tool when cut below the center, and the center of the thread roll. Then $D = 1.516 - 1.114 = 0.402$ inch. The distance r_3 (see also Fig. 4) equals $D - r_2 = 0.402 - 0.200 = 0.202$ inch. Then $T = R_3 + r_3 + r_2 = 0.178 + 0.202 + 0.200 = 0.580$ inch, which is the total rise on the cam for thread rolling and cutting off.

Rise on Cross-slide Cam when using Swing Roll-holder

When using a roll-holder of the type shown in Figs. 8 and 9, the rise on the cam can be found by the following formula derived from the diagram Fig. 12, where the thread roll is shown in two positions—before and after rolling the thread. The distance d represents the distance between the radius of the blank and the theoretical root of the thread. To this dimension, from 0.010 to 0.015 inch is added for the roll to approach the work. Let $d_1 = d +$ from 0.010 to 0.015 inch.

Then

$$R_3 = \frac{d_1 \times r_1}{r} \qquad (16)$$

For example, let $d_1 = 0.030$ inch, $r = 1\frac{1}{8}$ inch, and $r_1 = 2\frac{1}{4}$ inches

Then

$$R_3 = \frac{0.030 \times 2\frac{1}{4}}{1\frac{1}{8}} = 0.060 \text{ inch.}$$

There is another method of holding the thread roll when applying it to the work which has not been mentioned. This consists in holding the roll in a holder fastened to the cross-slide, but instead of passing the roll over or under the work, it is presented radially to the work. The rise on the cross-slide would be $d +$ from 0.010 to 0.015 inch (see Fig. 12).

Speeds and Feeds for Thread Rolling

When the thread roll is made from high-carbon steel and used on brass, a surface speed as high as 200 feet per minute can be used. Better results, however, are obtained by using a lower speed than this. When the roll is held in a holder attached to the cross-slide, and is presented either tangentially or radially to the work, it can be fed at a considerably higher speed than if it is held in a swing tool. This is due to the lack of rigidity in a holder of the swing type. Table I gives the feeds to be used when a cross-slide roll-holder is used; and Table II gives the feeds to be used for thread rolling with swing tools.

The feeds given in Tables I and II are applicable for rolling threads without a support when the root diameter of the blank is not less than 1/5 the double depth of the thread. When the double depth of the thread exceeds this amount, a support should be used. A support should also be used when the width of the roll is more than two-and-one-half times the smallest diameter of the piece to be rolled, irrespective of the pitch of the thread. When the smallest diameter of the piece to be rolled is much less than the root diameter, the smallest diameter should be taken as the deciding factor for the feed to be used.

TABLE I. FEEDS FOR THREAD ROLLING WITH CROSS-SLIDE HOLDERS

Root Diameter of Blank	Number of Threads per Inch — Feed per Revolution in Inches																
	80	72	64	56	48	44	40	36	32	30	28	24	22	20	18	16	14
1/8	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0015	0.0010	0.0005	......	......	......	......	......	......	......
3/16	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0015	0.0010	0.0005	......	......	......	......	......	......
1/4	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0015	0.0010	0.0005	0.0005	......	......	......	......
5/16	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0015	0.0010	0.0010	0.0005	0.0005	......	......
3/8	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0015	0.0015	0.0010	0.0010	0.0005	0.0005
7/16	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0020	0.0015	0.0015	0.0010	0.0010
1/2	0.0080	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0025	0.0025	0.0020	0.0020	0.0015	0.0015
5/8	0.0085	0.0080	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0030	0.0030	0.0025	0.0025	0.0020	0.0020
3/4	0.0090	0.0085	0.0080	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035	0.0035	0.0030	0.0030	0.0025	0.0025
7/8	0.0090	0.0090	0.0085	0.0080	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0040	0.0035	0.0035	0.0030	0.0030
1	0.0100	0.0095	0.0090	0.0085	0.0080	0.0075	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0045	0.0040	0.0040	0.0035	0.0035

TABLE II. FEEDS FOR THREAD ROLLING WITH SWING HOLDERS

Root Diameter of Blank	Number of Threads per Inch — Feed per Revolution in Inches																
	80	72	64	56	48	44	40	36	32	30	28	24	22	20	18	16	14
1/8	0.0030	0.0025	0.0020	0.0015	0.0010	0.0005	......	......	......	......	......	......	......	......	......	......	......
3/16	0.0033	0.0028	0.0025	0.0020	0.0015	0.0008	0.0005	......	......	......	......	......	......	......	......	......	......
1/4	0.0036	0.0030	0.0030	0.0025	0.0020	0.0010	0.0010	0.0005	0.0005	0.0005	0.0005	......	......	......	......	......	......
5/16	0.0040	0.0035	0.0035	0.0030	0.0025	0.0015	0.0015	0.0010	0.0010	0.0010	0.0010	0.0005	......	......	......	......	......
3/8	0.0043	0.0040	0.0040	0.0035	0.0030	0.0020	0.0020	0.0015	0.0015	0.0015	0.0015	0.0010	0.0005	0.0005	0.0005	......	......
7/16	0.0046	0.0045	0.0045	0.0040	0.0035	0.0030	0.0025	0.0020	0.0020	0.0020	0.0020	0.0015	0.0010	0.0010	0.0010	......	......
1/2	0.0050	0.0048	0.0048	0.0045	0.0040	0.0035	0.0030	0.0025	0.0025	0.0025	0.0025	0.0020	0.0015	0.0015	0.0015	0.0005	0.0005
5/8	0.0053	0.0050	0.0050	0.0048	0.0043	0.0040	0.0035	0.0030	0.0030	0.0030	0.0028	0.0025	0.0020	0.0020	0.0018	0.0010	0.0010
3/4	0.0056	0.0055	0.0052	0.0050	0.0045	0.0043	0.0040	0.0035	0.0035	0.0032	0.0030	0.0028	0.0025	0.0022	0.0020	0.0015	0.0013
7/8	0.0060	0.0058	0.0055	0.0052	0.0048	0.0045	0.0043	0.0040	0.0038	0.0035	0.0032	0.0030	0.0028	0.0025	0.0022	0.0018	0.0015
1	0.0062	0.0060	0.0058	0.0054	0.0050	0.0048	0.0047	0.0043	0.0040	0.0038	0.0035	0.0032	0.0030	0.0028	0.0025	0.0022	0.0018

* * *

In a paper on the "Dynamics of the Flying Machine," by Mr. James S. Stephens, read before the April meeting of the Western Society of Engineers, a statement was made that during the past decade, the public opinion of the flying machine may be said to have passed through three stages: *viz*: first, viewed as ridiculous, then as sublime, and now, on account of the great number of fatal accidents which have occurred, as tragical.

HARD VS. SOFT CAST-IRON WAYS FOR MACHINE TOOLS

By ROBERT GRIMSHAW

The Editor of MACHINERY wrote to me in April as follows:

"We know that American cast iron has been much criticized by foreign users of American machine tools because of its softness, it being alleged that slides, ways, etc., wear very rapidly. What has been your experience as to relative wear of American and foreign lathes?

"The reason we inquire is that a German, representing American machine tools in Germany and Austria, claims that the soft American irons wear much better than the harder Continental irons, because of their slight oil-absorbing capacity. He states that the ways of Continental tools soon become dry whereas the ways of American lathes, being comparatively soft porous iron, remain lubricated much longer, and hence wear relatively slower. He further states that a German copy of the Norton grinding machine had to be built with the ways fifty per cent wider than an American machine in order to preserve its accuracy.

"We think that an article by you containing authoritative data on the relative durability of American and Continental machines would be of considerable interest to our machine tool builders. We would be glad to have you prepare an article for publication in MACHINERY, if you can secure the necessary information and data."

Josh Billings was the father of the trite saying, "It is better not to know so many things than to know so many that are not so." and the Germans have a proverb in the same line:—"das Gewisswissen ist besser als das Wissen,"—that is, "Being certain is better than being sure."

While it is true that the average American cast iron is both softer and tougher than the average German iron, there is on both sides of the ocean, open-grained hard iron and close-grained soft iron, just as there is on both sides close-grained hard and open-grained soft iron.

When we consider that the average German cast iron is not only harder than the average American iron, but also more brittle, we will see a reason for making all parts of a German imitation of an American machine heavier than the original of the same nominal capacity. The extra weight will usually appear of necessity in the ways and bearings as well as in the frames. There is also to be taken into consideration "the agent's talking point." As Americans can and do make their machine frames lighter than the Germans and still have them "stand the racket," attempts have been made to give the American machines a black eye by saying that they are too light for good service—a statement which, in view of the heavier cuts usually taken on the average American machine tools as compared with the German, is not warranted, so the "talking point" consists in calling attention to the supposed superior strength of the imitation, as shown in the stouter legs and prolonged durability of bearing surfaces because of wider ways.

As regards the actual penetration of oil into the pores of the softer American metal, I take very little stock in that. Even if the oil does penetrate, it proves nothing, for we have no assurance that oil which has either been driven into the pores by pressure or drawn in by capillary attraction has any effect in forming either a protective film or a series of minute elevations to prevent the opposing surfaces from actually touching each other. If the oil gets into the pores, it stays in. Grit, on the contrary, either stays on the outside of the opposing surfaces and cuts both, or imbeds itself into the soft one and acts as a lap in grinding down the hard one.

The matter of local wear must be taken into account when considering durability of lathe ways. There is usually more wear at the head end than at the foot, because more short pieces are turned than long pieces. If the ways are softer than the carriage, the difference in local wear will be greater than if they are harder. Ways that are harder than the carriage will wear the latter, no matter where it is used most. Hence if the two rubbing parts are to be of unequal hardness, the carriage should be the softer.

In the matter of lubrication, there are many contradictions; in some places the attempt is made to have both the opposing surfaces as hard as possible, while in others it is the object to make the one which is more cheaply or readily replaced—as for instance an engine slide valve—the softer.

In the following letters received from German builders and users of machine tools, first comes the statement of a concern which answers with reference to the machines it builds rather than those it uses; that is not what is wanted, but, for all that, it is interesting as opening up another side of the question:

Friedrich Schmaltz, G. m. b. H., Offenbach, a. Main, builder of grinding machinery, says that the company has had no occasion since starting its works to make experiments or research in this line. In the last few years it has worked up iron of various degrees of hardness, and this quality is of importance to it only as concerns the ease of working the castings. Whether the harder or the softer material is better in service, the customers do not say. It would, perhaps, in the case of grinding machines be rather difficult to determine whether a machine ran dry on account of the quality of the iron, or not, all the ways being supplied with automatically continuous oiling devices except those pertaining to the chucking or fastening of the work.

It should be noted that this concern is a builder of grinding machines and that the question of ease of working the ways should be of less importance to it than if they were planed or milled. It is to be assumed that as a matter of convenience, as well as for advertising purposes, to impress visitors of the advantages of grinding as opposed to planing or milling followed by scraping, this company grinds wherever practicable.

We next have the opinions of some establishments that are advocates of comparatively soft bearing surfaces:

The Siemens-Schuckert Works, Charlottenburg, has made no systematic comparative experiments concerning the wear of soft cast iron. It has observed that hard cast iron wears more irregularly than soft, and for this reason the works would in many cases give the soft metal the preference. On the other hand, it states that the old rule that different materials work better together than similar materials should apply here; hence it is better to use hard iron for one part and soft iron for the other in contact. Where a planing machine is used, it would be best to make the bed of hard iron, and the table of soft iron; partly because the bed is more exposed to injury, and partly because the formation of hollows in the part where the table is most used would be avoided.

The Schladitz Safe, Bicycle & Machine Works in Dresden states that its experience with lathe ways is that soft iron is the better, it having found that the wear on soft iron machine tools is far less than on those made of hard gray iron.

Biesolt & Locke, manufacturers of sewing machines, Meissen, Saxony, think that soft ways are more durable than hard ones because the iron is porous, and for this reason the oil remains longer between the rubbing surfaces. Hard ways similarly lubricated become dry sooner.

Otto Froriep, G. m. b. H., machine tool builder, Rheydt, Rheinland, avoids, on principle, the use of hard ways for the reason that machining and other working is excessively difficult. He believes that they are unnecessary because lathe ways, especially, have such large surfaces in contact that the pressure per unit of area is low, and the wear consequently slight.

A manufacturer of special brands of cast steel, who does not want his name given in this connection, says: "We do not build lathes or such machines, but in order to be obliging we have put ourselves in communication with an experienced and practical man in this line who writes as follows: 'The correctness of the opinion of some manufacturers that soft ways are more durable than hard ways because the oil remains longer on a somewhat porous iron is not to be denied, but, for all that, good lubrication can also be attained in another way in most cases—for instance, by automatic oilers with wicks on the carriages.'"

According to the experience of the authority just quoted, it would be desirable to use the hardest iron for lathes subjected to very severe usage because the bed is more readily ruined by dirt and small turnings which score the ways, especially where high-speed steel tools are employed. Since the surfaces in contact are subjected to a sliding friction, two materials of unequal hardness should be used, particularly where the velocity is great; it is desirable with a hard bed,

Address: Dresden—A 16, Gneisenustr. 3.

to use a comparatively soft carriage, because the carriage could be more cheaply, easily and quickly replaced than the bed. The more readily and cheaply replaceable part should always be left soft. A hard bed would perhaps retain its accuracy longer and last longer. It is well known that soft beds, by reason of unequal wear, soon become inaccurate, especially in parts near the headstock. With planing machines, the case is different. Here the ways are protected, and in most cases are very long. With milling machines, on the contrary, very hard rubbing surfaces would be especially desirable for both the carriage and its bearing surfaces, particularly where much water is used in milling. With the soft iron commonly employed for these machines, the water penetrates the pores and soon makes it "rotten."

As proof that lubrication is the last thing of importance to think about in this connection, our authority mentions that in the sliding surfaces of cannon, with appliances for taking up the recoils, where hard steel bronze slides to and fro on quite hard bearings, even where the usage is very severe there is little wear. In a shop where there are 68 milling machines all the cast-iron work-tables were replaced one after another by steel tables and these have given good service.

And now let us see what has been written on the hard metal side of the question. The Vereinigte Schmirgel & Maschinen Fabriken of Hainholz, near Hanover, manufacturer of grinding machines for foundries, etc., writes that in the case of machine tools it is best to use iron as hard as possible without running the cost of working too high. It is considered that even with scraped surfaces there are sufficient uneven places to hold all necessary oil. Besides this, the rubbing surfaces must be adjusted with sufficient space between them to enable them to be moved without meeting excessive resistance. This necessary interstitial space provides for sufficient oil to lubricate the rubbing surfaces. If in order to lessen the cost of working, soft iron is used for machinery, the life of which is not shortened by the use of soft material, the hardening of the rubbing surfaces by chilling would seem to be highly desirable.

This concern, being an extensive manufacturer and user of grinding machines, naturally advocates the use of hard metal. Perhaps in the remark about scraped metal, we can read between the lines.

Ganz & Co., Budapest, have made no observations which would tend to clear up the disputed superiority of hard or soft irons, but are of the opinion that hard cast iron is the best for the purpose mentioned. They ascribe no special importance to the property of soft cast iron in holding oil longer between the rubbing surfaces. The workman has the ways constantly in sight, and, in general, is likely to lubricate them liberally.

Ferdinand C. Weipert, machine tool builder, Heilbronn, a. N., states that as regards durability of lathe ways, a rather hard cast iron is advantageous. Steps must be taken, of course, to insure proper lubrication, and in every detail the user should be sure that the oil goes where it is needed.

Breitfeld Danek & Co., of Carolinenthal, near Prague, with branch shops in Aussig, Blansko and Schlan, are manufacturers of very heavy machinery for coal-mining, sugar-making and other purposes. They state that they have in their main works in Prague a number of very old English lathes, some of them being forty-five and one fifty years old. All these lathes have hard ways and carriages and are in better condition than modern machine tools with soft ways and carriages purchased within the past few years. This concern, therefore, is in favor of the use of the hardest metal practical for ways, gears, wheels, spindles, etc., especially where the new brands of high-speed steel are in use and piecework is the rule.

A. Borsig, locomotive builder, Tegel, near Berlin, states that his experience is that hard iron is best for lathe ways when properly lubricated. He objects to soft iron because the pores admit not only oil but dust, which rapidly wears the bearings.

Klein, Schanzlin & Becker, manufacturers of pumps, valves, etc., Frankenthal, state that as they have seen no actual honeycombing of their lathe ways, they would assign as a reason for their rapid or slow wear the relative quantity of chips and dust present thereon. Inasmuch as soft cast iron, that is, iron with a porous surface, is favorable to the accumulation of chips and dust, this would wear very rapidly. Their experience is in favor of close hard cast iron as against soft and porous iron.

The Bernhard Stoewer Co., of Stettin, a large manufacturer of automobiles and typewriting machines, states that hard ways for lathe carriages, etc., are preferable, although the oil consumption is greater; and that soft ways, if properly lubricated, have the disadvantage that the oil by remaining longer thereon catches dust and chips, thereby forming an abrasive mixture which causes more rapid wear than where hard material is used.

My personal opinion is that none of those who were so obliging as to answer my question have really considered the subject in its full bearing. There are two elements to be considered—the question of wear after the machine is built and that of replacement or adjustment of worn parts after wear; also there is the matter of the care the machine is likely to receive in use and the character of its work and surroundings, both of which latter affect the rapidity and character of legitimate and illegitimate wear. If one of the surfaces be hard and the other soft, the hard one will wear out the soft surface, providing the lubrication is good and there is no grit. If the surfaces be of unequal hardness and the lubricating appliances defective or the oil unsuitable to the pressure and speeds, even if not affected by grit, the hard bearing will outlast the soft one. But if there be likelihood of grit getting on the ways or into the oil layer, and therefore into the pores, more will get into the soft metal than into the hard, and the soft metal will act as a lap and cut the hard metal and also be cut somewhat itself.

If both surfaces be equally hard, lubrication good, and surfaces clean, neither one of the pieces will act as a lap; the effect of use will be simply "wear and tear." If the opposed surfaces be of equal hardness and grit gets between them, the case will be similar, except that there will be a grinding and cutting action, but no true lapping. Therefore in the last two cases the harder both materials are, the better.

* * *

SHRINKAGE AND PRESS FITS IN THE BRADFORD SHOPS

In developing, several years ago, a system for making shrinkage fits, the Bradford Machine Tool Co., Cincinnati, Ohio, found that there was a great scarcity of reliable data on this subject, and that the available data, obtained from various sources, did not agree. In order to obtain a working basis for the experiments which it was found necessary to undertake, an average value of the most reliable data at hand was first obtained by calculation. These average

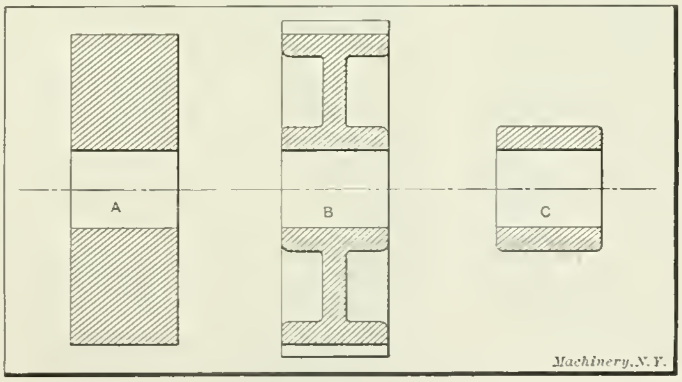


Fig. 1 Different Types of Castings with Same Diameter Hole requiring Different Shrinkage Allowances

values, however, did not give satisfactory results for the work to be done, and in the experiments undertaken it was definitely determined that it is impossible to give any general rule for shrinkage allowances for given diameters of hole, as the shrinkage allowance required varies to a very great extent with the form and construction of the part to be shrunk onto another member. The amount of iron around the hole is the governing factor, but the manner in which it is distributed has also a considerable influence on the re-

sults. The hole through an otherwise solid disk of cast iron as shown at *A*, Fig. 1, will expand less than the hole through a gear-wheel (see *B*, Fig. 1) with a thin web all around the hub, and this latter will expand less than a thin ring or collar of cast iron as shown at *C*, Fig. 1. The rate of expansion in a web-casting may be as much as three times greater than that in a solid casting.

Having established these facts, it became necessary to determine the required shrinkage allowance for every type of shrinkage fit to be made. In so doing it was further established that the rate of expansion of a hole in a metal disk or gear is not a quantity which is directly proportional to the temperature to which it has been heated. The rate of expansion is greater between 800 and 1200 degrees F. than between 400 and 800 degrees; and the expansion between the two latter temperatures is greater than that which takes place in heating a piece up to 400 degrees F. On account of the presence of these variable conditions, a rather unique system of making shrinkage fits was adopted. The pieces to be shrunk onto the shafts or spindles are not heated to the usual temperature for shrinkage fits, but only to the temperature of boiling water, 212 degrees F. They are heated by gas, but if the casting has a hollow portion, water is poured into it, and the proper temperature is reached when the water begins to boil. In other cases the temperature is judged by putting drops of water on the heated casting. The allowances required for shrinkage fits, when heating the outside piece as explained, are determined by experiments for each set of pieces to be joined by a shrinkage fit. When a standard has once been established for two pieces, gages are made for each, and they are turned and bored to these, so that the allowance will always be uniform.

The holes are made standard size and the allowances are made in the shaft, as usual. As an example of the allowances required for this method of making shrinkage fits, it may be mentioned that the allowance for a shrinkage fit of the faceplate and internal gear of a 36-inch lathe, shrunk

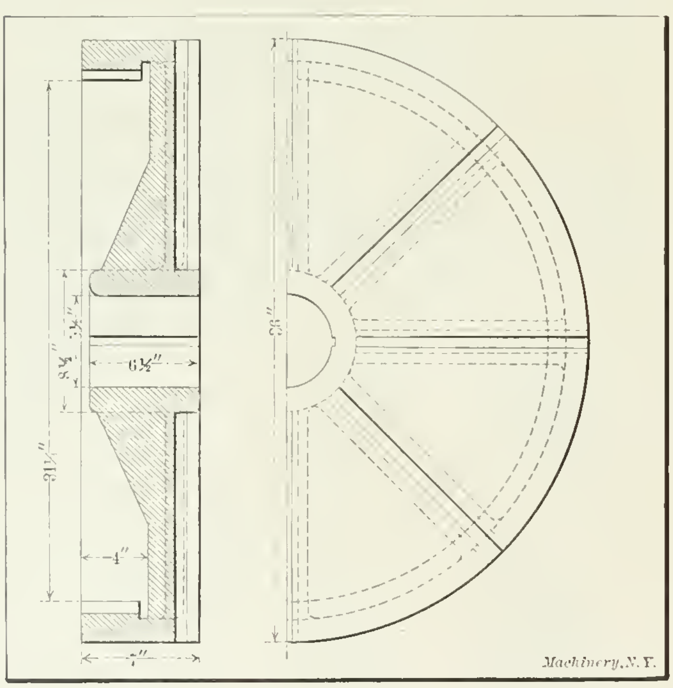


Fig. 2. Type of Casting shrunk onto its Spindle, for which a Definite Allowance has been determined by Experiment

onto its spindle, is 0.003 inch. The hole in the faceplate is 5½ inches. The construction of this faceplate is shown in Fig. 2.

Press fits are subject to the same general conditions as shrinkage fits. The amount and distribution of the metal surrounding the hole in the outer member is the determining factor. As an example of what has been found good practice, it may be mentioned that gears with a solid web and average size hub require an allowance of 0.002 inch for a 2-inch hole, 0.003 inch for a 3-inch hole, and 0.0035 inch for a 4-inch hole. The type of gears for which these allowances are suitable is shown in Fig. 3.

For an ordinary good running fit, properly oiled, the Bradford Machine Tool Co. allows 0.001 inch, and for a loose running fit, 0.002 inch. To provide for proper oiling, oil-grooves are cut in the spindle, running in the direction of two opposed helices around it. These oil grooves are cut in a lathe specially geared for coarse screw cutting, in a manner similar to that described in MACHINERY, December, 1910, engineering edition, in an article entitled: "English 24-inch Lathe."

The principles governing the making of shrinkage fits as outlined in the foregoing may at first sight seem to run

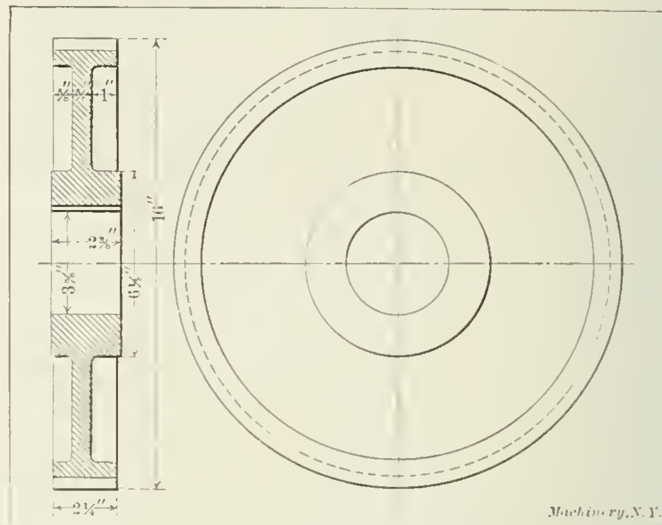


Fig. 3. Type of Gear for which Definite Allowances have been determined for Press Fits

counter to the generally accepted theory for shrinkage fits, as recently treated in a series of articles by Mr. W. L. Cathcart in MACHINERY. (See issues of April and May, 1911: "Shrinkage and Forced Fits.") It will be found, however, upon consideration, that the practical results referred to in the present article are not opposed to the theoretical principles laid down by Mr. Cathcart in his articles. The allowance to be made, according to theoretical calculations, depends on the thickness of the hub; and in a flat solid disk as shown at *A*, Fig. 1, the whole disk must be considered as the hub; in a gear with a solid web, as shown at *B*, the actual hub, and part of the web, must be considered as the hub; and in a thin ring or collar, as shown at *C*, the hub is only the thickness of this collar. Hence it seems that the practical results obtained and the theory of shrinkage fits as laid down in the articles in previous numbers of MACHINERY, are in close agreement. E. O.

* * *

INFORMATION WHAT AIN'T!

A well-known publication devoted to factory system, of Chicago and London (which some time ago gave a micro-photograph of babbitt metal, and mentioned it as being a kind of steel), says that the "metal trimmings" of a wrecked vessel bring a high price, "a *manganese* propeller" realizing from £400 to £800. On the same page it says "Old boots are used to make tan bark," giving a photo of "a million pairs, weighing five hundred tons," collected at the cost of labor only, but in the form of tan bark being worth £25!

What we don't learn by reading! A. MAZED
Squedunk.

* * *

In the discussion at the recent meeting of the National Machine Tool Builders' Association at Atlantic City, extravagant methods of finishing parts of castings were referred to. Not infrequently is a heavy casting transported to a large machine simply to plane or mill a boss of small area. The cost of machining the boss, to say nothing of handling the casting, is often two or three times as much as the cost of finishing the surface with hammer, chisel and file in the hands of a competent machinist.

THE MULTIPLE PLUNGER PRESS

THE HISTORY, CONSTRUCTION AND USE OF AN AUTOMATIC MACHINE FOR PRODUCING ARTICLES FROM SHEET METAL

By CHARLES DOESCHER*

Robert Cairns, Inventor

Undoubtedly there has never been a time like the present when the manufacturer has made such strenuous efforts to produce staple articles, automatically, and in so doing to reduce their cost to a minimum. Various machines have been invented and put to use for automatically producing small as well as large articles from sheet metal, some of which have met with success. The solving of the problem of automatic manufacture has to a large extent fallen upon the machinist and toolmaker, so that they have contributed to the industrial development of the present time. No better verification of this statement can be obtained, than by watching a multiple plunger press at work, simultaneously and automatically producing, by a series of operations, a complete staple article at every revolution of the press, at the rate of from 80 to 140 pieces per minute, the number, of course, depending on the size and nature of the work.

As the multiple plunger press is performing such an important part in the manufacturing of articles made from sheet metal, and as its application and the tools used in connection with it are not as well known as they should be, the writer will briefly explain, for the benefit of the readers of MACHINERY, what this machine is and what it can do.

The writer is indebted to Mr. Gilman C. Hill, secretary of the Waterbury Brass Co., and Mr. Robert A. Cairns, city engineer, Waterbury, Conn. (son of the inventor of the multiple plunger press), for the facts concerning the early history of this machine. He is also indebted to Mr. Roger S. Wotkyns, head of the sales department, and Mr. William D. Pierson, secretary of the Waterbury Machine Co., for information concerning the construction and use of this machine, as well as for the loan of the necessary drawings.

Historical Development, and Inventor of the Multiple Plunger Press

The multiple plunger press has a history, as is true of all machines of any account. It originated at the Waterbury Brass Co., of Waterbury, Conn., in the year 1860, its inventor being the late Mr. Robert Cairns who built the first machine on a small scale with two plungers, and a transfer slide for carrying the work. This machine was applied to the manufacture of percussion caps, which were used in the army rifles employed in the early part of the Civil War. A few years later, Mr. Cairns built other machines having a series of plungers, to which he added the lower camshaft. These machines were built on the same general principle of construction as those which are built today. The machine at that time in its improved form was used for making eyelets, and was called an "eyelet" machine, the name by which it is still known.

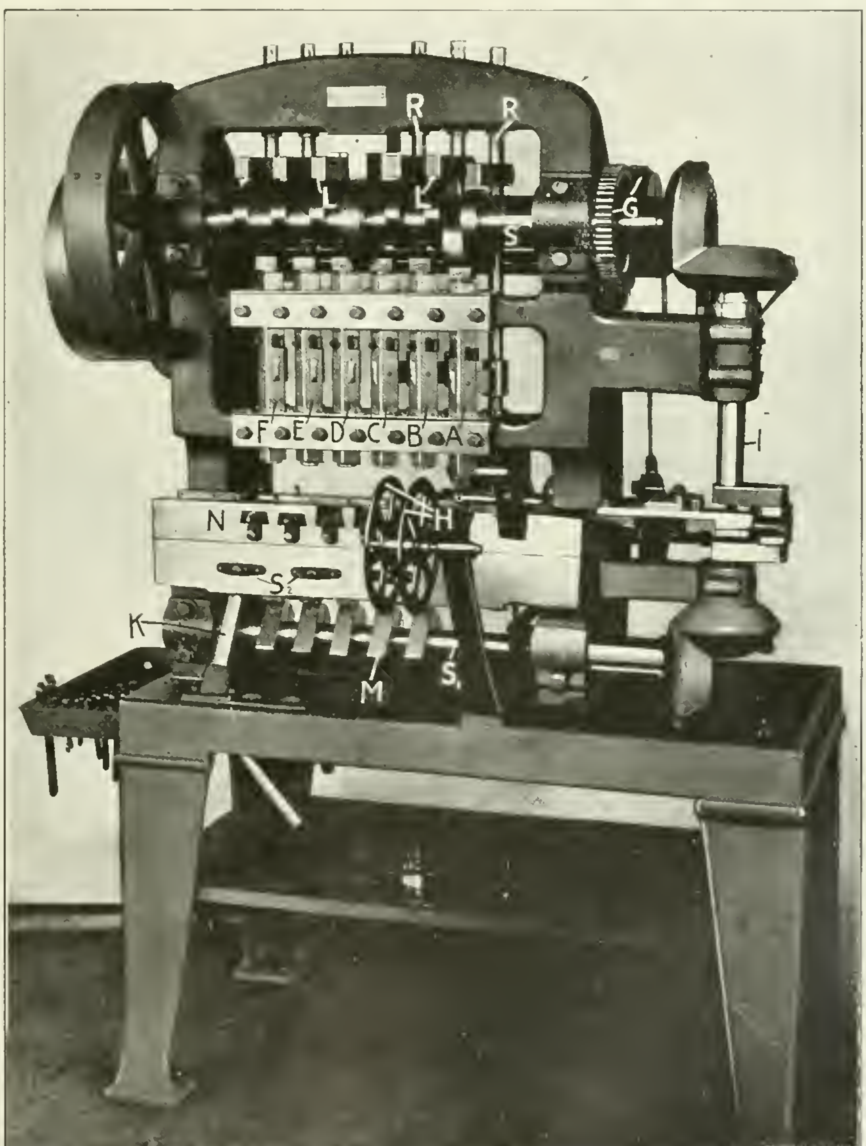


Fig. 1. Multiple Plunger Press having Six Plungers

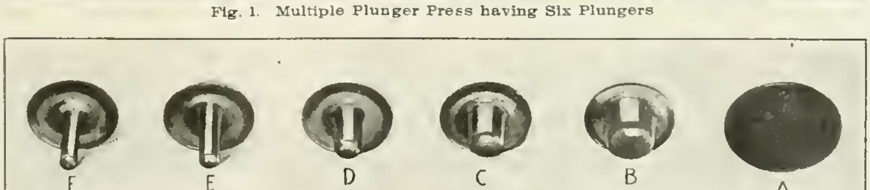


Fig. 2. Successive Operations on One-piece Collar Button—Head formed in a Separate Operation

Before proceeding with a description of the machine, it is only fair that the writer should give a brief sketch of the life of the late Mr. Robert Cairns, the father of the eyelet machine. Mr. Cairns was the son of Scotch parents and was born in Londonderry, Ireland, in the year 1824. He came to this country in 1835 and in 1857 came to Waterbury, Conn., from Haverstraw, N. Y. He was first employed by the American Cap & Flask Co., which shortly after became the property of the Waterbury Brass Co.

Mr. Cairns was an all-around machinist of the old school, and was a most painstaking mechanic in everything that he did, and what he accomplished had to be done right no matter how much of a hurry there was for the work. That there are still at this late date a number of the machines which he designed and built in daily use and in good working condition in the eyelet department of the Waterbury Brass Co., is a glowing tribute to his memory and skill as a mechanic of exceptional ability. It is to be regretted that he never lived

* Address: 1029 W. Main St., Waterbury, Conn.

to see how extremely useful and valuable his machines have become—something he always said would sooner or later be proved. Mr. Cairns died in 1886 and is survived by four daughters and one son.

The reason that the multiple plunger presses have not become generally known, is due to the fact that for many years they were built and kept in rooms that were under lock and key in the Waterbury Brass Co., to which no one had access, except those who were employed therein. The same may also be said of the Scovill Mfg. Co., also of Waterbury, where the machines were next introduced. The keeping of the merits of this most useful machine hidden from the eyes of the mechanical world has since been done away with by the previously mentioned concerns, and its real value and usefulness is now becoming widely known.

Construction and Operation of the Multiple Plunger Press

The multiple plunger press as made today is constructed in various styles and sizes, the number of plungers ranging anywhere from three to eight. The most common type, however, and that most extensively used for the general run of small work, is the one shown in Fig. 1, which is a six-plunger machine. This machine can be used for such operations as blanking, cupping, piercing, forming, embossing, stamping, curling, bending, lettering, perforating, clipping, etc., and in fact almost any light operation that is performed on sheet metal. A sample of its work—a one-piece collar button—is shown in its successive operations in Fig. 2. Of course this machine can be used when only three or more operations are required, by having the remaining plungers run idle; thus it will be agreed that this press has a bright future as regards the manufacture of sheet metal parts.

The machine is driven by tight and loose pulleys, as shown to the left of the illustration Fig. 1, and is back-geared; the ratio of the gearing is 4½ to 1, the larger gear shown guarded to the left being on the upper camshaft. This camshaft *S* is made from a crucible steel forging, while the cams held on it are made of tool steel and hardened. In addition to operating the plungers, this camshaft, through the gearing shown at *G*, operates the roll feed, the reel used for holding the metal being shown at *H*. The upper camshaft *S* also drives, through bevel gears, the vertical crankshaft *I*, which actuates the transfer slide and the lower camshaft S_1.

The plungers *A*, *B*, *C*, *D*, *E*, and *F* are made from tool steel of square section, and work in scraped bearings. The lower ends of the plungers *B*, *C*, *D*, *E*, and *F*, are tapped out to receive the punch-holders, which are threaded into them. The blanking plunger *A* is bored out to receive a tapered split bushing into which the blanking punch is driven. The lower part of this split bushing is made square, so that by turning it around with a wrench it can be removed and the blanking punch driven out. The blanking punch can also be made to fit directly into the plunger, if so desired.

The blanking plunger *A* is set one-half revolution in advance of the other plungers, so that the blank after it is cut is carried by the transfer slide over the first cupping die before the plunger *B* descends. This is accomplished by changing the position of the cam controlling the operation of the blanking plunger on the upper camshaft *S* in relation to the other cams. The plungers are operated by horizontal "lifters" *L*, one lifter being provided for each plunger. These lifters are clamped to round rods *R* located at the rear of the press, and knee pieces connecting these rods to the plungers effect their operation. The usual form of wedge adjustment is provided for increasing the pressure of the plungers, the adjustment being effected by means of wedges which lower or raise the "bumpers" as desired.

The lower camshaft S_1 is provided with five cams *M* as shown, these being split and held to the shaft by screws, so that they may be shifted around on the camshaft to the position desired and then clamped. These cams operate the knock-up plungers into which the ejecting-pins are lightly driven, used in removing the work from the dies. The work is carried from one die to the other by means of a transfer slide actuated by the vertical crankshaft *I*.

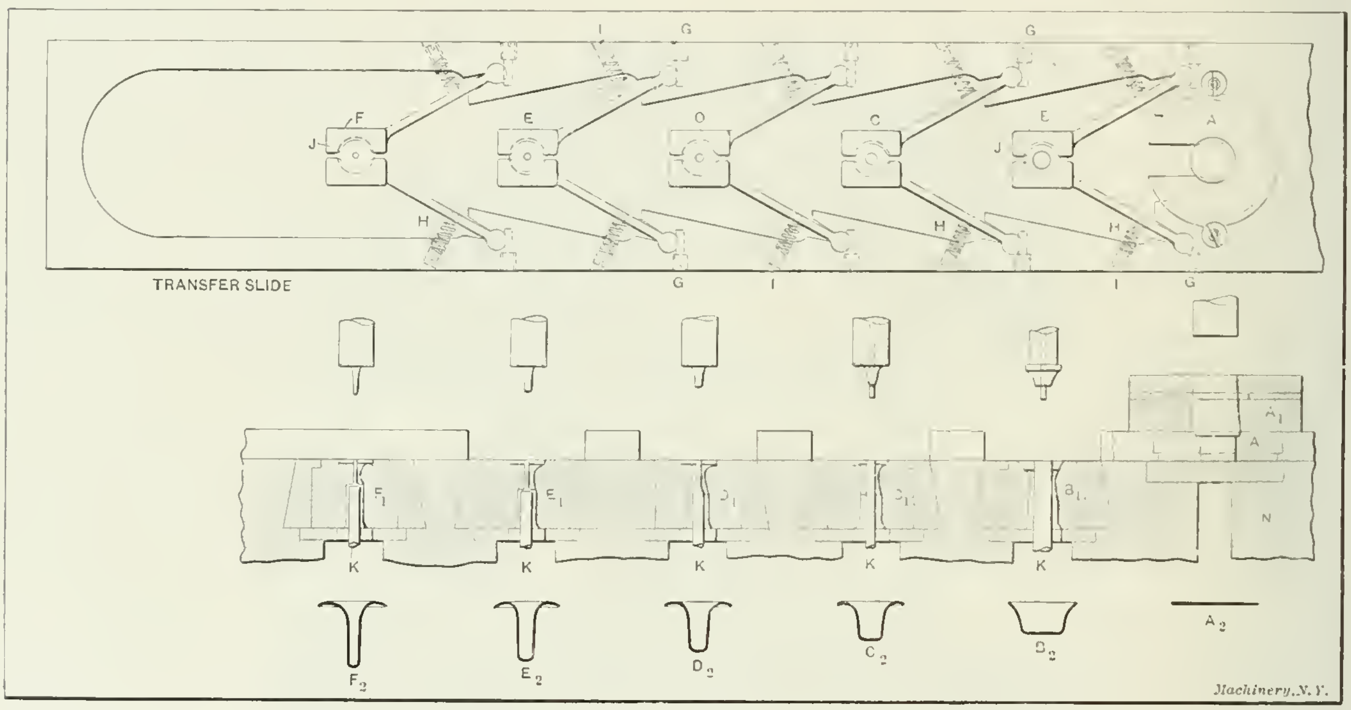


Fig 3. Diagram illustrating the Construction of the Transfer Slide, Ejecting-pins and Dies, and also the Successive Operations shown in Fig. 2

The Transfer Slide and the Auxiliary Mechanism

The transfer slide, or "carrier" as it is sometimes called, is made of tool steel, and is a sliding fit in the die-bed *N*, Fig. 1. This slide holds the fingers, which are used for carrying the work from one die to the other, and also holds the nest or set-edge used in carrying the blank from the plunger *A* to plunger *B*, where the blank is cupped.

A clear idea of the construction of the transfer slide, fingers and dies can be obtained by referring to Fig. 3, where a plan of the slide and a sectional elevation of the dies and punches are shown. The set-edge or nest is shown at *A* with the blank located in it. This nest may be removed and others substituted to suit the shape of the blank. It is cut out as shown, so that it will clear the first cupping punch, when the slide recedes.

The fingers *B*, *C*, *D*, *E*, and *F*, respectively, which are patented, are held in the transfer slide in smooth cylindrical bearings, the ends of the fingers being fitted into these bearings and held in place by screws *G* as shown. Each pair of fingers is actuated by coil springs *H*, which give them the desired tension on the blank, these springs being held in

place by short pins driven into the fingers, and screws I located in the slide. The fingers are rounded at J, so that they will readily open when the slide recedes and the fingers slide past the punches. They are also rounded at the top and bottom as shown in Fig. 4, so that they will swing out of the way when they come in contact with the punch on the down-stroke or with the shell on the up-stroke.

The blanking die A_1 is of rectangular section, and is fastened by cap-screws and dowels (not shown) to the die-bed N, Fig. 3. The stock is placed on the reel H (see Fig. 1) and passes over a lubricating sponge-box, and from there over the top of the blanking die in the usual manner. A pair of ratchet rolls located at the rear of the press and operated by the gears G on the upper camshaft S draws the stock over the die, after which it is wound into compact form on a scrap-reel, also located at the rear of the press. The blanking punch forces the blank, after it has been cut, through the die and locates it in the nest A. After the blanking punch comes out of the nest A, the transfer slide advances, carrying the blank, and locates it over the cupping die B_1, when the punch forces it out of the nest into the die. The blank, after being operated on, is removed from the dies by ejectors K which, in turn, are actuated by the cams M on the lower camshaft S_1 (see Figs. 1 and 5). The ejecting-pins K which are lightly driven into the knock-up plungers, when not

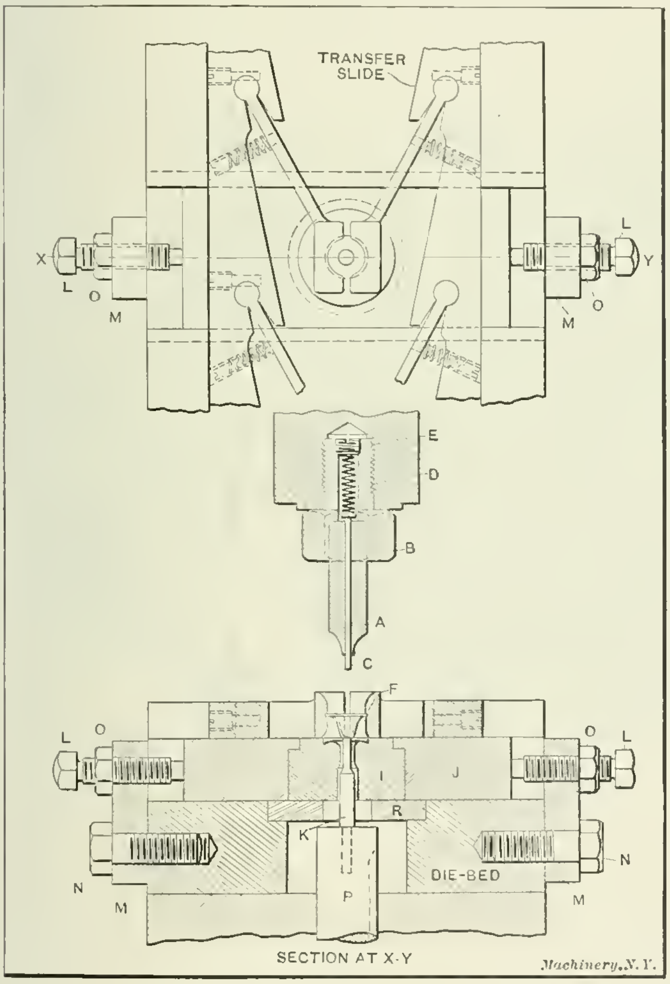


Fig. 4. Illustration showing the Construction of the Punches and Dies used and the Manner in which they are held

being forced down by the punches are retained flush with the top face of the dies, by means of flat springs S_2, which are shown in Fig. 1 and in detail in Fig. 5. These springs fit over bronze plugs B (see Fig. 5), which bear against the knock-up plungers P. The bronze plugs B are provided with a teat T which fits in a slot cut in the plungers, thus preventing them from turning. The springs are held in position by cap-screws, and are provided with elongated holes, which fit over the reduced ends of the bronze plugs. The shape of the knock-up plungers is more clearly shown in this illustration; they are of square section on the lower end, and rounded so that they work freely on the lifting cams M. A hole H is drilled in the top of the plungers into which the ejecting-pins are lightly driven.

Operation of the Transfer Slide

In operation, as the stock is drawn by the feed-rolls over the blanking die, it is blanked, and the blank is forced through the blanking die A_1 into the nest A. When in this position the transfer slide advances, and carries the blank from the die A_1 to the cupping die B_1. Here the slide dwells until the cupping punch descends, and forces the blank through the nest A into the die. The transfer slide now retreats before the punch has ascended out of the die, and for this reason it is necessary to cut out the nest as shown,

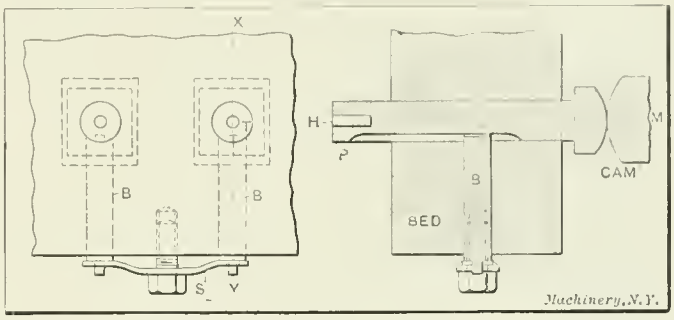


Fig. 5. The Knock-up Plunger and the Method of Operating and Retaining it

so that it will slip by the punch. When necessary, the punch is reduced in diameter just above the working part in order that the nest can slip past it. On the up-stroke of the plunger B (see Fig. 1), the ejecting-pin K, Fig. 3, which is held in the knock-up plunger P, Fig. 5, forces the cup out of the die B_1 into the fingers B; then as the slide again advances the finger B carries the cup to the die C_1, this order of operation being continued in a similar manner until the fingers F carry the finished piece to the last die F_1, after which it is forced out of the fingers and passes out of the chute K (Fig. 1) into a box. It can therefore be seen that the work is at all times under perfect control, the ejecting-pins K and the fingers working in unison.

After the work has been operated upon for the last time by the punch in plunger F, and when the operation is a clipping or redrawing operation, the work readily drops into a box; otherwise, if some other operation is to be performed, the work is ejected by means of compressed air or some other simple ejecting device or fixture. The successive operations on the one-piece collar button are shown directly under the dies for producing them in Fig. 3, the operations being designated by the letters A_2 to F_2, inclusive.

Method Used for Holding the Punches and Dies

As previously stated, the cupping and stripping punches are held in punch-holders, which are screwed into threaded holes in the plungers. This is more clearly shown in Fig. 4, where the punch is shown held in the manner referred to. The punch shown here is the one located in plunger C, Fig. 1, and is used for performing the operation C_2 on the collar button shown in Fig. 3. The punch A (Fig. 4) is made of the desired shape and is driven into the holder B, this holder being provided with an octagon head and threaded on the upper end so that it can be screwed into the plunger. A push-pin C for the punch A, is operated by a coil spring D, which is retained in the holder B by a headless screw E. This push-pin, however, is not used on all of the punches, other types of stripping fixtures being employed. For this class of work, the fingers are shaped as shown at F, so that they hold the cup by the flange alone, not touching the body of the cup at all. This holds the cup effectively, as the ejector-pin K is always in the up-position, except when being forced down by the punch A, thus additionally supporting the cup while in the finger and preventing it from tripping. The manner in which the ejecting-pin K is held in the knock-up plunger P is also clearly shown in this illustration.

The die I is driven into a tool-steel die-holder J, this holder being counterbored as shown, so that the die fits up against the shoulder, preventing it from being drawn out. The die I rests on a hardened tool-steel washer R located in the die-

bed, and which resists the thrust of the punches. The die-holder *J* is fitted in a dovetailed groove formed in the die-bed, and is retained in the desired position by means of set-screws *L* located in blocks *M*, which are held to the die-bed by means of cap-screws *N*. The set-screws *L* are provided with lock-nuts *O*, which lock the screws in the desired position.

Operating the Multiple Plunger Presses

These machines are mostly operated by girls and boys except the larger sizes or eight-plunger machines, which as a rule are operated by men. These machines work so successfully that they require very little attention. Under special observation, the writer has seen these machines run for weeks at a time without requiring any special attention beyond that of oiling, starting in a new coil of metal, and occasionally sharpening and polishing the punches and dies. This fact is well authenticated by the experience of others.

* * *

KNIGHT'S SLIDE-VALVE MOTOR

The poppet type of valve has been universally used in the construction of four-stroke-cycle internal combustion engines, for the inlet and exhaust openings. The high temperature of the burned gases makes the use of ordinary slide valves impracticable on account of the difficulty of providing sufficient lubrication. Poppet valves, being raised directly from their seats, require no lubrication on the bearing surfaces, and therefore may be employed successfully in gases of high temperature. An objection to poppet valves is the impact of the valves on the seats, and the cams, springs and lifters required to actuate them. These parts are likely to be noisy especially at high speeds, and in the development of high-grade automobiles a great deal of attention has been given to the construction of valve mechanism that shall be as nearly noiseless as possible.

Realizing the practical impossibility of eliminating all noise in poppet valves and valve mechanisms, the United States Motor Co., has brought out the Columbia car with the Knight slide-valve motor. This motor is of the four-stroke-cycle type with cylinders, cast in pairs, 4⅞ by 5⅛ inches. Its power by the A. L. A. M. rating, similar to the British "Club" rating, is 38 H. P., but the actual power is said to be 70 H. P. without motor racing, and nearly 85 H. P. when running at the highest attainable speed.

The illustrations show the general features of the construction. The cylinder heads are removable. The heads are depressed and contain two spark plugs for the Bosch double ignition system. The valves for each cylinder consist of two sleeves made of Swedish gray iron. These sleeves are reciprocated to perform the valve function by short connecting-rods attached to a lay crankshaft driven from the main crankshaft at half speed by "Coventry" silent chain.

Both inner and outer sleeves are open at both ends, and each sleeve has openings on two sides. During the suction stroke the right-hand slots of the outer and inner sleeve register, forming a large opening through which the gas charge enters. During the compression stroke the opening is closed by the sleeves moving, one up and the other down, so that the slots are out of register. The compression of the charge being accomplished, it is fired in the usual manner, and the explosion or power stroke takes place. The piston now being at the bottom of the power stroke, the left-hand slots of the sleeve come into register, forming a large exhaust opening through which the spent gases escape.

The advantages claimed for this valve mechanism are that the inlet and exhaust openings are fully twice the size of the gas passages obtainable in the most liberal design of tee-head poppet valve type motor, and nearly three times the size of the gas passages in the ell-head type or valve-in-head motors.

Another feature of general mechanical interest is the lubricating system. This is designed to supply lubrication proportionate to the work being done by the motor, and is a further development of the Columbia "movable dam" system. Four troughs are hinged on a shaft in the lower part of the crank-case. This shaft is connected with the throttle, and when the throttle is opened and closed, the troughs are automatically raised or lowered. When the throttle is opened and the troughs raised, the connecting-rod scoops deep into the troughs and splashes the maximum amount of oil onto the bearings. As the throttle is closed, the amount of oil splash is lessened. Hence when running with the throttle nearly closed, a small amount of oil is used. The economy resulting in the use of lubricating oil is appreciable. A single gallon of lubricating oil has sufficed for 750 miles running and even for as great a distance as 1200 miles. It is claimed that a gallon of lubricating oil is made from two to three times as efficient as with the ordinary type of motor in which it is common practice to set the oil lubrication to meet the most sever tests of hill-climbing and continued high-speed work.

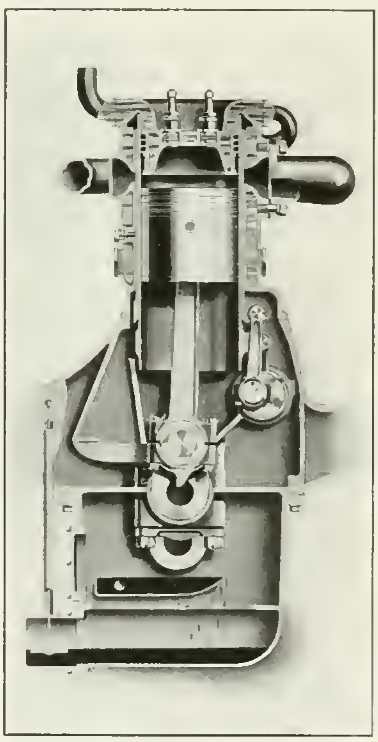


Fig. 1. Cross-section of Knight's Motor

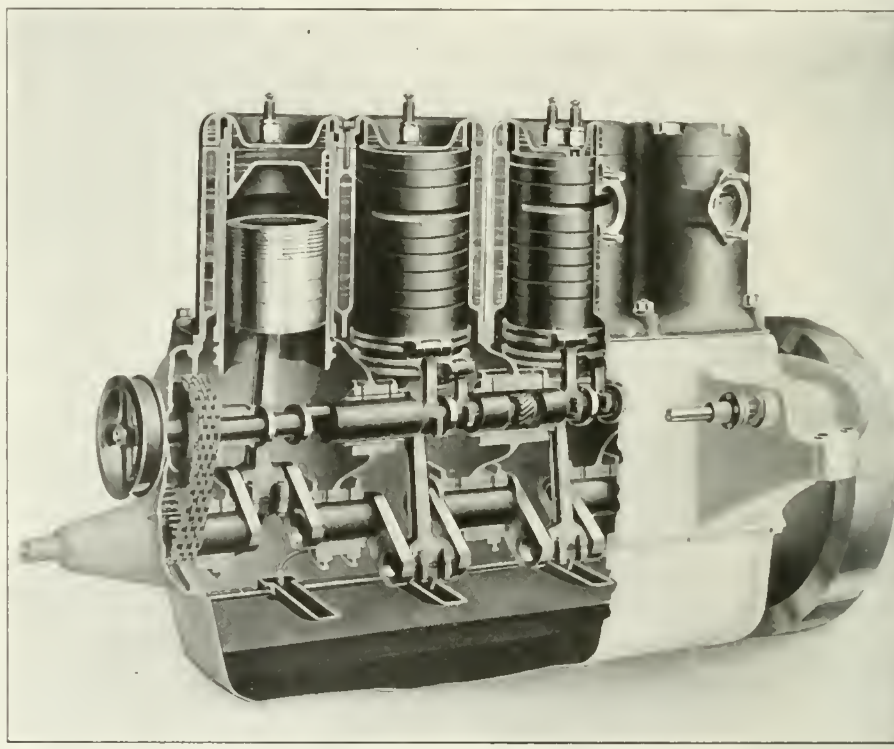


Fig. 2. Knight's Slide-valve Motor, showing Sleeve Valves and Valve-actuating Crankshaft, etc.

* * *

A broken tap is often followed by a broken commandment.

MACHINE SHOP PRACTICE

THE MAKING OF REAMERS—2

By J. C. CUSTER*

Much has been written against the practice of making right-hand reamers with right-hand spiral flutes because they will be "drawn in" by the spiral; that this fear is without foundation in the case of a positive feed, such as used in automatic screw machines, is obvious, but in a chucking machine, where the reaming is done by hand-feed, the chances are that the operator feeds the reamer forward in the same ratio as that which the spiral of the reamer bears to the revolutions of the work. In this case no reaming, in the proper sense, takes place, but simply a grooving action, resembling that to which the barrels of fire-arms are subjected. An end-cutting roughing

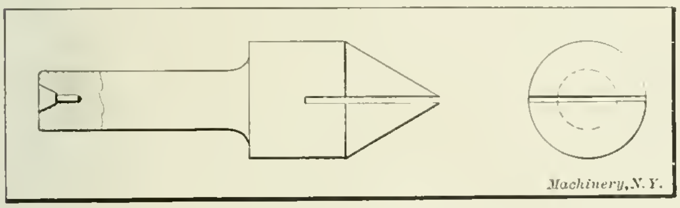


Fig. 4. Polishing Center

reamer, however, cannot be thus fed any more than a four-lipped core-drill. Many such end-cutting reamers with right-hand spiral flutes have been made by the writer, and all give better satisfaction than those with left-hand spiral or straight flutes, as the chips pass out more freely.

Center Reamers

The center reamer has an included angle of 60 degrees and is made in various sizes. The size for general use in the machine shop is commonly made from stock about ½ or ⅝ inch in diameter, and provided with 4 or 5 teeth. The center reamer is more liable to chatter than some other reamers, which is quite troublesome in the case of arbors, etc., where a true center is wanted. A simple and quick way of obtaining a true center is to rough ream it with a four-tooth reamer, and then take a light shaving cut with a five-tooth reamer, using a slow speed. A center reamer for high-class work, such as arbors of which the centers have to be polished after

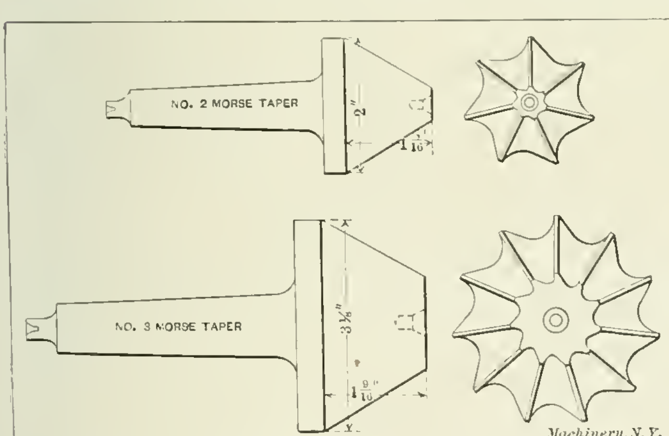


Fig. 5. Bull Center Reamers

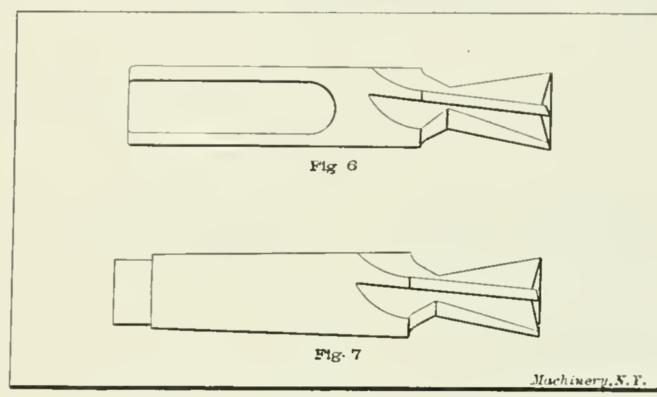
hardening, should be in first-class condition; otherwise the center will present a mass of small ridges. A polishing center is shown in Fig. 4. Two strips of emery-cloth are inserted into the slot, face to face, and then bent around the outside and trimmed off to suit.

For heavy work, requiring larger centers, a reamer with a guide or teat gives good results; this guide is of the same size as the center drill (about 3/16 or 1/4 inch). Such a reamer is steadier in action, and cuts true with the center hole. A center reamer of this style, ¼ by ⅞ inch diameter, should have five or six teeth.

By "center reamer" we generally understand a reamer the teeth of which meet in a point so that very small centers may be reamed, but when large holes—usually cored—must be center-reamed, a large reamer is ordinarily used in which the teeth do not meet in a point. Center reamers for such work are made as shown in Fig. 5 and are called "bull" or "pipe" center reamers. These reamers should not be made for too large a range, as the teeth cannot be of good proportions at both ends of the reamer. When making tools of this type for reaming or chamfering holes from ½ inch to 3 inches in diameter, one reamer should not be made to cover the whole range, but at least two should be provided; the smaller one should be suitable for holes from ½ inch to about 2 inches, and the other for holes from about 1½ inch to 3 inches, the former having 7 and the latter 11 teeth. A bull center reamer should have an odd number of teeth, for it often happens that square holes, such as the blanks for socket wrenches, etc., have to be chamfered, and it can readily be seen that an odd number of teeth will give better results. Bull center reamers used for square holes exclusively should have finer teeth than those for all-around service.

Adjustable Reamers

The best known reamers of this type are those with inserted blades, the blades being held in place by various means. In most cases the blades are dovetailed in their seats. If we were to make reamers with inserted blades for the trade, jigs and fixtures or special machines would be required in order "to make it pay," but as we are not here interested in the manufacture of reamers, but in the methods to use in



Figs. 6 and 7. Cutters with Straight and Tapered Shanks used for Dovetailing the Seats for Adjustable Reamer Blades

case it falls to our lot to be employed in the tool-room of some shop that makes its own small tools, we will not consider special machinery or jigs.

The dovetail for the blade is of an angle of 5 or 10 degrees on the side, and the blades are held in position by a snug fit. Reamers intended for power-reaming are generally supplied with a check-nut, while those for hand use are mostly without that nut. The adjustment for size is provided by milling the seats for the blades tapering towards the front. The bottom of the slots are thus at an angle of about 2½ or 3 degrees with the center line of the reamer. The dovetail, after roughing, is finished with the cutter shown in Fig. 6. Milling cutters are generally supplied with taper shanks, but for this purpose the cutter shown is far better, first, because it is cheaper to make, and second, because a set-screw will hold it firmer than the taper shank cutter can be held in a taper socket. The cutter with the taper shank cannot be driven in firmly enough on account of the slender neck of the cutter.

A cutter for work of this kind must run true, and in order to get it so, we turn the blank in the machine where it is to be used. This is done by holding the blank in an adjustable vertical milling attachment, setting this to an angle of 10 degrees, and then turning, using a lathe tool held in the vise. The tool is fed by means of the raising screw. The shank should have a flat for the set-screw. If we have no vertical attachment, we must hold the cutter blank in the main spindle, the turning being done with a square-nosed tool held in a vise. The vise or saddle is swung to an angle of 10 degrees, and the table-feed used; we may also use a tool ground to an angle of 10 degrees, in which case vise and saddle are left at the zero position.

The cutter for dovetailing should have four teeth cut at an angle of about four or five degrees, but not spiral. This

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is done by holding the blank in the dividing head, and swinging the saddle to an angle of 4 degrees. Then a 90-degree cutter is sunk down to the proper depth of the tooth. The milling cutter, when doing this work, should run in a right-hand direction. The face of the tooth should be radial at the middle of the tooth, and the angle on a right-hand cutter should be right-hand *i. e.*, it should resemble a right-hand spiral. While it is true that the corners of the teeth would have a better backing and consequently would be stronger if the inclination of the teeth were made in a left-hand direction on a right-hand cutter, it would not strengthen the cutter itself, since the weak point in this cutter is at the neck. Furthermore, a right-hand angle on a right-hand tooth will draw the chips up and out, while a left-hand angle will draw them down so that they will clog the cutter. Straight teeth are not to be recommended, because a straight tooth takes a new "bite" all at once, which means a great shock in so slender a cutter, while the angular tooth has a shearing cut. The cutter should have very shallow end teeth; it is backed off with a fine file and then hardened, the neck being drawn to a blue.

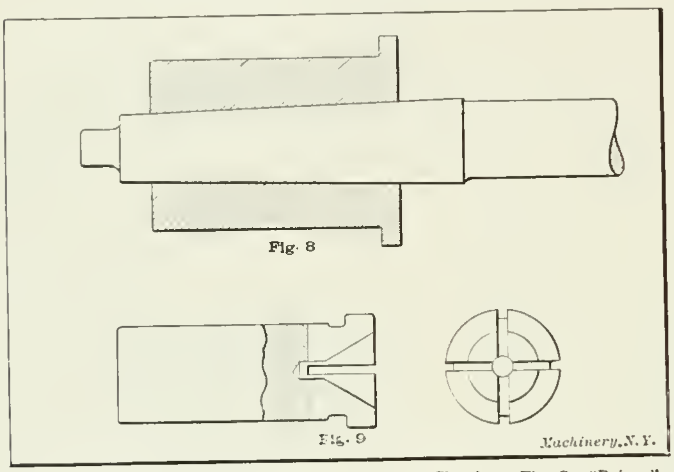


Fig. 8. Bushing for Holding Taper Shanks in a Chuck. Fig. 9. "Driver" for Small Reamers provided with a Square

The adjustable reamer with square seats for the blades is a newer style of reamer which has the advantage that it can be rebladed at smaller cost than the dovetail reamer. A reamer of this kind is made by the Pratt & Whitney Co., of Hartford, Conn. This reamer has previously been described in MACHINERY. (See the July, 1907, number.)

A still newer type, known as the "Mussler" reamer, will soon be put on the market by the Bullard Machine Tool Co. of Bridgeport, Conn. This reamer is very simple for reblading; as the application for a patent for this reamer is in the patent office at the present time, a description can as yet not be given.

Milling Operations on Reamers

We will now return to the one-inch machine or chucking reamer previously mentioned. The first operation is to mill the tang on the shank. During this operation we may hold the work between centers or in a chuck at one end, preferably in the latter, as then the work can be handled with more facility. Right here the young mechanic might be urged to ascertain with how light a grip a chuck will hold the work sufficiently firm for the operation, rather than to ascertain how much abuse is required before the chuck nut or screw either breaks, springs or strips. Tangs may be milled with an end mill, using the up-and-down feed. A better way, however, is to use a small "butt-mill" from the top.

The next operation is the fluting. A bushing fitting the taper shank should be used for holding the reamer in the chuck during this operation. Such a bushing is shown in Fig. 8. The one-inch reamer referred to ought to have eight teeth of a 35-degree angle which, according to the formula previously given, calls for an 80-degree cutter. A cutter for fluting reamers should not have too finely spaced teeth. A pitch of the teeth of ½ inch at the large diameter provides for a cutter which cuts well and does not get clogged up too easily; lard oil sparingly used—just enough to moisten the chips—gives good results as a lubricant. The first flute is only started to locate the face of the tooth; then index (toward the operator) for the next flute, which is cut to a depth so that the land measures about 1/16 inch at the top. This land will be somewhat wider after the reamer is ground to size and backed off. After the first flute is cut, index around and cut the rest of the flutes in the same way.

A straight-fluted reamer—whether it has an even or an odd number of teeth—should have the teeth "staggered," *i. e.*, unevenly spaced to prevent chattering as much as possible. It is immaterial how the teeth are staggered in a reamer with an odd number of teeth, since it cannot be measured directly over the cutting edges anyway, but with an even number of teeth some system should be employed so that at least two teeth are exactly opposite each other for calipering. A simple method of staggering the teeth when fluting an eight-tooth reamer is as follows: Put the locking pin behind the index-plate into the hole stamped with the number of the index circle; then start cutting the first flute, but cut only a slight distance—not to the full depth; now index forward, turning the crank five turns; finally disengage the locking pin, and turn the index-plate back four holes in the 49-hole circle or three holes in the 33-hole circle, and lock again with the pin. In this way we get a tooth space that is less than one-eighth of the circumference. We now cut the second flute to full length and depth. For the third and fourth flute we repeat the procedure, and for the fifth flute we index the five turns forward the same as before, but with the lockpin we index twelve holes in the 49-hole circle forward, which gives us a wider flute between those teeth; this flute is cut deeper, so that the land is of the same width as it is for the other teeth. We then cut again three small flutes, as noted before, and for the ninth flute—which is the first flute started—we must index twelve holes forward, which gives us another wide flute.

A ten-tooth reamer we would cut with three teeth spaced four holes smaller each; then two teeth spaced six holes larger each; and repeat this for the remaining five teeth. By using this method, the teeth become sufficiently staggered, but all teeth are opposite each other, the same as in an evenly spaced reamer. When staggering is effected by this method of compound indexing, we need not keep track in our mind, of the difference in spacing, as a glance at the index plate shows just "where we are at."

Sometimes conditions may be such that we must not reduce the land on the wider teeth by cutting the flutes deeper, because it reduces the strength of the tooth too much. In such a case we cut the flutes all of the same depth, and then the lands of the wider teeth are reduced afterwards by "rolling" the work, or, in other words, by taking a second cut after having moved the wide land up towards the cutter by indexing in such a manner that the land is reduced by the second cut without deepening the flute.

Sometimes the reamer looks best by cutting three teeth four holes larger each and then one tooth twelve holes smaller. This can merely be hinted at here, as the judgment required to properly handle cases of this kind can only be gained by experience.

Staggering the teeth by the method given may meet with the objection that one-half of the reamer is fluted exactly the same as the other half. To this objection the best answer is that close observation and tests covering a period of several years have convinced the writer that such a "stagger" is sufficient for all-around work in the machine shop.

Reamers with Spiral Flutes

The "spiral" reamer is fluted with a double-angle cutter, similar to those used for cutting spiral-tooth milling cutters; the angle of the spiral—more properly helix—should be about 14 or 15 degrees. The writer usually employs a spiral angle of about 14 degrees 34 minutes. This, however, is not because of any advantages that this particular angle has in itself, but simply because the tangent of that angle is a two-place number (0.26), which can be carried in the mind, and saves looking up a table of tangents when calculating leads, etc.

Here we may digress a moment to say a word about calculating spirals, for it is spiral milling work that has special attractions for most apprentices and young mechanics. Mak-

ers of milling machines generally furnish a table with their machines, giving a condensed list of leads, angles of spiral, and the gears required, for diameters most frequently met with in ordinary shop practice. These tables, however, often only give the gearing and the leads, so that a calculation becomes necessary if we want to know the angle of the spiral. The formula for this calculation can be found in the table furnished with the milling machine and is as follows: Let

C = circumference of the work in inches,
L = lead of spiral in inches,
T = tangent of angle of spiral.

Then

$$T = \frac{C}{L}, \text{ and } L = \frac{C}{T}$$

Hence, if we know that the tangent of the angle of a reamer flute should be 0.26, and if we are required to cut a reamer 1½ inch in diameter, then $\frac{1.5 \times 3.14}{0.26} = 18.115$. Now, in a table of leads, find the nearest lead given, which for the Brown & Sharpe machines is 18.181. This lead is used, as it is near enough for all practical purposes. From the table of leads we now find the gears which will give the required lead. We generally place the larger of the driving gears on the screw and the larger of the driven gears on the worm, and the two smaller gears on the intermediate stud; but if the gears do not properly mesh if so placed, transpose them, taking care that a driving gear is not put in place of a driven gear or *vice versa*.

When fluting spiral reamers, the saddle should be swung to the angle of the spiral of the reamer tooth. This is done for all other spiral work with comparatively shallow flutes, but in the case of deep flutes, such as those in a large counterbore with a small guide, the angle to which the saddle should be set must agree with the angle of the spiral nearer the bottom of the flute, otherwise the face of the tooth will be curved along the cutting edge instead of radial and straight. As an additional means to overcome the tendency toward a curved face in such cases, use a cutter with a greater angle on the side that forms the face of the tooth; the other angle, of course, has to be correspondingly less. Note also that a cutter of large diameter is more apt to cut the front edge of a spiral tooth curved than a cutter of small diameter.

The Taper Reamer

The taper pin reamer for hand use is supplied with a square, which is first milled. For fluting, use a taper milling attachment as made by the Brown and Sharpe Mfg. Co., if much of this work is to be done. When such an attachment is not available, proceed as described in the following:

If the shank or unfluted part is long enough, a dog may be used as driver, but as taper reamers are generally fluted close up to the square, it is seldom that a dog can be used. A suitable driver is, however, shown in Fig. 9. The driver is held in the chuck, and the corners of the square on the reamer placed into the slits while the other end is supported by the tailstock center. This driver is better for taper reamers than a dog, even if the shank should be long enough, because the tail of a dog will bind or become loose in the driver of the dividing head while indexing from one tooth to the next, and the actual spacing obtained does not correspond with the indexing. The greater the taper in the reamer, the greater will be the binding effect and the error in the spacing.

For taper pin reamers 4 inches long, ¼ inch in diameter at the small end and having ½ inch taper per foot, the head is dropped the equivalent of about ½ degree. Now mark the location of the face of the first tooth in the manner already described, except that in this case we must mark the entire length. Then, index to the next tooth and take a trial cut, and if necessary, adjust the drop of the dividing head.

* * *

If Jules Verne were alive now and had that vivid imagination of his working, he would probably give us a picture of an aerial machine shop especially designed for making quick repairs on aeroplanes when they have trouble aloft.

AUTOMATIC PISTON-RING PEENING MACHINE*

By J. A. LUTHER†

The pioneer internal combustion engine builders recognized the superiority of the peened piston ring over that of any other make. This peening process, however, was accomplished by hand and was found to be a rather expensive item in the manufacturing of the rings. It also was a poorly executed job, and the lack of good judgment as to the intensity of the blow to be delivered at the various points on the ring resulted in the production of a ring which did not have the desired resilience or tension. Owing to this drawback the peened piston ring was discarded, and the eccentric ring, as shown in Fig. 1, was substituted.

A newly invented automatic peening machine is producing the much desired result, that is, correctly peening a piston ring. This machine not only turns out a correctly peened piston ring, but produces a ring at a cost of from 35 to 45 per cent cheaper than that of any other ring now on the market. This advantage, coupled with the prevailing idea that a peened piston ring is superior to an eccentric ring, has caused considerable stir among some of the engine builders.

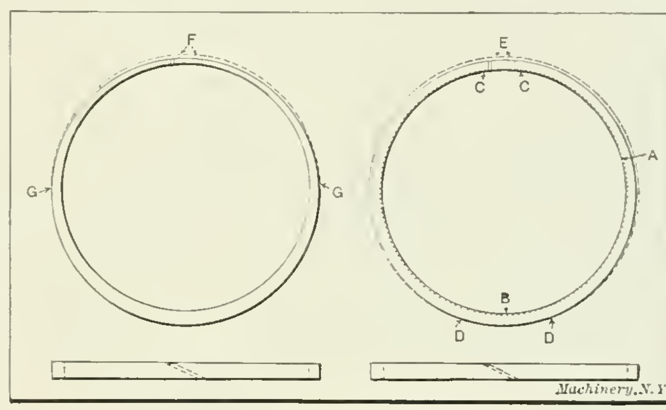


Fig. 1. Eccentric Piston Ring of the Usual Type   Fig. 2. Peened Piston Ring, showing Location of Peening Marks

The Peened Piston Ring

In Fig. 2 is shown a peened piston ring as now made, and it will be seen that instead of being made eccentric, as is the ring shown in Fig. 1, it is concentric and of an equal thickness throughout its entire circumference. The marks A represent those produced by the peening hammer. The heaviest blow is struck at the point B, directly opposite the split in the ring, and the intensity of the blow gradually diminishes from this point on either side, until the points C are reached. The blow struck at the point B is equal to approximately 2250 pounds, and decreases in intensity on either side of this point, so that a blow of only approximately 625 pounds is delivered at the points C. One-hundred blows are delivered to the ring on each side between the points B and C, making a total of 200 blows in all.

The result from this method of peening is claimed to be as shown by the dotted line between the points D and E, which represents a more uniform resilience throughout the ring, thereby insuring the perfect fitting of the ring when in the cylinder, and with decreased friction. In comparison to this, the resilience of the ring shown in Fig. 1 is not so evenly distributed, and is represented by the dotted line from the points G to F; thus it can be seen that the peened piston ring gives a more uniform fit in the cylinder than does the eccentric piston ring.

Construction of the Automatic Piston-ring Peening Machine

A side elevation, and part section of the head of this piston-ring peening machine is shown in Fig. 3. This machine consists mainly of a cast-iron base or frame A which is bored out to receive a ¾ inch driving shaft B, and is turned out in the front end to receive a rotating head C. The front of the machine, which is more clearly shown in Fig. 4, is bored out to receive the revolving head, as shown, which is held in the

* For additional information on this subject see "Automatic Piston-Ring Hammer," August, 1904, engineering edition.
† Address: 120 West 50th St., Bayonne, N. J.

machine by a cap D. The revolving head C carries the piston ring receptacle E, held in position in the revolving head by the key R_1. The piston ring F is held in this receptacle by a clamping ring G, which, in turn, is fastened to a clamping nut H. This clamping nut H is ¾ inch thick and has a 10-pitch thread cut on it. As it would require considerable time to remove and replace this clamping nut, part of the thread is cut away in four places, and the thread in the revolving head C is also cut away to correspond, so that the clamping nut can be slipped in, and by giving it a quarter turn the ring can be tightly clamped.

This machine is driven by a grooved pulley I which, in turn, is driven by a ⅜-inch round belt from a pulley placed under the bench. Normally, the pulley I runs freely on the shaft B, but when the clutch J is engaged, the pulley drives the shaft B. This is accomplished by having the part of the clutch J to the left, slide on a key, while the part of the clutch J to the right is fastened to the pulley and thus rotates with it; therefore, when the machine is to be started, rod K is pulled to the right by means of the knob L, which, through the starting lever M and links N, engages the clutch. A washer O is held on the rod K to limit the travel of the rod. A tension device P is also provided, so that the clutch will not become disengaged until the operator forces it out by pushing on the knob L.

The striking hammer Q is held in a head R, which slides up and down on two vertical square shafts S, screwed into the base. Attached to the head R is a bracket T holding a roller U which runs on the lifting cam V. As shown in Fig. 3, brass strips W, which are 0.007 inch thick, are placed between the two parts of the head R, and are removed when the babbitt bearings in the head become worn. This provision is necessary on account of the continual up and down movement of the head. The two square uprights S are held together by

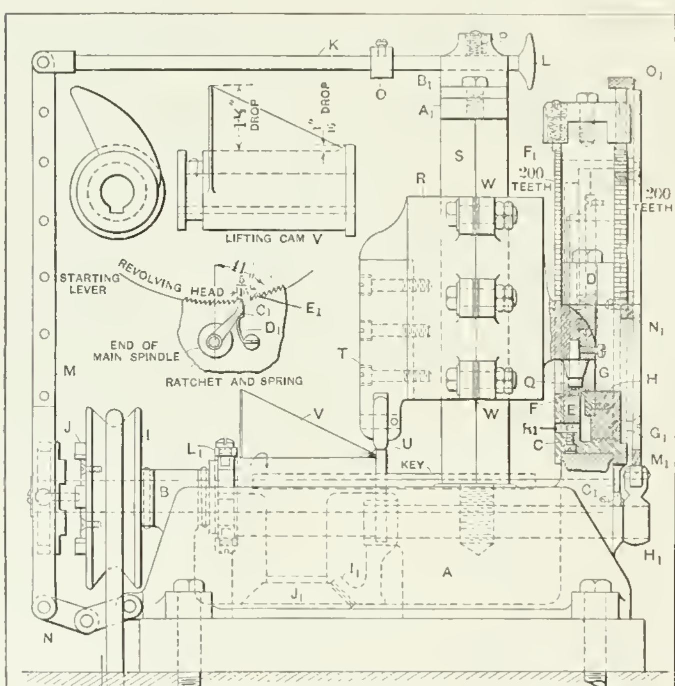


Fig. 3. Side Elevation of Automatic Piston-ring Peening Machine

a strap A_1, on which is held a bracket B_1, bored out to receive the shifter rod K. The clutch J, to which the starting lever is attached, has a groove cut in it, and two shoes attached to the starting lever slide freely in this groove, so that the clutch can easily be moved longitudinally when revolving.

The manner in which this machine is driven is as follows: A pawl C_1 is attached eccentrically to the front end of the driving shaft B, and is retained by a spring D_1. Now, as the clutch is engaged and the pulley drives the shaft B, the ratchet which is attached eccentrically to the shaft is given an oscillating motion, and as ratchet teeth are cut in the rim of the revolving head, the action of this pawl rotates the head. To prevent the head from dropping back, when the ratchet is retreating to come in contact with another tooth, additional ratchet teeth are cut in the rear flange of the revolving head C. A spring plunger F_1 fits in these teeth and prevents the head from retreating or dropping back.

The hammer head R is operated in the following manner: A cam G_1, which is fastened to the revolving head as shown in Fig. 4, operates a lever H_1. This lever is connected to a segment gear I_1 which rotates on a bevel gear J_1. This bevel gear, in turn, has a tapered hole in it, and is driven on a shaft K_1 on the upper end of which is attached a clevis L_1. This clevis has attached to it two shoes which fit in a groove cut in the rear end of the lifting cam V, as is shown in the detailed view in Fig. 3. Now as the clutch J is engaged, the spindle B rotates and, in rotating, drives the revolving head C. As the cam G_1 is attached to this revolving head, it, therefore,

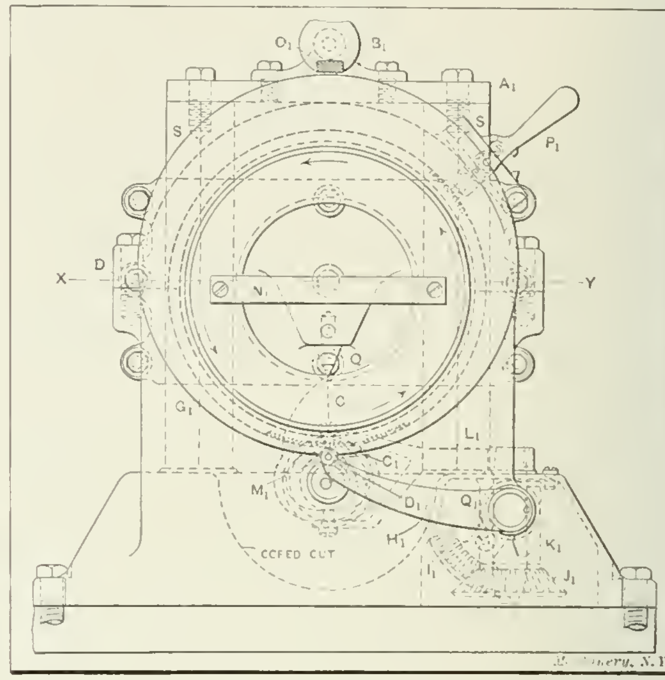


Fig. 4. Front Elevation showing Indexing and Striking Mechanism

rotates with it, and, in rotating, it forces down the lever H_1. This lever, in turn, through the segment gear, bevel gear, and then through the clevis L_1, forces in the lifting cam V, this action raising the hammer head R. As the lifting cam is cut away, as shown in detail in Fig. 3, the hammer head is allowed to drop for each revolution of the cam V, and, in dropping, the hammer makes an indentation in the inside face of the piston ring.

Operation of the Machine

In operation, the cam G_1 is brought into the position shown in Fig. 4, where the roller M_1 drops into the groove cut in the cam. When the cam is in this position, the roller U, held in the bracket T on the hammer head, is placed on the cylindrical part of the lifting cam V, so that the hammer head is not operated upon. The revolving head when in the position shown in Fig. 4 is also not given a rotary motion as four teeth are removed from the ratchet at E_1; therefore the operation of the machine is stopped when the cam comes into the position shown. To place the piston ring in the machine, the clamping nut H is removed by giving it a quarter turn, when it can be pulled out, owing to the threads being cut away in four places. When this clamping nut H is removed, the piston ring is placed in the piston receptacle E with the split in the ring directly under the striking hammer Q. When the piston ring is located properly, the clamping nut H is inserted, and is tightened by means of a wrench or other tightening device, which can be placed on the bar N_1, fastened to the revolving head by screws as shown. When tightening the clamping nut, the locking pin O_1 is inserted in a hole in the ratchet rim to prevent it from rotating.

Now that the piston ring is inserted in the machine, the clutch J is engaged by pulling on the knob L. The spindle B now rotates, but does not operate the machine until the pawl C_1 engages with the teeth in the driving ratchet rim. To bring the revolving head into position, the ratchet lever P_1 is

operated, which forces the head around until the ratchet C_1 comes in contact with the teeth in the ratchet rim. As soon as the ratchet C_1 engages with the teeth in the ratchet rim, the machine commences to operate, and as the cam G_1 is rotated it forces the lever H_1 down which, in turn, as previously mentioned, through the segment gear, bevel gear and clevis, operates the lifting cam V. The lever H_1 is forced down against the tension of the spring Q_1, which keeps roller M_1 in contact with the cam G_1. When the machine starts, for the first tooth, the hammer head is raised to a distance of 1/16 inch, which height increases until the top point of the cam V is reached, when the hammer head is raised to a distance of 1½ inch.

As the piston ring is located in the revolving head with the split in the ring directly under the striking hammer, the lightest blow is, therefore, delivered nearest the split in the ring. The blank space between the points C on the piston ring, shown in Fig. 2, is accomplished by having the four teeth cut out of the driving ratchet rim, so that no blow is delivered between these two points. As the cam G_1 continues rotating, the hammer head is raised to a greater distance for each tooth in the ratchet rim, as the lifting cam V is forced in a little further for each revolution of the driving shaft. This operation continues until the revolving head C has made one-half revolution, which means that the point B of the ring shown in Fig. 2 will be directly under the striking hammer. Here the hammer head is lifted to a distance of 1½ inch, as the roller is now on the highest point of the lifting cam.

Owing to the shape of the cam G_1 shown in Fig. 4, the height to which the hammer head is raised after passing the center, begins to decrease, and keeps on decreasing until the head revolves around into the starting position, as shown in Fig. 4. This means, therefore, that the blow delivered to the ring also decreases as the cam completes the second half of its revolution. The ring is now completed, and as the cam G_1

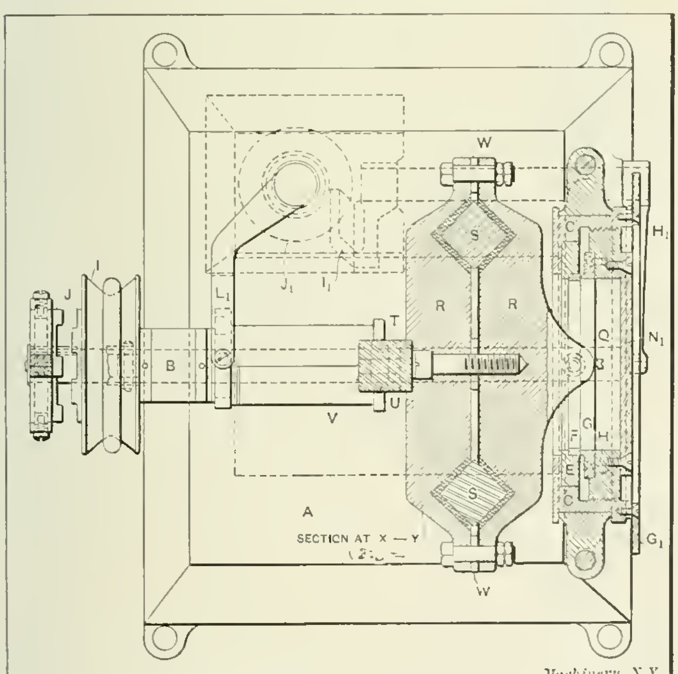


Fig. 5. Plan View and Cross-section at X-Y, Fig. 4

is cut away as shown in Fig. 4 the roller M_1 drops into the depression, which allows the roller U to slide up on the cylindrical part of the lifting cam V, thus discontinuing the movement of the striking hammer.

Calculating the Intensity of the Blow

As the weight of the hammer holder (15 pounds) and the distance through which it falls is known, it is a simple matter, when the penetration of the hammer point in the ring is known, to calculate the force of the blow delivered on the ring. When the roller is at the bottom of the incline of the cam, it falls through a distance of 1/16 inch or 0.0052 feet. The penetration of the hammer point is closely approximated at 0.0015 inch, which = 0.000125 feet; then, neglecting friction, the foot-pounds of work delivered at the face of the ring = 15 × 0.0052 = 0.0780 foot-pounds; dividing the foot-pounds by the penetration of the hammer point in feet will give the intensity of the blow in pounds, thus

$$\frac{0.0780}{0.000125} = 624 \text{ pounds}$$

this being the force of the blow at the points C on the ring.

When the roller is at the top of the incline of the lifting cam, the hammer holder will drop through a distance of 1½ inch, or ⅛ foot; here, again neglecting friction, the foot-pounds of work delivered at the face of the ring = 15 × ⅛ = 1⅞ foot-pound. The penetration of the hammer in the ring at this point is closely approximated at 0.010 inch—0.000833 feet; then the force of the blow at the point B on the ring equals:

$$\frac{1.875}{0.000833} = 2251 \text{ pounds.}$$

The force of the blow delivered between the points B and C on the ring can, of course, be found by calculating in a similar manner, when the penetration of the hammer is known.

Output of the Machine

As this machine is entirely automatic in its operation, except for the insertion of the piston ring, it only requires a boy to run it, and as it takes considerable time to peen a ring, one boy can easily look after two machines. These machines are mounted in couples on an ordinary work bench, and to eliminate vibration as much as possible an iron plate is put under them. The driving pulley is mounted beneath the bench from which a round belt runs up to the driving pulley on the machine, thus doing away with overhead pulleys and belting, thereby allowing free working space around the machines. With the machines running constantly, one machine turns out fifty rings per hour.

* * *

TIN-PLATING METHODS

In the manufacture of household utensils, only pure tin should be used as a plating for ironware. Cast iron contains carbon, and in order to make the tin adhere to it, the surface to be coated must be chemically treated to remove the carbon, or else it must be made absolutely smooth by mechanical means. The carbon may be partially removed by covering the vessel to be plated with oxide of iron or manganese, which develops oxygen when exposed to heat, thus oxidizing the carbon. To accomplish this, the vessels to be plated are placed in cases made of fireproof clay, covered with powdered oxide of iron or manganese, and exposed to an intense heat for a period of from four to six hours. The iron by this time becomes sufficiently decarbonized to admit of the adhesion of the tin.

After this process, the utensils are "pickled" by means of immersing them in a solution of diluted sulphuric acid. In order to prevent the acid eating the iron and to insure that only the layer of oxide is removed, small quantities of ordinary starch sugar, blue vitriol or salt of tin, are added. The vessel is then immediately dipped into melted tin; but if only the inside is to be coated, the metal is poured into it, together with sal ammoniac or chloride of ammonium, which mixture is rubbed quickly over the surface. The cast-iron vessels should preferably be heated before applying the tin, but this must be done very carefully in order to prevent the discoloration of the oxidized metal, which would prevent the adhesion of the tin. After the vessel has been dipped into the melted tin, it is immersed upside down in cold water; the water does not enter into the vessel on account of the air which is confined in it.

Another method is to cover the vessel to be plated by a galvanizing process with pure iron, and then coat it with a solution of zinc chloride, and finally dip the vessel into the melted tin. Bars which are to be galvanized are cleaned in water, dipped in a solution of one part sal ammoniac and sixteen parts of water, and when dried are exposed to heat, after which they are dipped into the melted tin.—*Daily Consular and Trade Reports.*

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DEVICE FOR TESTING BALL-RACES

The accompanying illustration Fig. 1 shows a new and simple device designed by the writer for testing hardened steel surfaces, which has been found very satisfactory for testing ball-races. The shank *A* of the holder is made to fit the spindle of a small single-spindle drill press. A plate or holder, with a clamping device to attach it to the drill press table, holds

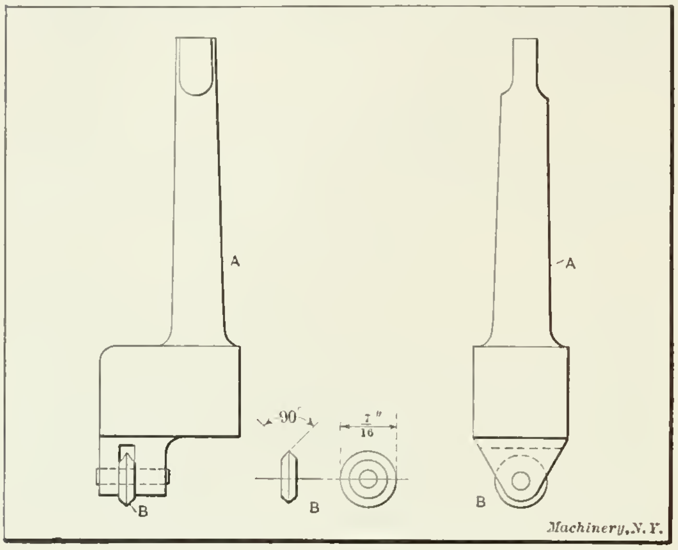


Fig. 1. Device for Testing Hardened Steel Surfaces

the ball-race stationary and concentric with the wheel *B*, which rotates over the same path as the balls, or, in other words, on the same circle as that on which the balls travel; thus this device tests only that surface pressed upon by the balls. It has been found that the roller *B* will not only locate soft spots, but will also show where the thin casehardened spots are by breaking through, which could not be located by filing, and it is doubtful whether the scleroscope would detect these thin spots.

To insure that every ball-race is tested under the same pressure, a special straight handle about 12 inches long is put in the drill press spindle actuating disk, and when the wheel *B*

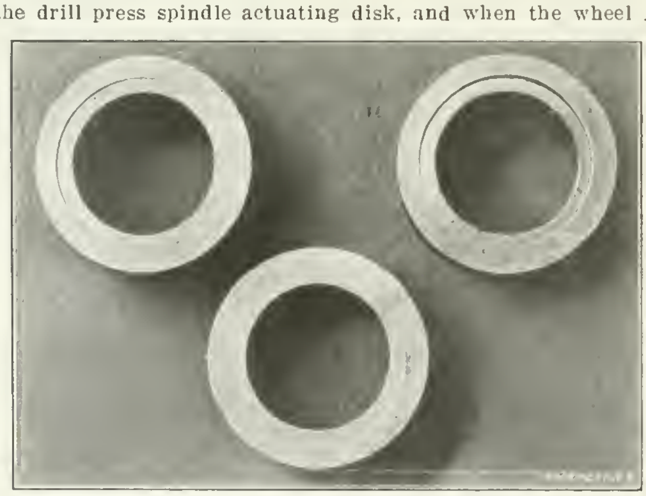


Fig. 2. Flat Ball-races of the Thrust-bearing Type, after Testing. Note Semicircular Impressions formed by the Roller

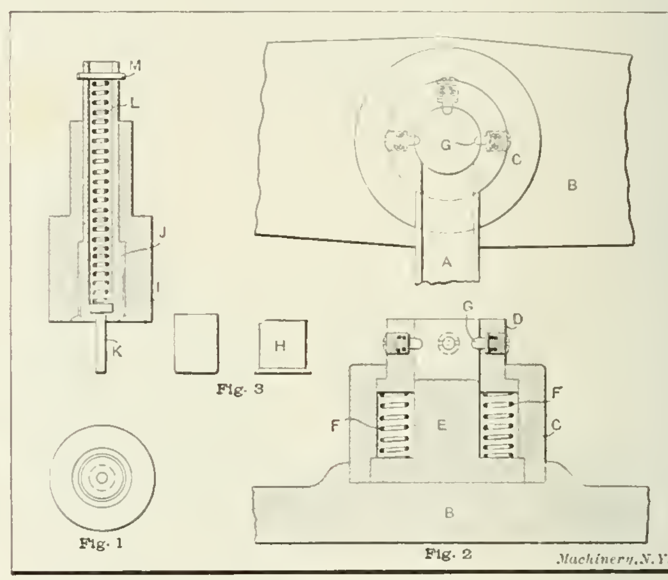
is placed on the race, the handle is adjusted to a horizontal position. On this handle is placed a cylindrical weight, which has a set-screw in it, so that it can be adjusted along the handle, thus giving any desired pressure on the wheel *B*. All sizes of wheels from small glass cutters up to very large cutters were tried out, but were found unsatisfactory, the cutter shown at *B*, Fig. 1, giving the best results. Some of these wheels which the inspector used stood up for over 1100 ball-races.

When using this device, the spindle is run at about 300 R. P. M., and the wheel *B* is allowed to make from ten to fifteen revolutions over the surface of the ball-race. The illustration Fig. 2 shows three flat races of the thrust bearing type for vertical shafts, which have been tested by this device, and it can be seen that the wheel has made semicircular impressions in them. In testing some of the ball-races, very short arc impressions are formed, while in others the impression forms a complete circle. All races that show any defect or break in the surface under this test are rehardened and polished. It is evident that this device will not register the degree of hardness like a scleroscope, but it has been found that if the surface stands up under the wheel, the ball-races will be sufficiently hard to withstand the pressure of the balls.

St. Louis, Mo. WILLIAM G. WINTER

A SHELL-HEADING DIE

The shell-heading die and punch shown in Figs. 1 and 2 were used for heading the shell shown in Fig. 3. This shell is made from tin plate about 0.012 inch thick, and is drawn up in a drawing press in the usual way and then trimmed—that is, the irregular top edge is straightened in an automatic trimmer, thus bringing the shell to the length required. After the shells are trimmed, they are fed into the chute *A*, attached to the die, Fig. 2, and as this die is set up in an inclined



Figs. 1 and 2. The Shell-heading Punch and Die. Fig. 3. The Shell before and after Trimming and Heading

press, the shells slide into the die by the action of gravity. The punch, Fig. 1, then descends and forms the flange, as shown at *H*, Fig. 3.

The die, Fig. 2, consists mainly of a cast-iron bed *B*, counterbored to receive a holder *C*. This holder, as shown, is counterbored so that it forms a seat or stop for the locater *D*. The locater is actuated by coil springs *F*, and is made a sliding fit on the anvil *E* which also is seated in the holder *C*. Three small spring plungers *G*, held in the locater, serve to center the shell properly in the die.

The punch, Fig. 1, consists of an outer sleeve *I*, which is made a good fit in the holder *C*. Sleeve *I* is counterbored to receive a punch *J* which holds a stripper *K*, acted upon by a coil spring *L*, this spring being retained by a pin *M*. The lower face of the sleeve *I* is recessed, as shown, to make a seat for forming the flange, and the punch *J* is reduced to fit the inside diameter of the shell, so that a seat or shoulder is formed on the punch to force the shell down, and in this way form the flange.

In operation, the shells are placed in the chute *A* by the operator, whence they slide down into the die. Here they are located by the spring plungers *G*, when the punch descends, and the spring pin *K* forces them down on the anvil *E*. The shell now rests on the anvil *E*, and on further movement of

the punch, the locater is forced down into the die, and the stripper K forced up into the punch, so that the lower face of the outer sleeve I forces the shell down tightly on the anvil, thus expanding the flange. As the diameter of the shell is considerably less than the diameter of the anvil, the rounded corners do not in any way affect the flanging operation.

Denver, Col. W. J. KIRKMAN

FRESH AIR AND NEW IDEAS FOR DRAFTSMEN

In the April number of MACHINERY, engineering edition, on page 630 appeared a short note which was an extract of a letter asking for suggestions as to a feasible plan for draftsmen changing their places of employment, so that they could get fresh air and new ideas. The following is the manner in which one draftsman (a single man) accomplished this result. Business with a certain Ohio firm was rather slack and the draftsman had an offer to fill a limited engagement in Iowa. He did not decide, however, to accept this offer until firm A agreed to take him back at such time as he had finished the engagement with firm B. He went West, worked almost a year, and by the time he was nearing the end of the engagement, firm A had a request from firm C for the use of a man for a few weeks; so the draftsman came home and is now filling a supply with firm C. If firm A, when he completes his engagement with firm C, is not ready to give him employment, he has another offer to go West and do some work for firm D. Such a plan could be followed by other firms who have good men whom they want to retain, yet must lay off at slack times. This gives the draftsman a chance to "brush up," see the country, and get some fresh air.

Salem, Ohio. H. W. WEISGERBER

PRESS TOOLS FOR MAKING AUTOMOBILE LAMP-GLASS RETAINING RING

The peculiarly shaped ring shown in Fig. 1 is for holding the glass door in position in an automobile headlight used on the Ford automobile. The ring is made from 3/16-inch round bright drawn steel wire, and has alternate inward and outward projecting bulges. The object of the inward

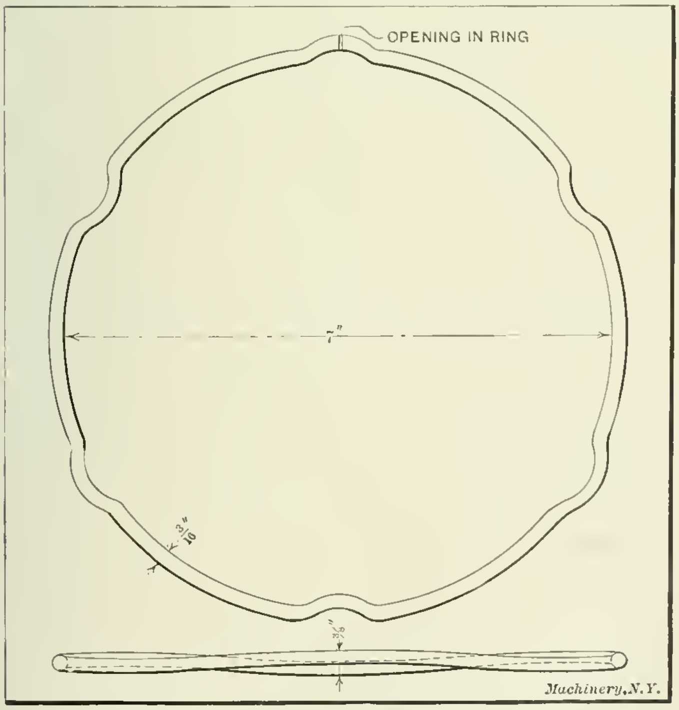


Fig. 1. Retaining Ring for Holding Lamp-glass in the Headlight of a Ford Automobile

projecting bulges is to hold the glass door against its band, while the outward projections snap under the edge of the door rim. In addition to these bulges, the ring is bent as shown in the lower view, being offset about 3/16 inch, so that it will have sufficient resiliency to hold the glass securely.

The rings, before bending, are automatically rolled into circular form and cut off in a spring coiling machine, after which they are placed in the punch and die shown in Fig. 2. This punch and die consists mainly of a cast-iron bolster A, which is drilled and counterbored for the reception of the six hardened tool-steel forming bushings B. The drilled holes in the bolster are made sufficiently large in diameter to allow

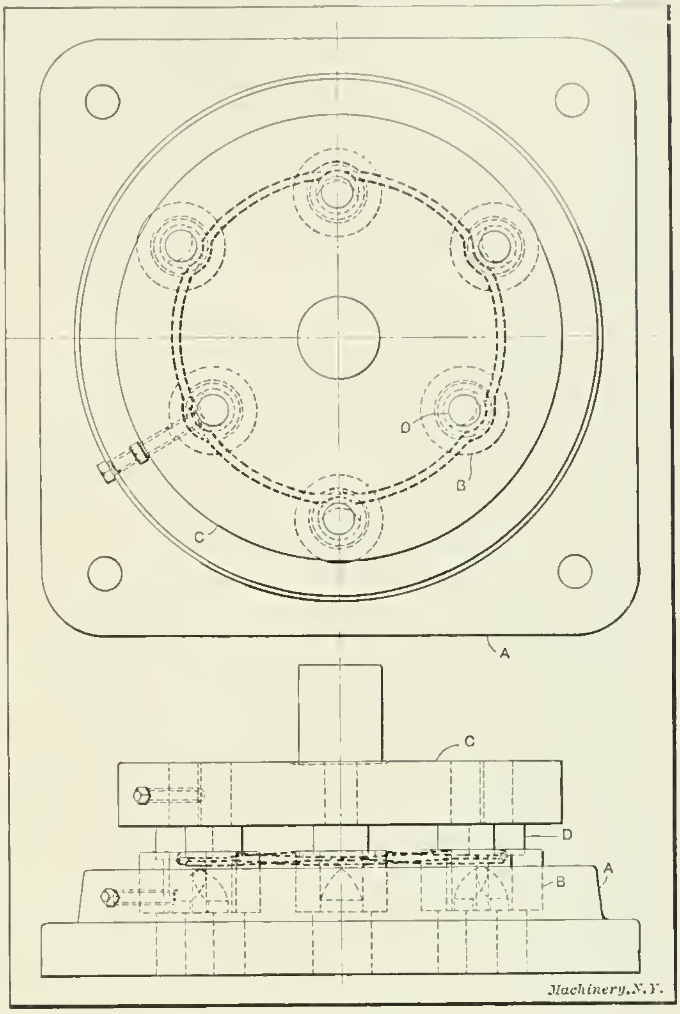


Fig. 2. Assembled View of the Punch and Die for Shaping the Retaining Ring

the bushings to be driven out if necessary. These bushings are drilled and counterbored as shown in Fig. 2, the counterbored shoulder in each alternate one being of a different height, so that they will produce a ring of irregular shape, as shown in Fig. 1. The shape of the punch and forming

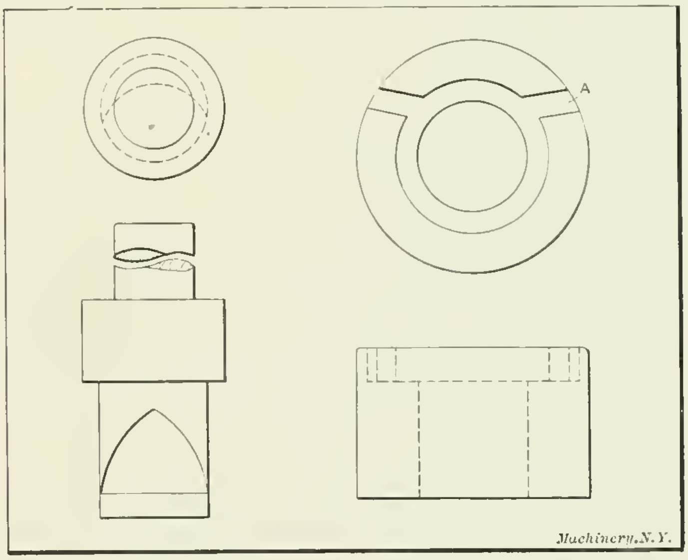


Fig. 3. Detail Views of the Punches and Forming Bushings used

bushings used for shaping this ring are shown in detail in Fig. 3. The slot A is made slightly wider than the diameter of the wire, and is used for "gripping" the wire while it is being bulged.

The punch-holder *C* consists of a cast-iron disk, which is furnished with a shank fitting into the ram of the press. Forming or bulging punches *D* are held in this punch-holder by means of set-screws, as shown. Similar set-screws are provided for holding the forming bushings or dies in bolster *A*.

No stripping device is provided on this die, the finished ring being pried out of the bushings with a screw-driver or similar tool. A stripping device, however, could readily be incorporated by providing a number of vertical sliding pins, operating through the base *A* and distributed around in a circle under the ring being bent. These pins could be actuated either by a rubber pad or by helical springs located beneath the die in the usual manner. Satisfactory results were obtained with this punch and die, and it was found that the bulged portion of the ring was not scored or flattened to any extent during the operation. ARON LAWRENCE

Detroit Mich.

WHAT IS A MACHINE TOOL?

In the January issue, beginning on page 378, engineering edition, Mr. T. S. Bentley gave to the readers of MACHINERY quite an interesting talk on the philological question—What is a Machine Tool? Personally, the writer confesses to having read it after the manner of a school-girl with a novel—backwards. In the conclusion the couple were not happily married which compelled the reading of the entire text in an attempt to learn wherein the trouble lay.

Now for fear Mr. Bentley may suspect this of being one of those non-understandable American jokes, I hasten to explain that in the case of a machine tool, it would seem that the tool and the machine are wedded for life, that this is the secret of the name, and that any machine which holds a tool and performs a machining operation can, with considerable propriety, be called a machine tool.

Now all such general terms are necessarily somewhat vague when we attempt to prescribe exact limits for their proper usage, and there is always room for honest differences of opinion when we approach the borderland; for instance, the definition, properly construed, includes grinding machines, while it might seem preferable to classify such specifically. Punching, shearing, riveting, pressing, flanging, bending, rolling, straightening, forging, burnishing, chipping, hammering, hardening, annealing, tempering or molding machinery would be eliminated by such a definition, and properly so. Woodworking machinery and cutting-off machines it would seem preferable to specifically classify as such, although, broadly speaking, they are included by the definition and there should be no doubt whatever about the manufacturers of these classes of machinery being entirely eligible to membership in any association of machine tool builders. For that matter, why should not manufacturers of files, hacksaw blades or machine screws be equally as welcome in such associations as the builders of the old reliable engine lathe?

The reason a punching machine is not a machine tool is because the surface of the hole it produces is not a machined surface. In the case of broaching, the operation is allied to slotting—a finished or machined surface is produced and the broaching machine would therefore be classified as a machine tool by the proposed definition. Now, given a machine so designed as to be capable of broaching but used exclusively for punching rough holes, and we have in potentiality a machine tool, but by use a punching machine. This machine is then a machine tool to its builders, but a punch to this particular user. So, also, if a foundryman buys an antiquated lathe for scrap iron, and then rigs up a barrel between the centers for rattling castings, he has a rumbler, not a machine tool.

Location has no bearing on the subject *i. e.* all machines in a machine shop are not machine tools; take for example, a wheel press. In the plate shop we have plate planing, plate scarfing and countersinking machines, which are properly classified as machine tools, side by side with bulldozers and flangers which are not.

The borderland, the place where the line of demarcation is not so clearly drawn, seems to the writer to lie in such machines as "the Lovekin pipe beading machine", thread rolling machines, or machines designed exclusively for knurling. Now a machined surface is not necessarily a smooth surface, it may be checkered or otherwise, and the writer would consider a knurling machine a machine tool, but of a special variety. The pipe beading and thread rolling machines possess many of the earmarks of the true machine tool, but the work they produce cannot properly be said to be machined in the sense of being cut into or abraded, but is rolled, kneaded or otherwise caused to flow by the action of pressure. They are, therefore, not true machine tools, although the addition of a device for chamfering the end of the screw or machining the beaded end of the pipe would suffice to place them in that category. The apprentice boy who rigged up a device for holding keys so he could grind the ends to a true circular form, transformed that emery wheel into a machine tool.

The suggested definition could be made more specific by enumerating the classes of operations, thus: A machine tool is a machine holding a tool and performing such machining operations as turning, boring, drilling, facing, milling, planing, slotting, shaping or grinding. Such a definition would not include an ordinary grindstone or emery wheel, but would embrace all tool grinding machines which hold and shape the tool; it would eliminate from the machine tool classification such machines as power hacksaws, and cold saw cutting-off machines, since their performance cannot properly be called a machining operation, but would include a power-driven file or hand miller; it makes no distinction between those machines designed for the production of a specific part and those having a wide range of activity, its only requirement being that of a tool held and an operation performed which can be properly termed a machining operation. The bench-hand who falls from the high estate of man to that of a mere machine is a machine tool.

Philadelphia, Pa. JOHN S. MYERS

TAPS AND TAPPING

The contribution under the above title, by "A" in June MACHINERY, beginning on page 778, engineering edition, criticizes the accepted method of making taps, and advances a new theory, with the object of producing better threads. The article deals both with square thread taps and taps of the usual form of thread, and both alleged improvements are based upon a fallacy and an almost complete misconception of actual tap action, as will be shown.

Before any attempt had been made by "A" to improve ordinary taps, he should have tried to understand the basic principles of thread cutting as done in the usual way, by a single point tool in a lathe, the travel of the tool being controlled by mechanism. The travel of the tool along the thread is positively controlled, and yet it is a common experience to produce rough and poor threads. This is due, as has often been explained, to the threading tool cutting on two sides, the material removed being wedged together and being unable to escape from the confined space between the threads. This is just the action of the proposed V-form taps.

The two methods of overcoming this defect consist in cutting threads by tools that cut on one side only, either by feeding in the tool at the same angle as one side of the thread or threading with a special device which cuts the thread the full width at the top first and gradually deepens the thread by successive cuts, by end action only.

Now, the ordinary tap works in the latter way and should produce, therefore, the better work, as against the alleged improvement of the method suggested by "A."

Then as to the action of "A's" taper tap. It is an accepted fact that taper taps, unless properly relieved in the thread, work with great difficulty, as explained in former articles in MACHINERY (March and April, 1908). In the proposed tap there is no mention of any relief. It would start easily enough, but as it enters the hole, the turning effort will have to be increased, as the unrelieved portions of the tap are wedged into the hole, with the result that the tap will be broken. The ordinary form of machine screw tap has not the strength of body of a pipe tap and will not stand the extra friction of the taper portion proposed. In fact, as toolmakers having any experience with tap-making know, a taper tap blank gives

the hardest cutting tap, and good taps are made the same as good reamers, tapered slightly backwards, so as to minimize the pressure and friction on the sides of the tap.

It may be conceded that a tap made on "A's" principle might work fairly well on the first or second hole, but for reasons apparent to practical men, it would soon be out of business as a cutting tool.

The lack of "taking-hold power" in the ordinary tap is not its greatest defect, and it is understood that pressure is needed to make any tool cut, a tap not needing more than other tools in proportion to area of cut.

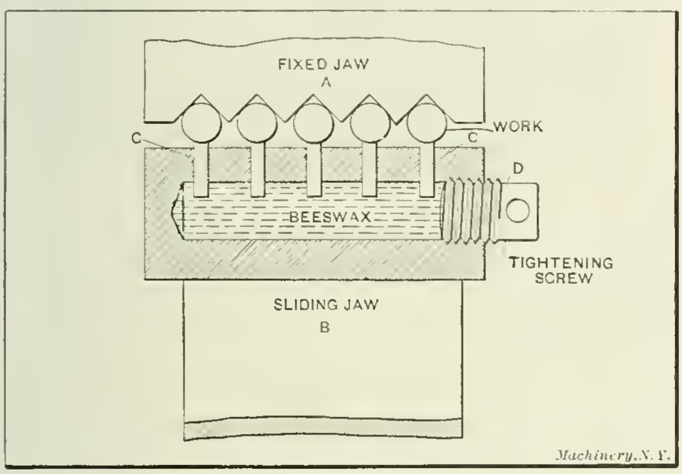
As to the square threaded taps of "A," their superiority is very doubtful; the second and third taps will very likely refuse to follow the former cuts and will thus produce worse ridges than the ordinary kind is presumed to cause.

New York ALEXANDER BLIDEN

VISE JAW FOR HOLDING ROUND PIECES WHILE SLOTTING

The vise jaw shown in the accompanying illustration is of an excellent but unusual form, and is intended for holding round pieces for such light operations as slotting the ends, where the work is likely to vary slightly in diameter.

The face of the fixed jaw A is provided with V-shaped recesses for holding the work. A hole is drilled in the other



Vise Jaw for Holding Round Pieces in which the Clamping Pins are operated upon by Beeswax

jaw B as shown, and the space filled with beeswax. Plungers C project from the jaw, and when the screw D is tightened, these plungers engage the work, being forced out by the beeswax. This insures all of the pieces being gripped in the jaw, which would not be the case were the jaw to have a straight face of the usual form. DESIGNER

PLANING A LARGE FLYWHEEL

A certain works in Russia, which the writer visited recently, had received an order for four flywheels from a foreign firm that was sending engines into the country. The wheels were 16 feet in diameter, and on account of their size and weight

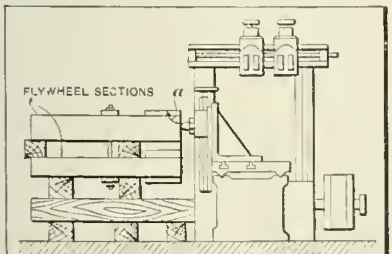


Fig. 1. Elevation of Device for Planing Flywheel Segments

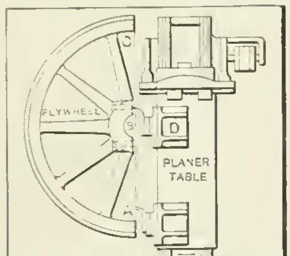


Fig. 2. Plan View of the Method adopted

it was necessary to cast each wheel in two sections and plane the joint to fit. Of course, no planing machine in the shop was big enough for this class of work, and, as an open side planer was unknown, the Russians, who were not to be stuck, adopted the following method of overcoming the difficulty.

A bed of timber was prepared at the side of the largest planer, which had a table about 14 feet long. On this the halves of the flywheel were placed, one on top of the other, separated by three cast-iron distance pieces. The whole was then bolted together to make a steady job. As shown in Figs. 1 and 2, two toolposts were fastened to big cast-iron brackets, bolted on the table of the planer. The machine was then put in operation, and the surfaces A and B finished simultaneously. When that was done, the toolpost D was removed, the table moved back to the proper position, and D fixed in a convenient position for finishing surface C. All measurements for A and C were made between the side of the table and the wheel. The surfaces at B were made 1-32 inch lower in order that the bolts might clamp the hub more tightly onto the shaft. When turning the wheel in the lathe, narrow strips 1-16 inch thick were fixed between the halves in this space to keep it together.

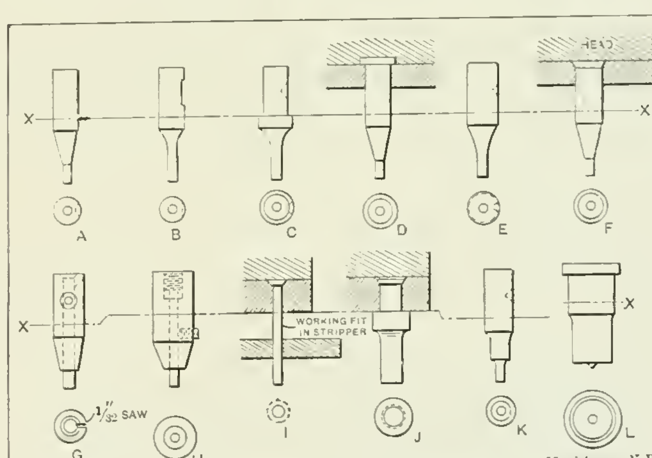
It may seem difficult to make angle a exactly 90 degrees, but, as the manager explained, it does not matter what the angle is as long as the halves for the same wheel are planed together. A little consideration will prove the truth of this; a reversal of the planed face will make them fit perfectly.

Penn, Wolverhampton, England. A. WIND

A COLLECTION OF PIERCING PUNCHES USED IN DIE MAKING

In the designing of punches and dies there arises the question of what kind of punch to use and how it shall be fastened. This depends upon the character of the die, and the purpose for which it is to be used, as well as the ideas of the designer or die-maker. The accompanying illustration shows a few styles of piercing punches, from a combination of which a number of other forms can be evolved.

The punches shown at A, B and K are simple forms, can be cheaply made and easily replaced when broken. Punch E has a taper shank, and while more difficult to make than the



Various Types of Piercing Punches

straight shank it has the advantage that it can be fitted more closely in the punch-holder, and will therefore not become loose. When made in quantities, it can be cheaply produced. The punch C is sometimes used where it is desirable to have the punch seat on the face of the punch-holder instead of in the bottom of the hole into which it is driven. This punch is more expensive to make than the straight punch, and is especially hard to repair should the hole become worn. This would make it necessary to peen the punch, so as to make it fit more tightly, which is not a desirable condition.

Punches D, F, I and J are used when it is desired to fasten all the punches to a soft-steel back plate, which is screwed to the punch-holder. This method is desirable when a large number of punches are to be brought close together, or where it is necessary to detach them from the head without disturbing their alignment. The punches shown at G and H are what are called "quill" punches, and are used where a large amount of stock is to be pierced, or where the stock is thick in proportion to the diameter of the punch. As drawn wire is tougher than a punch turned down from larger stock, these

punches stand up where the latter would fail. The only expensive part about them is the making of the quills. L is a plate punch, and is used for punching large holes in "center-pierced" plates or flat stock. The line X-X in the illustration represents the face of the punch-holders. From this line to the back of the punches should be 1 inch for ordinary conditions, except for I and J, which should be ½ to ¾ inch, depending on the size of the die.

Buffalo, N. Y. ARTHUR F. KUNZE

SIZE OF PIPES FOR A DUST-COLLECTING SYSTEM

In the March number of MACHINERY, page 568, engineering edition, Brown & Sharpe Mfg. Co., gave a reply regarding the size of fan required for an exhaust system, which does not agree with my experience. The Sturtevant No. 00 "Monogram" exhaust fan is much too small for the purpose mentioned in the inquiry, and is constructed for much greater pressure differences than should be used in dust-collecting systems.

If the fan is to blow the dust out into the air directly, without using a separator, a pressure difference of 3 inches water column gage should be sufficient; hence the fan ought to be constructed for low-pressure work, not requiring more than 4 inches water column difference of pressure.

As regards the size of inlet, the internal diameter should be at least 5½ inches, because the surface grinder and the cutter grinder each require a 2½- to 3-inch diameter pipe, and the emery stand requires two pipes of 3 inches diameter. The outlet should be at least as large as the inlet, and consequently, the section of the fan's inlet should be about one hundred per cent larger than recommended by B. & S. Mfg. Co.

If the branch pipes from the different machines are of about the same length, and can be drawn together into the main pipe at short distances from each other, it is a matter of indifference where the fan is placed. Of course, the main pipe should be of such size that in each part its section is just as large as the sum of the sections of those branch pipes which are drawn together in or before that point. The branch pipes should join the main pipe at an angle of 5 to 10 degrees; if joined at an angle of 45 degrees the loss of pressure is excessive. The radius of the curved bends ought to be from four to five times the diameter of the pipe. IVAR SJOBLOM

Malmo, Sweden.

BACKING-OFF A LEFT-HAND TAP

The accompanying illustrations, Figs. 1 and 2, show a unique application of a backing-off attachment to a 16-inch Le Blond lathe, for relieving left-hand taps. In backing off left-hand taps, it is customary to allow about two inches of extra stock

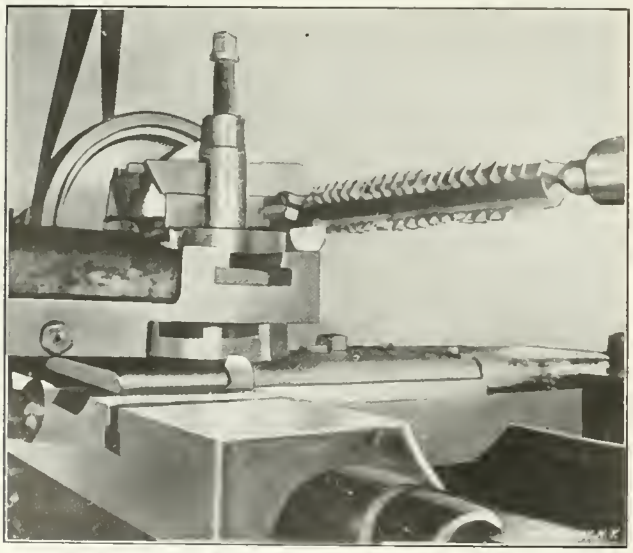


Fig. 1. Compound Rest set to back-off a Left-hand Acme Tap

on the threaded part of the tap on which to secure the dog, the threaded end being next to the headstock and the tap being threaded from the headstock back. This method resulted in loss of time and waste of metal.

About a year ago the simple method described in the following, was introduced by the writer, and from repeated use he can heartily indorse it. It has been used quite successfully on cutters as well, but more especially on taps and hobs which our firm manufactures in large numbers.

Fig. 1 shows an Armstrong tool-holder set upside down in the toolpost, the tool being blocked up to the height of the lathe center. The compound rest is set at an angle of 14½ degrees for Acme taps, the tool being set to the face of the tap with a gage. Fig. 2 shows more clearly what changes were made in order to accomplish the desired result. The re-

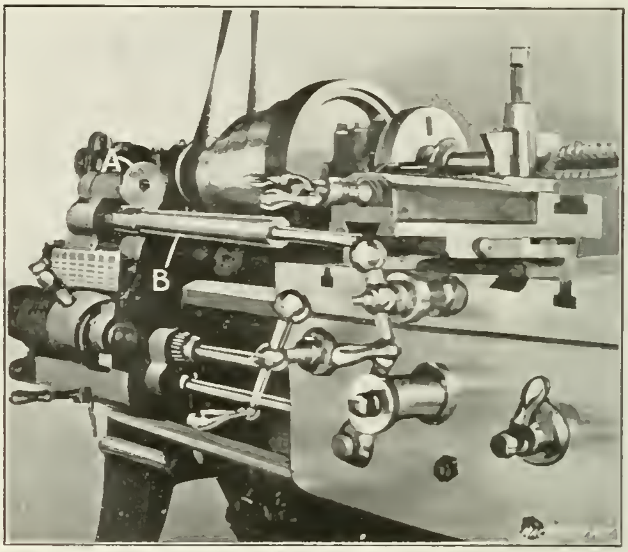


Fig. 2. Arrangement of Relieving Cam for Backing-off Tap

lieving cam A, which operates on a lever attached to the telescopic shaft B, is reversed in position, the lobes usually being in the opposite direction. The belt is crossed so as to give a reverse direction to the arbor. This reverse direction of the belt and reverse direction of the relieving cam combine to give the original forward relieving action of the cam.

It might be of interest to note that the tool used is ground at a half angle to 29 degrees, or, in other words, only one side of the tool is used. One side of the thread is cleared, and when this is completed the tool is replaced with another and the other side of the thread cleared. The tap operated on is first chased, then the flutes are milled, and lastly they are relieved, insuring the correct timing of the stroke and thereby a perfect tap.

Covington, Ky. FRANK LANO

BENDING SHEET METAL

In the May number of MACHINERY, engineering edition, Mr. K. George Selander presents tables and formulas for ascertaining the length of a blank of sheet steel which is to be bent, making the necessary allowances for the bends. This article was particularly interesting to the writer, because the results exactly agree with those he has obtained by the use of a formula which is much more simple and easily remembered, no tables being necessary. The formula for making bends in V-dies is as follows:

$$L = l + \frac{n\,t}{3}$$

in which

L = length of blank required,
l = sum of inside dimensions of bent piece,
n = number of bends,
t = thickness of stock in inches.

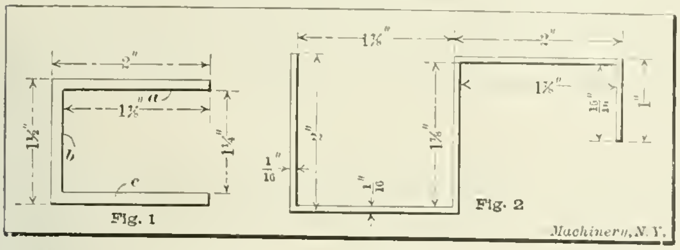
For a piece made from ⅛-inch stock with two bends and with the outside dimensions as given in Fig. 1, according to Mr. Selander the blank should be 5.0833 inches long. When obtaining the length of the same blank by the formula given above, in which the sum of the inside dimensions a, b and c equals 5 inches, the length of the blank is:

$$L = 5 + \frac{2 \times 0.125}{3} = 5.0833 \text{ inches,}$$

which corresponds with the former result. Expressed as a

rule, the length of the blank is found by adding one-third of the thickness of the stock for each bend, to the sum of the inside lengths.

It might be interesting to know that the formula given by Mr. Selander for rolled bends is equal to adding two-thirds of the thickness of the stock for each bend, to the sum of the inside lengths. Referring to Fig. 2, the sum of the outside dimensions equals 9 inches. If the stock is 0.0625 inch



Figs. 1 and 2. Diagrams used in Calculating the Length of the Blank Required when bending Sheet Metal in V-dies and Rolls respectively

thick, and if there are four bends, according to the table in the article referred to, 0.3333 inch should be subtracted from the sum of the outside dimensions, giving 8.6667 as the result. By obtaining the length of the blank with the formula given above, and adding the inside dimensions, which equals $8\frac{1}{2}$ inches, we get:

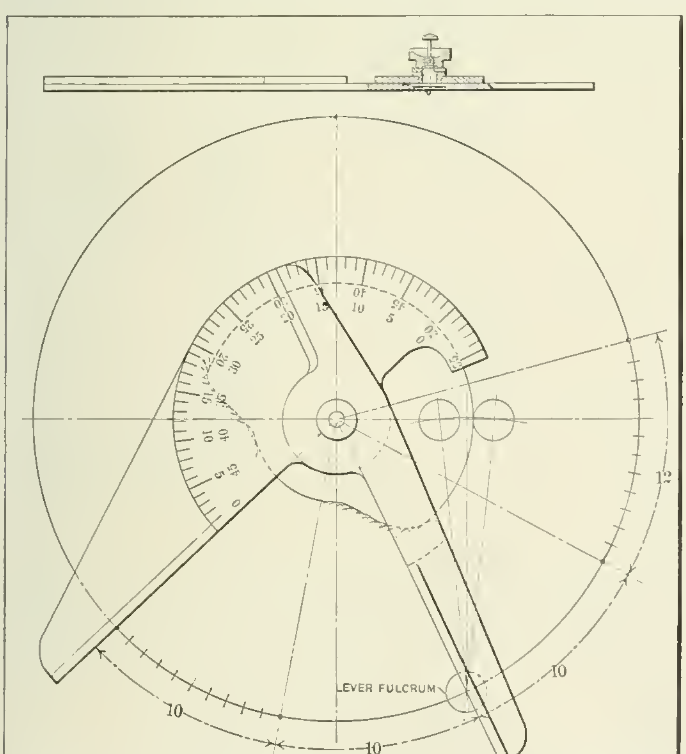
$$8\frac{1}{2} + \frac{4 \times 0.0625 \times 2}{3} = 8.6667,$$

which agrees with the former result. E. J. G. Phillips

Aurora, Ill.

A DEVICE FOR LAYING OUT CAMS

The accompanying illustration shows a device which has been found by the writer to be useful for laying out cams when it is necessary to divide the circumference into hundredths of the cam surface. Before this device was made, it was necessary when laying out cams to convert the hundredths of the cam surface into degrees, and then lay out the



A Simple Device for Laying out Cams

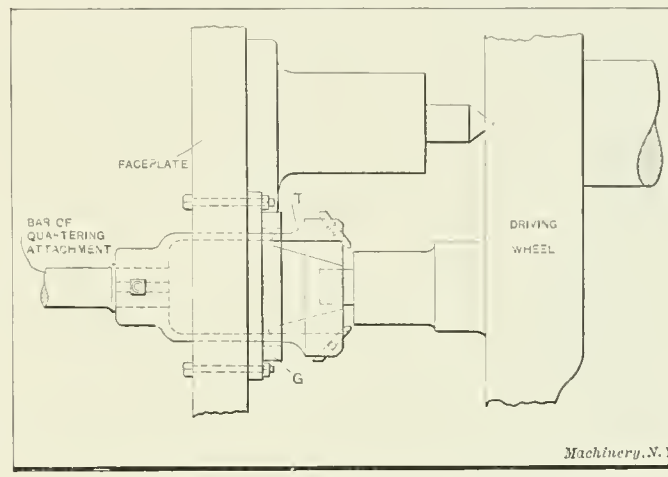
graduations with an ordinary draftsman's protractor. This method is unreliable in most cases, especially when the hundredths converted into degrees give a fraction of a degree, which is very difficult to lay out, and practically impossible to do with an ordinary draftsman's protractor. Then, again, any error of setting is multiplied when transferring the division from the center of the cam to the lever fulcrum circle, as would be the case for instance when laying out cams for the Brown & Sharpe automatic screw machines.

This device is made complete before the graduations are marked on it, which are transferred from a large circle that has been carefully divided, thus minimizing any errors in the marking off. The circumference of this device is graduated in hundredths of a circle, so that it is not necessary to convert the markings into degrees to lay out the divisions on the cam circumference. Alfred Laurens

Manchester, England.

ATTACHMENT FOR TRUING CRANKPINS IN THE WHEEL LATHE

A simple device that can be used in conjunction with the wheel-lathe quartering attachment for truing worn crankpins is shown in the accompanying sketch. This device does accurate work, and the worn pins can be trued without changing the "quartering" or angular distance between them. It consists principally of two parts, namely, the tool-holder *T*, which is fitted to the quartering bar, and a rest or guide *G*, bolted to the faceplate as shown. The tool-holder is made of



Application of Crankpin Turning Attachment to Wheel Lathe

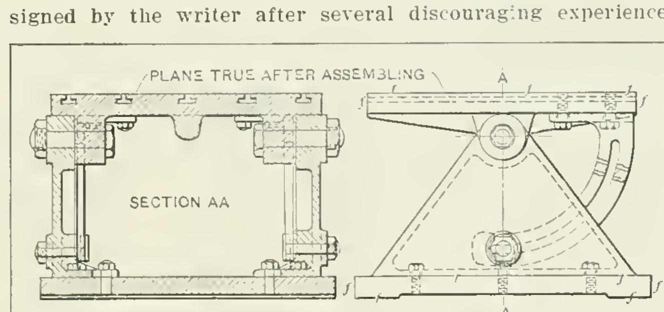
cast steel and contains two cutters located on opposite sides. The guide plate *G* is made of cast iron and has a brass lining or bearing for the cutter head.

In using this attachment, the driving wheels are placed between the lathe centers, and the crankpin to be turned is located by the bar of the quartering attachment on the opposite side, assuming that the lathe has a double quartering attachment. The bar of this opposite attachment is provided with a center which enters the center of the pin. The toolhead *T* is then attached to the bar to be used for turning, which is set to the required radius or stroke, and the tools are fed across the pin, which is finished round and to the correct angular distance from the pin on the opposite side of the wheel. August Meitz

Grand Rapids, Mich.

A UNIVERSAL ANGLE PLATE

The angle plate shown in the accompanying view was designed by the writer after several discouraging experiences



Universal Angle Plate

with various types of adjustable angle plates. This one has a range of from 0 to 90 degrees. The base is a cast-iron plate, 12 inches square, finished all over, with a clearance space

planed on the under side, so that burrs on the drill press table will not interfere with a level setting. The upright side pieces are of cast iron, triangular in form, and 10 inches in height, with the inner edges ribbed. The height should not be less than this, to allow the slotted arc sufficient radius to support the top plate, on which the work is clamped by means of T-slots, as shown in the sectional view. The heavy center rib, shown transversing the under side of the top plate, prevents spring caused by clamping or feed pressure.

The lower bolt in the slotted arc should act as a stop for the horizontal position of the table, bringing the table level, or at 0 degrees. When first assembled, and in this position, the top plate is planed, so that it may be absolutely true. Work should always be secured to the table when the latter is in a horizontal position, after which it may be set to the angle desired by means of a protractor.

One universal angle plate is sufficient for six upright drill presses, and with proper care it will last indefinitely.

CHIPS

LINING UP SHAFTING

In the June, 1909, issue of MACHINERY there is a description of a method of lining up shafting by the use of an architect's level and leveling targets; but the writer has found that the average manufacturer hesitates to buy such equipment and trust it to the abuses to which tools are frequently subjected in the shop. The same results may be successfully accomplished by less expensive tools which may be carried in an ordinary tool chest. The object of this article is to describe such a set.

Although a shaft may have been aligned when erected, it does not follow that the alignment will always remain true. The building may have settled, new equipment been added, the belt tightened, or other equally disturbing influences may have militated against the original correct alignment.

In the method to be described, the first step is to obtain a pair of leveling hangers, such as are shown at *A* in Fig. 2. These are made of aluminum or bronze and are large enough to be used on 3 15-16-inch shafting, which is of sufficient size for general purposes. The suspension rods *B* are made of ⅜-inch machine steel or gun-screw rod, and should be long enough to permit of the straightedge *F*, attached to its lower end, swinging free of the largest pulley. The rods *B* are flattened at their lower end where they are attached to the straightedge by wood screws. The straightedge *F* should be long enough to reach from one hanger to another, although it is preferable to have it about one foot longer than this distance. It should be made of some light wood, such as pine or cypress, at least an inch thick, and deep enough to prevent springing. The top edge must have a perfectly true surface to secure accurate results.

The hangers and straightedge, when assembled, are placed on the shaft as shown in Fig. 1. In order to make the straightedge parallel with the shaft, a stick such as shown at *D*, just long enough to go between the straightedge and shaft, is used as a pair of inside calipers. Adjustment at either hanger may be made by the nuts *C*. When this has been accomplished, the level *E* is secured at the center of the straightedge. The level, previous to this, however, should be carefully tested for accuracy, as incorrect alignment might result from the use of a poor level.

In leveling the shaft, it is preferable to commence in the center and work toward each end. Assuming the center hanger to be correct, the next one is adjusted to it. When this is done the straightedge is moved on, but it is advisable to reverse its direction at each move, for if there should happen to be any slight variation in either straightedge or level, this reversal would automatically compensate for the error. This method has been used by the writer on lineshafts as much as 500 feet in length, and the greatest difference in height between the ends after testing with an engineer's level was less than 1-16 inch. On such shafts, of course, a longer straightedge is used, but in both cases the principle is the same.

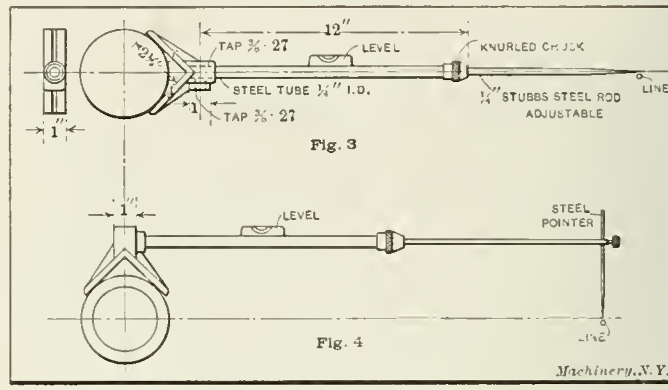


Fig. 3. Method of Testing for Lateral Alignment. Fig. 4. Method of Testing for Lateral Alignment when Sizes of Shafting vary

Having the shaft aligned correctly in the horizontal plane, it next remains to correct it laterally. For this purpose arms are built from each end of the shaft projecting far enough out to clear all pulleys or belts. These arms must be very rigidly built. From the ends of the arms is stretched a line, preferably fine piano wire. This line is drawn tight, and for this reason the arms must be solid. If the line is very long it must be supported near the center, so as not to be affected by the drafts of air which might otherwise impair its accuracy.

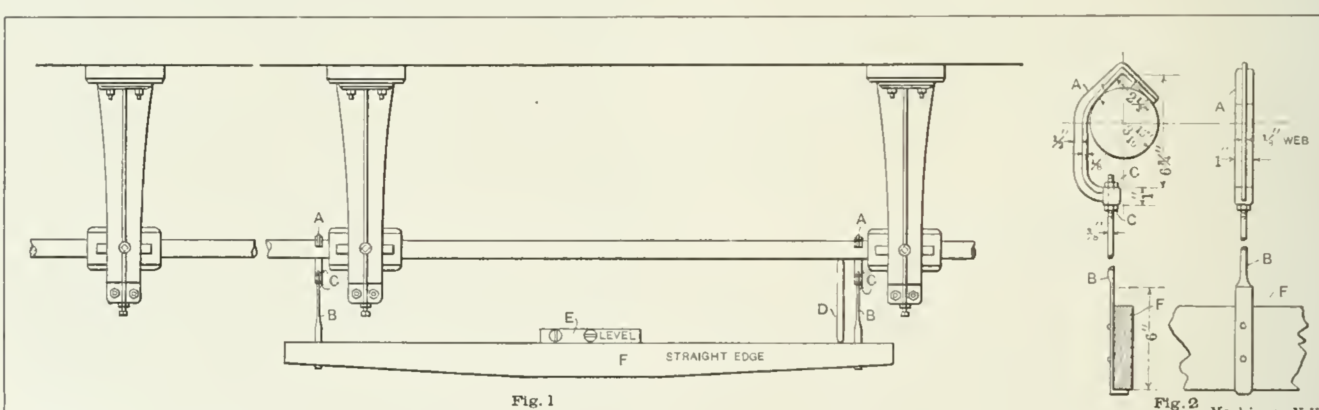


Fig. 1. Method of Leveling Shafting

Fig. 2. Rig for Leveling

Figs. 3 and 4 show the tools used for the lateral alignment. A V-block having rod openings at right angles at the top, as shown, can hold an extensible arm in either hole. Fig. 3 shows this extensible arm in the central hole. This is the method used for laterally aligning a lineshaft which is of the same diameter throughout. For a lineshaft of varying diameter, the extensible rod in the right-angle hole as shown in Fig. 4 is used.

The writer knows of no firm that manufactures these devices, but believes they would find ready sale if placed on the market. There is no patent on them, as they have been known to the writer for the past twenty-five years and were in use when he was learning his trade. Their initial cost is slight and they take up little room in the tool chest.

Lakewood, Ohio. E. B. GAFKEY

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

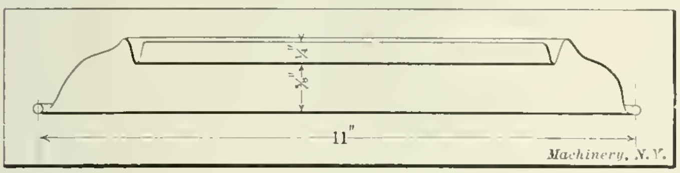
Give details and name and address. The latter are for our own convenience and will not be published

FORMULAS FOR CLAMP COUPLINGS

J. P.—Kindly give a formula for determining the number and diameter of bolts in common clamp couplings, and also a formula for finding area of metal in contact in clamp couplings.

CAN THIS SHAPE BE DRAWN IN TWO OPERATIONS?

O. H. J.—I would like to know if any reader of MACHINERY has designed drawing tools for the shape shown in the accompanying illustration which perform the work in two operations. I am especially interested in the reversing operation, and would like to hear from those who have had experience on this class of work.



ECONOMY OF THE EXTRUSION PROCESS

F. J.—I have seen padlock hasps that were cheaply made by cutting them off the end of a brass or bronze bar of the required cross-section shape; also gear pinions and other machinery parts that were made in the same way. Are the shaped bars drawn or rolled?

A.—The material was probably neither drawn nor rolled, but formed by the so-called "extrusion" process which was developed back in the early '80's by Mr. Alexander Dick of London (see MACHINERY, August, 1906). A number of American concerns have taken up the process and developed a comparatively small trade in extruded shapes. Little is generally known of the process or the economies that could be effected in many lines of manufacture by the use of the product—owing largely, no doubt, to the absurdly secretive policy of the concerns in the business.

FLUTING SPIRAL MILLS

In reply to the inquiry of R. H. in the How and Why columns of the July number of MACHINERY, the following method for setting double-angle milling cutters for milling grooves with one side radial, is submitted:

After placing the work between index centers, set the vertex of the angle of the cutter on the center line of the work. (For method of so doing, see MACHINERY'S Shop Operation Sheets, Nos. 1 and 2).

Next bring the knee of the milling machine up so that the cutter just touches the circumference of the work where it is to be milled, and then move the table longitudinally till the cutter clears the work. Set the cutter for offset and depth by means of the graduated dial, as given in Rules 1 and 2 below. The distance that the cutter is to be set off center is found by Rule 1.

Rule 1. Subtract the depth of cut measured radially from the radius of the work, and multiply the remainder by the sine of the angle included between that side of the cutter with which the radial side of the groove is to be cut and a plane perpendicular to the axis of the cutter, as the angle *A* in Fig. 1.

The distance that the cutter is to be set below the circumference of the work is found by Rule 2.

Rule 2. Subtract the depth of cut measured radially from the radius of the work, and multiply the remainder by 1 minus the cosine of the angle included between that side of the cutter with which the radial side of the groove is to be cut and a plane perpendicular to the axis of the cutter, and to the product add the depth of cut measured radially.

The accompanying table gives the multipliers for the angles most commonly used for double-angle cutters.

The rules here given for the offset and depth of double-angle cutters apply to straight grooves as well as to helical grooves. In the case of a helical groove, the cutter should be set correctly while the line of motion is at right angles to the axis of rotation of the cutter; the table is to be swiveled to the angle of the helix after setting the cutter off center.

MULTIPLIERS FOR COMMON ANGLES OF DOUBLE-ANGLE CUTTERS

Angle A, Degrees	Cutter Multipliers		Angle A, Degrees	Cutter Multipliers	
	Offset	Depth		Offset	Depth
12	0.208	0.022	45	0.707	0.293
27½	0.462	0.113	48	0.743	0.331
30	0.500	0.134	53	0.799	0.398
40	0.643	0.234	..	.....	.....

In cutting helical grooves with double-angle cutters having unequal angles, the work should always revolve toward that side of the cutter where the teeth have the greater angle. Fig. 2 shows the four cases that arise in practice; in each case the work should revolve in the direction of the arrow.

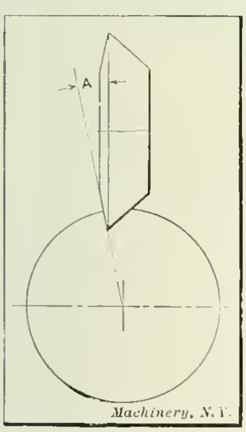


Fig. 1. Cutter and Work set to give the Correct Radial Face at Angle A

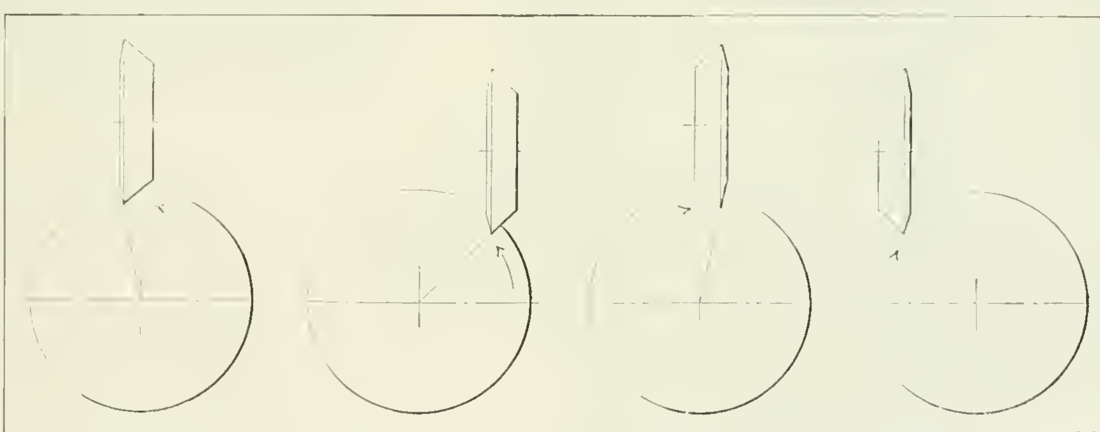


Fig. 2. Diagrams showing the Way in which the Work should be revolved with respect to the Cutter in all the Four Cases that arise in Practice

This applies to right-hand and left-hand spirals or helices; the direction of rotation that will bring the work toward the greater angle of the cutter can be secured by a proper arrangement of the cutter and feed.

The object of feeding the work toward the side of the cutter having the greater angle is to make the sides of the grooves smooth; experience has shown that smooth sides cannot be obtained except by rotating the work in the manner shown.

Before running the table back, when the cut has been completed, take the work away from the cutter, in order that the cutter may not drag in the groove; otherwise it will mar and score the groove. WILLIAM W. JOHNSON

Cleveland, Ohio.

* * *

A machine is a cold unresponsive thing to make up to, yet just the same a friendly feeling on the part of a man toward the machine he is operating generally insures their getting along better together.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

HYDRO-PNEUMATIC DRILLING MACHINE

A hydro-pneumatic drilling machine has been placed on the market by the Walter H. Foster Co., 50 Church St., New York City, embodying new features which are said to effect a very material economy both in operation and maintenance. The most important of these features relate to the application of power and the method of feeding the drill.

This machine differs from standard types of radial drills in the combination of the saddle on the arm with a cylinder having a gear-box mounted on top, containing high- and low-speed gears for variation of spindle speeds in connection with a variable-speed motor. The cylinder through which the spindle passes is surrounded by an oil chamber, and a piston, sliding in the cylinder, is connected with the spindle which revolves in the piston and takes its thrust on ball bearings.

The direct-current variable-speed motor that drives the spindle is directly attached to the cylinder through a set of gears, giving two speeds to the spindle for each motor speed. Spindle rotation may be had in either direction through a drum type controller, and when the machine is used for facing or tapping, the spindle may be operated vertically by a handwheel in either direction.

The feed is regulated by a graduated valve, which controls the flow of oil between the cylinder and surrounding chamber, under an air pressure of eighty pounds. This combination gives a steady feed to the spindle, and the absence of backlash eliminates all danger of breakage under such conditions as the burning of a drill, striking an extremely hard

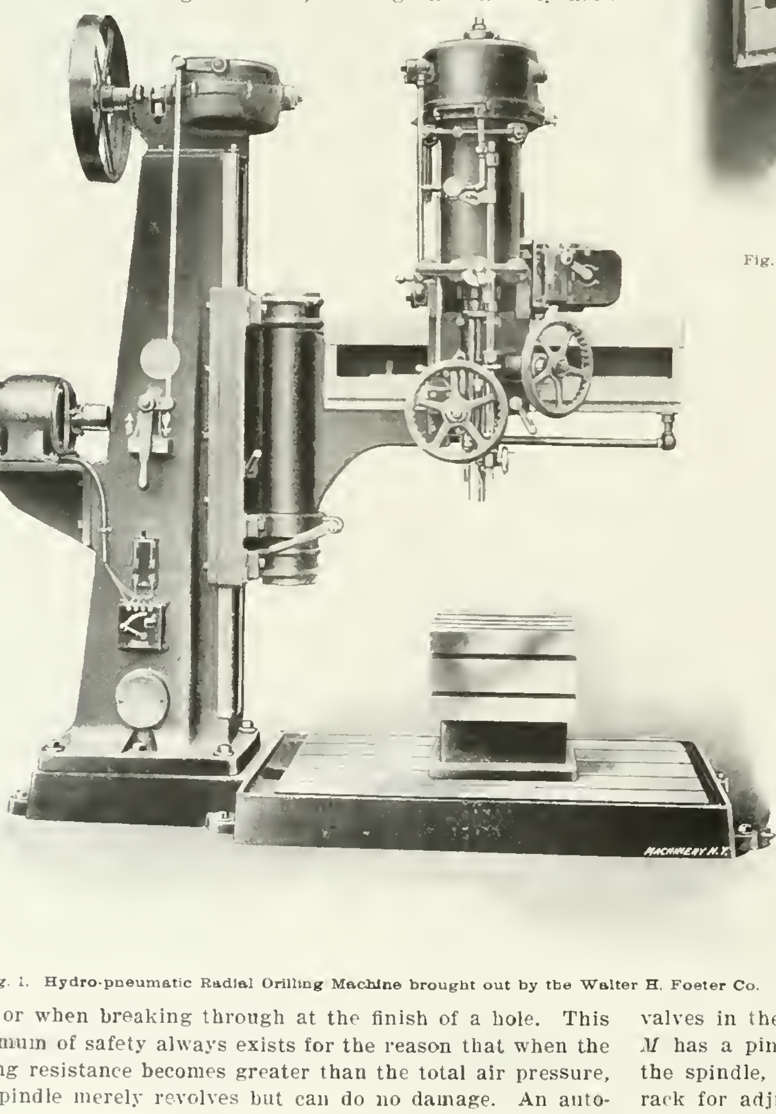


Fig. 1. Hydro-pneumatic Radial Drilling Machine brought out by the Walter H. Foster Co.

spot, or when breaking through at the finish of a hole. This maximum of safety always exists for the reason that when the cutting resistance becomes greater than the total air pressure, the spindle merely revolves but can do no damage. An automatic device shuts off the air pressure at any desired point and returns the spindle to its original position.

The enlarged view of the head, Fig. 2, shows more clearly the construction. The motor is shown at A. The drum type controller B is a new design, having ten points of contact,

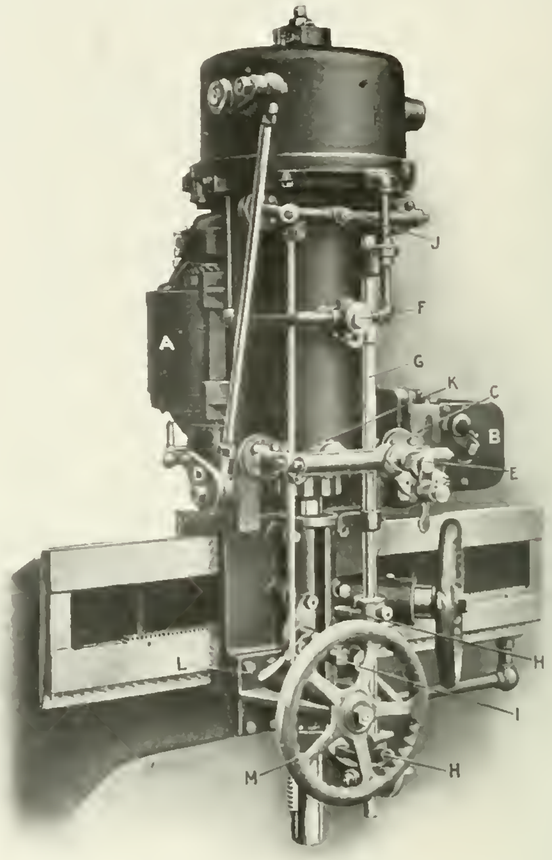


Fig. 2. Drilling Head of the Hydro-pneumatic Machine

and the resistance C is attached in a very neat and compact form. The lever D operates the clutch of the high- and low-speed gears.

The feed-operating valve E has a flat seat graduated to permit the passage of oil from the cylinder to the surrounding chamber, and as the air pressure on top of the piston in the cylinder forces the oil which is under the piston, through these graduated passages, the feed is constant. The four-way valve F controls the passage of the air, whether it is on top of the piston, forcing the spindle down (under which condition the oil is being forced into the chamber through valve E), or forcing the oil back into the cylinder under the piston, thus returning the spindle to its original position. The air valve is operated by the vertical shaft G which carries adjustable trip dogs H; these dogs are arranged to swing out of the way when the spindle is operated by hand, so as not to interfere with tappet I, which slides with the spindle.

The by-pass valves J and K, which are operated by lever L through the connecting-rod shown, allow the air and oil to pass freely in either direction while operating by hand. The line drawings, Fig. 3, show the air and oil valves in their different operating positions. The handwheel M has a pinion engaging with a rack for hand operation of the spindle, and handwheel N has a spiral gear engaging a rack for adjustment of the head on the arm.

For raising and lowering the arm, a constant-speed motor is provided. A tight and loose pulley can also be furnished for this purpose if desired. The oil pump furnished with this machine is bolted to the column and is driven by a pulley from the raising shaft. The oil pan is cast integral with the base.

This machine is built in four- and six-foot sizes. The principal dimensions of these two machines are, respectively, as follows: Maximum diameter of circle the center of which can be drilled, 111 and 161 inches; traverse of head on arm, 36 and 56 inches; maximum distance from trunnion to spindle, 48 and 72 inches; minimum distance, 12 and 16 inches;

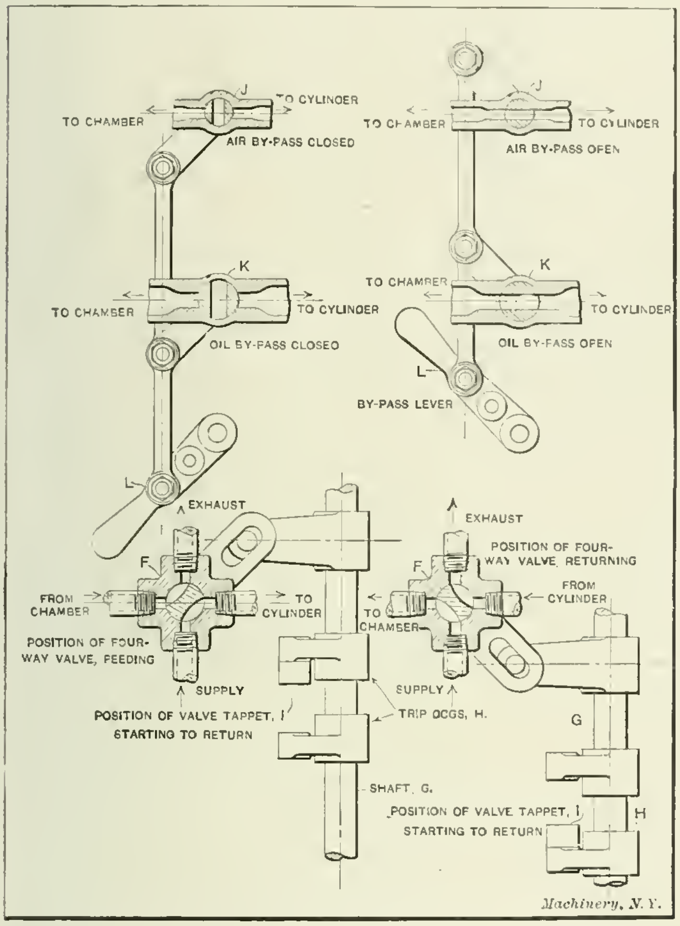


Fig. 3. Air and Oil Valves of Hydro-pneumatic Drill in Different Operating Positions

vertical travel of saddle on column, 36 and 42 inches; maximum height from nose of spindle to base, 62 and 78 inches; minimum height, 12 and 23 inches; vertical travel of spindle, 15 inches for both sizes; variations of spindle speeds, 50 to 400 and 26 to 350; size of motor for driving spindle, 3 horsepower and 5 horsepower; size of motor for raising and lowering arm, 1 horsepower and 2 horsepower; net weight, including motor and table, 7000 and 12,000 pounds.

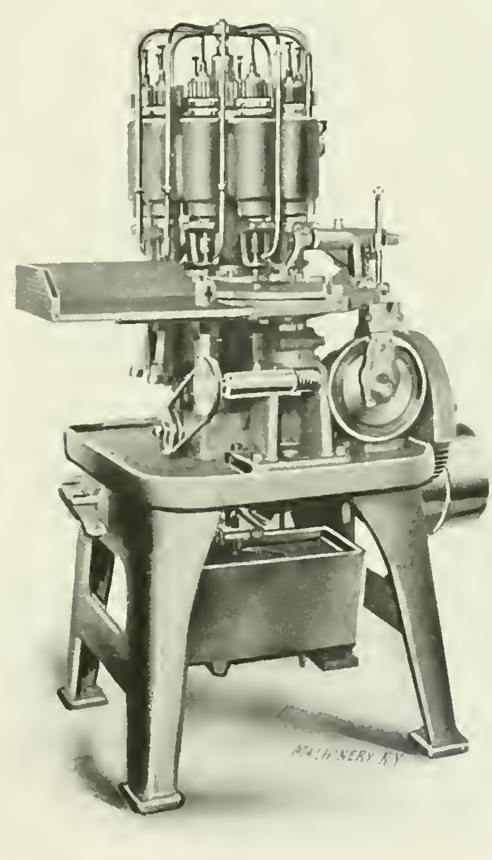
The following figures are the results of tests made to determine the relative power consumption between the hydyro-pneumatic machine and one of the geared type. The friction load on a high-speed geared radial drill driving the spindle and feed gears at 330 revolutions per minute, was 3.5 horsepower; whereas the friction load on a hydro-pneumatic machine operated under the same conditions was 0.8 horsepower. The working load on a geared radial using a 1-inch drill, running 338 revolutions per minute, with a feed of 0.022 inch per revolution of the spindle, and drilling 7.4 inches per minute, was 30 horsepower; whereas, the working load on the pneumatic machine with the same speed and feed was 8 horsepower.

LANGELIER SEMI-AUTOMATIC RIVET DRILLING MACHINE

The Langelier Mfg. Co., of Providence, R. I., has recently designed a machine for drilling the ends of solid rivets of various styles to obtain a tubular form. One style of rivet drilled on this machine is used on the tread of auto-truck tire shoes. The form of hole drilled in the ends of rivets can be either cylindrical, conical or countersunk. The drilling is carried on continuously, thus eliminating loss of time while inserting or ejecting rivets. In fact, the main feature considered in the design was high production combined with low cost of operation.

There are nine drilling spindles constantly working and one rivet-loading or inserting spindle. The actual output of the machine while drilling 0.17-inch holes, 7/32 inch deep, in soft steel rivets, is fifty per minute. This machine was designed for semi-automatic operation in order to eliminate the expense of maintaining an automatic machine in running condition. A fully automatic hopper-fed type would probably have given trouble when drilling rivets continuously at the rate of fifty per minute, and for this reason a simple and quick hand-feed is employed.

The accompanying illustration shows the front or operator's side of the machine. The construction consists principally of a one-piece column of ten drilling heads revolving at the rate of five revolutions per minute around a central stationary upright post which is cast in one piece with the table. Each drilling head is provided with a drilling spindle that runs in a two-piece feed quill of such construction as to allow the drilling pressure to be overcome should hard rivets be encountered; in this way the stalling of the machine or the breaking of drills is prevented. On the inner side and at the top of each feed quill a roll is located which is kept in contact, by a compression spring, with a rim feed cam fastened to the top of the central post. As this rim feed cam is stationary and the drilling heads revolve five revolutions per



Semi-automatic Machine for Drilling the Ends of Rivets, built by Langelier Mfg. Co.

minute, nine rivets are drilled simultaneously or ten rivets for each revolution of the column, thus making a total output of fifty rivets per minute.

Means of adjustment for different depths of holes and for taking up the wear of the drills is provided at the top of the central column. Very minute regulation can be obtained and the adjustment is readily effected. The rim cam is also adjustable vertically to allow rivets of different lengths to be drilled. Each drilling spindle is driven by a fiber pinion, the ten pinions meshing with a common central driving gear. The shaft on which this central gear is mounted passes down through the central post and connects, through bevel gears,

with the pulley driving shaft. The column is driven by worm-gearing, the worm-shaft being connected by a pair of spur gears to the pulley shaft.

Each drilling head is provided with an anvil and a clamping vise jaw for holding the rivets while they are being drilled. These vises are opened and closed at the proper time by bell-crank levers having a roll that is in contact with a stationary plate cam. This cam is adjustable to allow the vise jaws to clamp rivets having heads of different thicknesses. A drill steadyrest or jig is attached to the lower end of each feed quill, and in the lower part of each jig there is a sliding bushing having a cupped end that accurately locates the rivet central with the drill and also supports the drill laterally during the drilling operation. This locating action takes place at the beginning of the downward feed of the drill spindle, just previous to the clamping of the rivet by the vise. The downward feed of the spindle causes the bushing to be pressed firmly onto the rivet by the resulting action of a flat spring, and the continued feed of the spindle drills the rivet.

The rivets are automatically carried to the vises by the rotary movement of a circular friction dial, and they are automatically fed into the vises by a push finger that derives its motion from a cam. This cam is mounted on a shaft that is operated through a pair of spiral gears by the worm-shaft. A hard-wood shelf is provided, level with the top face of the dial, for holding a quantity of rivets accessible to the operator, who pushes them with both hands, head downward, onto the dial. The drilled rivets are ejected by a stationary thin sheet-steel finger that reaches into the vise opening and wipes them out as they pass by.

Oil is supplied to the drills by a Brown & Sharpe oil pump, which forces the oil up through the middle of the central gear shaft, to a distributing head at the top from which it is led to each drill through oil tubes. The oil, after being used, is thoroughly filtered and returned to the supply tank underneath the table. The floor space occupied by this machine is about 32 by 39 inches and the net weight of the machine is approximately 1600 pounds.

FOOTE-BURT HIGH-DUTY DRILLING MACHINE

The powerful motor-driven drilling machine shown in the accompanying illustration is the product of the Foote-Burt Co., Cleveland, O. This machine will drive 3½-inch high-speed drills up to their full cutting edge capacity in steel.

DRILLING RECORDS MADE WITH FOOTE-BURT HIGH-DUTY DRILLING MACHINE AND CLEVELAND DRILLS

	Size and Kind of Drill	R. P. M.	Feed per Rev.	Inches Drilled per Min.	Periph. Speed, Feet per Min.	Cu. Ins. Metal Removed
Cast Iron	1¼" flat twist	575	0.100	57½	188	70.6
	1½" flat twist	355	0.100	35½	139.4	62.7
	1¾" flat twist	350	0.100	35	160	84.18
	2 5/16" flat twist	190	0.050	9.5	115	39.9
	3" flat twist	120	0.100	12	94	84.8
Machinery Steel	1¼" flat twist	350	0.030	10.5	113.7	12.8
	1⅝" flat twist	225	0.040	9	94.8	18.6
	2½" milled	175	0.040	7	114.7	34.3
	3" flat twist	150	0.030	4.5	116	31.7
	3¼" flat twist	150	0.030	4.5	127	37.33

Its power and strength, as well as the proportions of the various parts, are clearly indicated by the illustration.

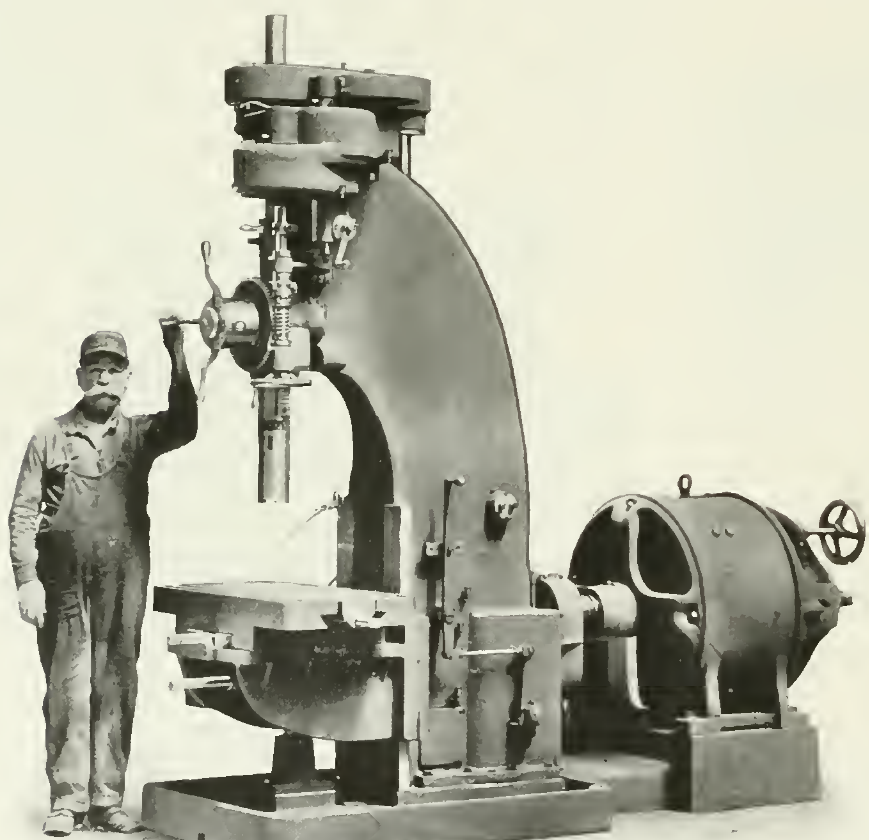
The driving motor is a 20-horsepower, four to one, variable speed type, with a speed range of from 300 to 1200 revolutions per minute. The drive is direct through two to one reduction and back-gears, giving spindle speed variations ranging from 37½ to 600 revolutions per minute.

All feed changes are obtained through a quick-change device, operated by conveniently located levers. Nine changes of feed are available, any one of which can be obtained without stopping the machine. The power feed has an adjustable automatic stop and a hand stop. The hand feed is through worm-gearing, and a quick traverse of the spindle, in either direction, is obtained by the spider handwheel shown, which can be engaged or disengaged by the in or out movement of any one of the handles.

All the bearings of this machine are bronze-bushed except those for the main driving shaft at the base and top, which has Hyatt roller bearings. Spur gears are used throughout, with the exception of one pair of miter gears at the driving end and one worm-gear for the feed. The spindle is of forged high-carbon steel and is fitted with a ball thrust bearing, designed to withstand the most severe duty.

The particular machine illustrated has a compound table which is an extra attachment, and has a knee of special design. This table has a longitudinal movement of 14 inches, a cross movement of 8 inches, and a working surface of 16½ by 30 inches. When the compound table is furnished, the maximum distance from the nose of the spindle to the top of the table is decreased 5¾ inches. The regular table is of the bracket knee type, and it has a large square lock bearing surface on the upright to which it is securely gibbed. Both the regular and compound tables are supported and elevated by a square-threaded telescopic jack-screw located slightly back of the spindle to permit passing boring-bars or other tools through the table if this should be necessary.

The principal dimensions of this drilling machine, which is one of seven different sizes manufactured, are as follows: Distance from center of spindle to face of the column, 18 inches; maximum distance from nose of spindle to top of



Foote-Burt No. 25 1-2 Motor-driven Drilling Machine

table, 31½ inches; length of power feed, 16 inches; diameter and length of spindle sleeve, 4½ and 24¾ inches, respectively; diameter of spindle, driving end, 2⅞ inches; diameter of sleeve, 3 inches; diameter of spindle nose, 4 15/32 inches; taper, No. 6 Morse; working surface of plain table, 24 by 24 inches; vertical adjustment, 18 inches; the net weight is 7000 pounds.

Some remarkable records made by this machine at the recent convention of the American Railway Master Mechanics' and Master Car Builders' Associations at Atlantic City are given in the accompanying table. The results recorded speak for themselves. It should be mentioned that the machine used in connection with these tests was a standard type, and not built especially for the occasion. The drills used were the product of the Cleveland Twist Drill Co.

APPLICATION OF ALUMINUM PULLEYS TO AMERICAN PLANERS

The American Tool Works Co., Cincinnati, O., has adopted for use on its large size planers (36-inch heavy pattern and up) an aluminum driving pulley. This style of pulley has been applied to many of the planers in this company's shop and the results have been so satisfactory that it was decided to use aluminum pulleys on the large planers instead of the regular cast-iron pulleys. It was not, however, the company's original intention to adopt aluminum pulleys as a standard construction, as they were used in an experimental way to overcome certain conditions which existed in their shops.

The aluminum pulley has many decided advantages over the cast-iron type. To begin with, it is made of a special aluminum alloy, the specific gravity of which is only about one-third that of cast iron. The weight of the cast-iron pulley formerly used on an American 36-inch planer is approximately 105 pounds, while the weight of the new aluminum pulley of practically the same dimensions is only 35 pounds, the aluminum pulley weighing only one-third as much as one made of cast-iron. It is this diminution in weight which gives the aluminum pulley the advantage over the heavier one of cast iron.

Those who understand the planer and its operation are familiar with the flywheel action of the tight pulley, especially on a planer having a high countershaft speed. This feature results in the loss of considerable time owing to the over-run of the table at each end of the stroke, and to overcome this the belts must be tightened to such an extent that they soon wear out the loose pulleys. Another serious feature is the rapid deterioration of the belts, which are rapidly worn by the friction and resulting heat caused by the belt overcoming the momentum of the tight pulleys at the instant of reversal. The use of the aluminum pulley is said to entirely overcome these objectionable features.

The momentum of an aluminum alloy pulley as compared with a cast-iron pulley of the same dimensions and running at the same velocity, is in the same proportion as the difference of the specific gravity between the two metals. Therefore, the aluminum pulley will have only about one-third the momentum of a cast-iron pulley if both are running under the same conditions. The advantages of this reduced momentum are obvious: The belts do not have such a tremendous force to overcome and will therefore "pick up" more quickly, thus effectually eliminating practically all over-run of the table.

The actual efficiency of this construction is shown by the results obtained on a planing job done on an American 48- by 48-inch by 26-foot, quadruple head, multi-speed planer equipped with aluminum tight pulleys and driven by a 25-horsepower motor at a 40-foot cutting speed and an 80-foot return speed. The piece being planed was a table for a locomotive frame drilling machine, having a length of 26 feet 4 inches, a width of 30 inches and a depth of 30 inches. The total weight of this casting was 21,390 pounds. The length of the cutting stroke was 26 feet 10 inches and the difference between the stroke and the length of the table was 6 inches, which was necessary to permit the lifting and dropping of the L-tools. As the limit of the table travel is 27 feet, the bull-wheel was in mesh with only three teeth of the rack at the end of each stroke. Evidently this permitted practically no over-run at the ends of the stroke, as otherwise the table would have run off the bull-wheel. This test clearly demonstrated the superiority of the aluminum pulley.

At first thought it might seem that the over-run of a planer table is due more to the momentum of the table itself than to that of the driving pulley. The momentum of the table and work, however, is small as compared with that of the driving pulley. The following quotation from an article previously published in MACHINERY (see "Electrically Driven Machine Tools," April, 1902) shows how the relative momenta of the table and that of the driving pulleys may be compared.

"The question now arises, from where does the planer get the momentum which will drive the table and work for perhaps several feet, and even sometimes chase it through a brick wall? Strange as it may seem, it gets this momentum from the driving pulleys, and, for a small portion, from the gearing. The momentum of a body, or the live energy which is stored up in it on account of its being in motion, is in proportion to its mass and the square of its speed. If, therefore, we multiply the weight of a body by the square of its speed, we obtain a number which is a measure for its energy, and which will enable us to compare this energy with that of some other body."

By comparing the energy of the table with that of the cast-iron driving pulley on an American 36-inch by 10-foot planer, the momentum of the pulley was found to be over fifty-six times that of the table; in other words, if the momentum of the table itself was sufficient to cause an over-run of 1 inch, the momentum of the driving pulley would cause an over-run of approximately 56 inches. It is evident from this that it is the *momentum* of the pulley which should be reduced, and this has effectually been done by substituting the light aluminum alloy pulley. By comparing the momentum of the table with that of an aluminum pulley, it was found that the latter had a momentum only fifteen times greater than the table as against fifty-six times that of the table when using a cast-iron pulley of similar dimensions. Therefore, by the use of an aluminum pulley a reduction in the ratio of the momentum between the driving pulley and the table of over 70 per cent, is obtained.

It is also interesting to know that the belts on planers equipped with an aluminum pulley were made 2 inches longer than on those planers having cast-iron pulleys and working under the same conditions, and more satisfactory results were obtained. The reduction of belt tension not only prevents undue wear of the belts, but also entirely eliminates the shrieking and burning up of the belts which is common to the heavy pulleys. This new pulley is similar in construction to the regular cast-iron type formerly used, the only decided difference being in the design of the arms which are made S-shaped, thus giving sufficient elasticity to prevent any breakage due to the arms shrinking away from the rim.

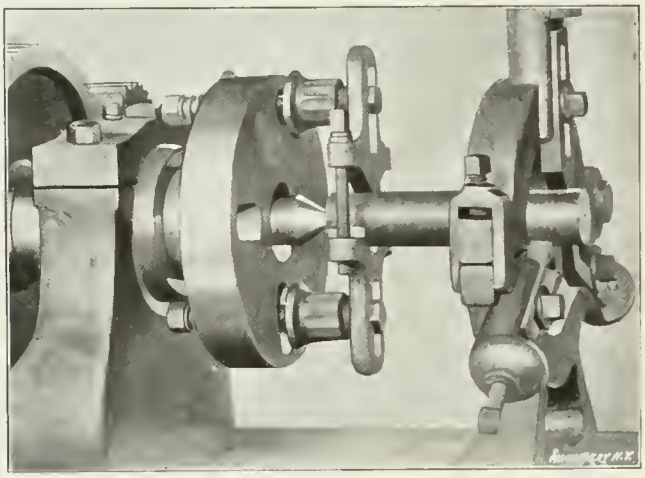
HILL HOLDBACK AND FACEPLATE DOG

Every machinist who has had experience in lathe work is familiar with the use of the belt lacer for holding work against the headstock center when drilling or boring the outer end while the latter is supported by a steadyrest. The M. B. Hill Mfg. Co., of Worcester, Mass., has brought out a holdback dog designed to be used instead of a belt lacer or hook-bolt.

The construction of this dog and the method of applying it to the work and faceplate, is indicated in the accompanying illustration. The device consists principally of an adjustable dog or driver and two bolts which pass through the faceplate as shown. These bolts are supported by spiral springs at the back of the faceplate, which gives them the required flexibility and permits them to be so adjusted as to draw equally on both ends of the dog, thus eliminating inaccuracies common to rigid clamping bolts. These holdback bolts do not come in contact with the dog, but enter internally threaded sleeves that are confined in the slots of the dog.

When placing the dog in position, the bolts are inserted from the back of the faceplate and screwed into the threaded sleeves

two or three turns. After the dog is tightened on the work, the bolts are screwed in the sleeves far enough to compress the springs to one-half their length. The fluted nuts shown, which are threaded on the sleeves previously referred to, are to prevent the springs from pulling the dog back when the latter is loosened. Before releasing the dog, these nuts are



Holdback Dog for Lathes

adjusted against the front of the faceplate, and when the dog is again tightened on the work, they are run back to the position shown in the illustration.

These dogs are made in two sizes designated as Nos. 1 and 2. The first will take work varying from 1/4 inch to 2 inches in diameter, and the larger size has a capacity for diameters varying from 1 inch to 3 1/2 inches.

GARVIN MOTOR-DRIVEN GRINDING MACHINES

The Garvin Machine Co., Spring & Varick Sts., New York City, has equipped the grinding machines illustrated in Figs. 1 and 2 with a motor drive. The arrangement of the drive is such that it can be applied to standard stock machines (thus

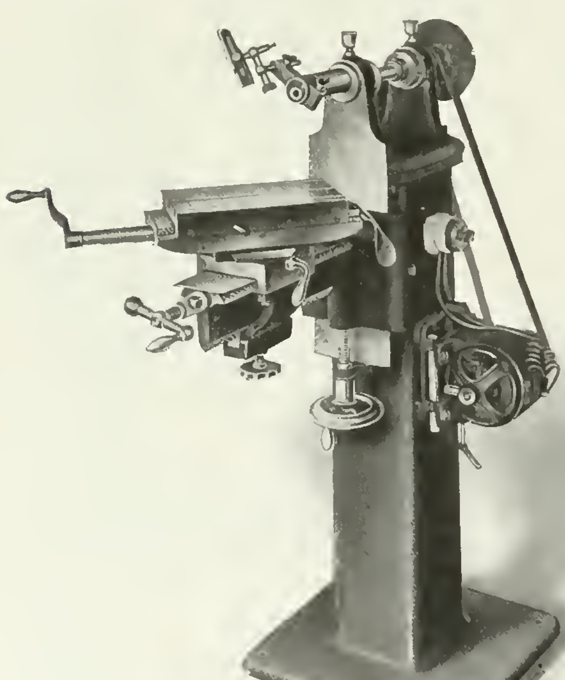


Fig. 1. Garvin No. 3 Motor-driven Universal Cutter and Surface Grinding Machine

insuring prompt delivery), without interfering in the slightest degree with the adjustments or utility of the machine.

The machine illustrated in Fig. 1 is a No. 3 universal cutter and surface grinder. This machine is adapted to the grinding of all forms of milling cutters, ranging in size from 14 inches in diameter and 6 inches face width, down to the smallest sizes. It can also be used for surface grinding and will cover surfaces 6 inches wide by 9 1/2 inches long. The spindle is of steel, hardened and ground, and runs in compensating boxes that are fully protected from floating emery. The motor is a constant-speed type, of 1/6-horsepower capacity, and operates at 1800 revolutions per minute. As the illustration shows, it is bolted to the column of the machine and has suitable adjustments for keeping the belt under the required tension. The weight of the machine is 435 pounds.

The surface grinding machine shown in Fig. 2 is a standard type. The motor is supported by two steel arms that are bolted to the side of the column as shown. On these arms a track is mounted on which the motor can be adjusted for varying the belt tension. The looped belt that drives the spindle also has a compensating belt-tightening device. The motor is a constant-speed type, of 1/2-horsepower capacity, and operates at 1650 revolutions per minute. The machine will

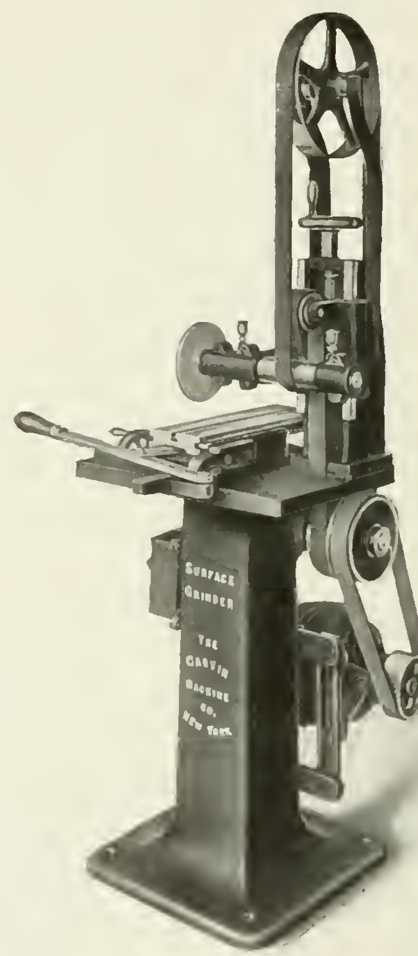


Fig. 2. Motor-driven Surface Grinding Machine

grind surfaces 7 inches wide by 9 1/2 inches long, and will take work having a thickness varying from 1/8 to 6 inches. The weight of this machine for domestic shipment is 450 pounds.

The application of a motor drive to these machines is of special value, as tools of this character are commonly located in isolated places where there is no lineshafting. The self-contained drive also enables them to be placed in the most convenient position, and eliminates the use of countershafts.

SARGENT TWO-STAGE GAS-DRIVEN AIR COMPRESSOR

The increasing demand for compressed air for industrial purposes has resulted in many improvements in compressor construction which have increased their efficiency and reliability, but the thermal and volumetric efficiency of many air compressors is still too low. On account of the high cost of electric power and floor space and low mechanical efficiency of compressors belted from gas engines, small quantities of compressed air are not available to many who would use it if the cost of compression were less.

To meet the demands for a self-contained, highly efficient, gas-driven air compressor, the machine shown in Figs. 1 and 2 was brought out. It consists of a vertical gas engine having a differential trunk piston, which forms the regular engine piston and is also used for compressing the air in the annular space *G*. As there is but one piston, one connecting-rod and one crankshaft for both the gas engine and compressor, the combined efficiency of the unit is high.

On the up stroke, air is drawn into the crank-case through the port *K*, when the latter registers with a corresponding port in the crank-disk *J*. On the down stroke, air is compressed in the crank-case and flows through the valve *E* into the annular chamber made by the differential piston. On the return stroke this air is forced through the discharge valve *H* and outlet *I* to the storage tank or receiver, during which time the crank-case is again filled. On account of the large surface surrounded by cold water and the short distance the heat has to travel when generated in the annular space by compression, the thermal efficiency should be higher than in compressors having a small cooling surface per unit of volume. The cold water surrounding the annular chamber in which the air is compressed, passes up and around the combustion cylinder.

As the upper end of the connecting-rod is spherical, the piston and rings can revolve, thus maintaining uniform wear of the cylinder. The engine proper is of the four-cycle type, and as air is compressed every stroke, the two fly-wheels and crank-disks are made heavy, to maintain a sufficiently uniform speed. The speed is controlled by an inertia governor that falls slower than the spring-seated exhaust valve *B*, when the engine tends to run above normal speed, and allows *U* to engage *V*; this holds the exhaust valve open and the inlet valve stem *W* in such a position

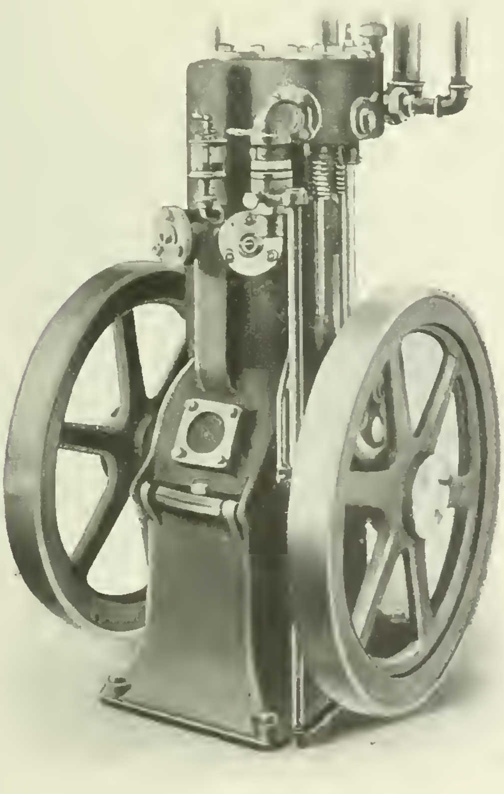


Fig. 1. Sargent Two-stage Gas-driven Air Compressor

that *X* will miss *Y* and the inlet valve will remain closed. When the speed drops, *U* will miss *V* and the engine will resume its normal speed.

Either gas, gasoline or kerosene can be used for fuel. When gas is used, it is admitted through a graduated valve to the space *R* from which it flows to the explosion chamber *C* with the air, when the collar *Q* on the admission valve stem rises. Gasoline or kerosene are taken in through a mixing valve on the air pipe. Compressed air is used from a storage tank for starting. It is admitted through the valve *N* which is positively opened at the beginning of each working stroke, as long as the compressed air is turned on and the pressure is greater than in the explosion chamber.

The crankpin is accessible through the hand-hole plates, or the piston-rod and crank may be adjusted or removed by turning back the cylinder which is hinged to the base. One sight-feed oil cup lubricates both ends of the piston. The superfluous oil gathered by a narrow groove in the piston, is delivered through diagonal holes to the ball end of the connecting-rod, and, passing half-way around, flows through a hole in the connecting-rod to the crankpin. The main bearings are

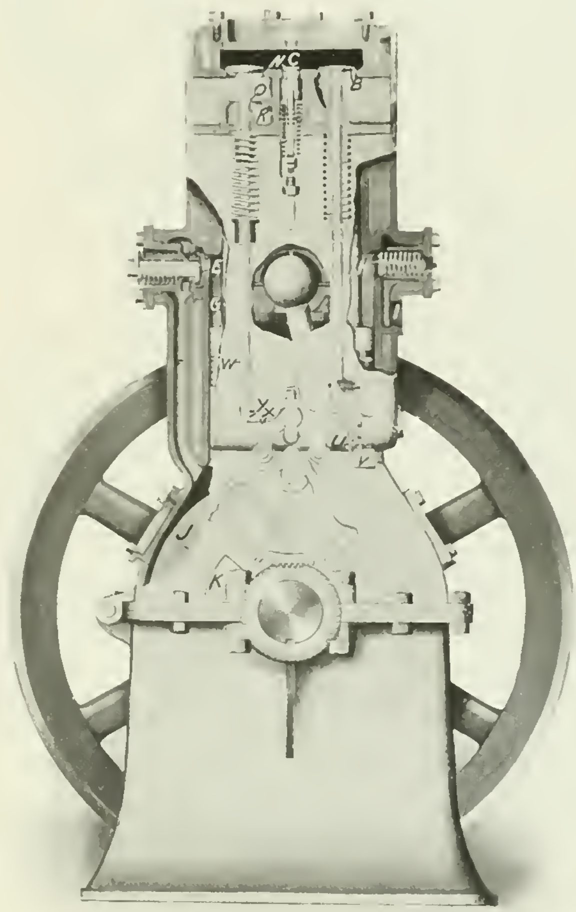


Fig. 2. Side View showing Arrangement of Two-stage Compressor

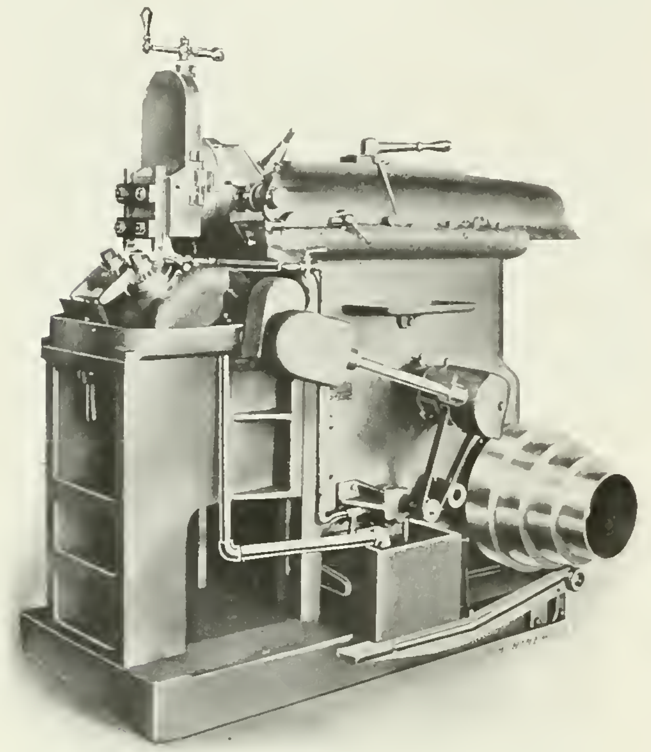
lubricated by heavy grease which also makes an effectual air seal. Ignition is by jump spark and the primary circuit is closed once in two revolutions by a pin on the secondary gear.

Compressors of this type will compress air up to 200 pounds gage. One cam controls both admission and exhaust, and the valve motion is quiet, positive, and so proportioned that it will run continuously for months without adjustment. This compressor was designed by C. E. Sargent, 136 West Lake St., Chicago, Ill., and it is built in four sizes to compress from 9 to 150 cubic feet of air per minute.

GOULD & EBERHARDT BEVEL-GEAR ROUGHING SHAPER

A shaper for rough planing bevel gears has been brought out by Gould & Eberhardt, Newark, N. J. The principal function of this machine, which is shown herewith, is the roughing or "stocking out" of bevel gears preparatory to the finishing operation in a bevel gear planer. Ordinarily this roughing operation, which consumes most of the time in cutting a bevel gear, is done in a gear planer. These planers are, however, expensive, as compared with the roughing shaper, so that the use of the latter enables the bulk of the work to be done in an inexpensive machine. There is an additional advantage in first roughing out the blanks, in that the finishing planer is relieved from the strains to which it is subjected when roughing.

This shaper is particularly adapted to roughing out automobile differential gears having projecting hubs on the small end that would prevent them from being roughed out in an ordinary disk-cutter type of gear-cutting machine, because of interference between the rotary cutter and the hub. By referring to the illustration, which shows this type of bevel gear, it will be seen that a disk cutter would encounter the hub before the cut was entirely across the face of the gear. This



Gould & Eberhardt 24-inch High-duty Shaper with Bevel-gear Roughing Attachment

shaper, which is a high-duty type, lends itself very well to this class of work, owing to its high number of cutting strokes made possible by the "double-train gear drive."

The machine has been modified so as to allow one or two bevel gear blanks to be rigidly held at the proper angle for planing. The work is indexed at every return stroke of the ram, and the shaper head is automatically fed down for each stroke until the proper depth is reached; the feed is then automatically disengaged and the blanks removed. The machine makes 100 cutting strokes per minute. As the illustration shows, the regular crosshead slide and table have been removed and a special work-head with an indexing mechanism has been substituted. This work-head can be arranged for cutting one or two gears at a time, up to the capacity of the machine. The blanks are held rigidly in a fixture which enables them to be removed rapidly when finished, and replaced with new blanks.

The particular gears shown in the illustration, which are of nickel steel and have 20 teeth of 0.714 pitch, were roughed out simultaneously in six minutes, or in three minutes per gear. In order to remove the chips that accumulate in the groove between the projecting hub and the inner ends of the teeth, two hook tools are provided that fit in the groove. These are held in place by spring tension and can easily be thrown out of position when removing the gears.

The indexing of the blank from one tooth to the next, as previously stated, takes place at every return stroke of the ram. The indexing is positively controlled by the reciprocating action of the ram, and it is effected when the tool clears the work. After the indexing is completed and before the tool engages the work, means are provided to lock the work-spindles so that the blanks are securely held while the tools are at work.

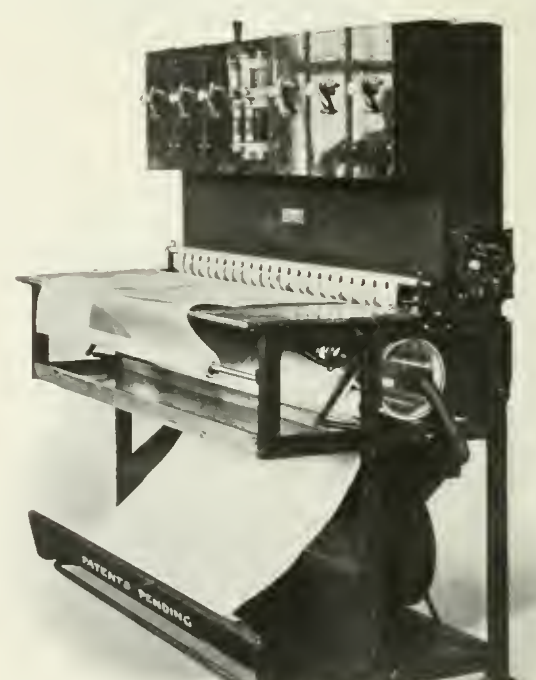
The automatic vertical feed also takes place at the end of the return stroke and continues to operate for each successive cut until a small trip dog, located on the side of the head, disengages the feed. This trip can, of course, be set to feed the tool to any predetermined depth. The machine is equipped with a large foot-brake, operated by the lever shown, which acts on the driving pulley and enables the operator to stop the machine instantly. An automatic oil pump and large oil reservoir are regularly furnished for lubricating the tools. This machine weighs about 4300 pounds.

CONTINUOUS ELECTRIC BLUEPRINTING MACHINE

The blueprinting machine illustrated herewith is a recent design brought out by the Revolute Machine Co., 417 E. 93rd St., New York City. The machine is of the continuous electrically-driven type and its operation is similar in principle to the Everett-McAdam machine previously illustrated in November, 1906. In this latest design, however, the mercury vapor lamps formerly used are replaced by six high-power arc lamps especially made for this work.

Either continuous rolls or separately cut sheets can be printed. The paper travels across the feed table with the tracing on top and both are carried by suitable guides around a top roller and onto the revolving glass cylinder. The paper and tracing pass between this cylinder and a set of thirty-eight endless canvas belts. These belts hold the paper and tracing in close contact with the cylinder through one-half a revolution, during which time the printing is done. The print and tracing then drop into a chute and are caught in a trough at the base of the machine. A long brush bears against the under side of the cylinder to prevent the tracing or paper from continuing around with the cylinder and into the reflector in case they should cling to its surface. The canvas belts referred to return over an idler roller as shown, and the cylinder is held against them by a single tension belt at each end.

The six lamps are placed in a reflector and the light passes through both walls of the glass cylinder to effect the printing,



Continuous Electric Blueprinting Machine

there being no intervening contact aprons. The lamps are of the gas-tight enclosed-arc type and they are supplied with separate variable resistance coils so that the resistance may be easily changed for fluctuations in the voltage, to keep the arcs at their most efficient point. These lamps will operate with standard carbons, but carbons made especially for this high-power work are recommended. The lamps are provided with separate switches so that any number may be used at one time. The light distribution is very uniform, as the distance from center to center of the arcs is much less than the

distance from the arcs to the printing surface. The globes are very large so that the heating is about one-third that of ordinary globes. The heat of the lamps is carried off by air blown between the cylinder and the globes and through a pipe into one end of the cylinder. This air is supplied by a blower mounted on the armature shaft of the motor.

The cylinder, which is of the finest glass, is blown in one piece, 8¼ inches in diameter and 60 inches long. A one-fourth horsepower motor of the enclosed type is used. The speed gear consists of a leather-shod wheel operating between two iron disks. The motor drives one disk and the speed of the second disk is determined by the position of the leather-shod wheel, which is controlled by a convenient lever, so that the speed can be quickly changed to any desired rate shown on the quadrant. A belt from the second disk drives the lower roller of the machine through a worm-gear. The rotation of the cylinder can be stopped without stopping the motor, by pressing a treadle seen extending across the front of the machine near the floor. This control will be appreciated when feeding old or curled tracings or when a print is started crooked.

The capacity of this machine is said to be greater than that of any other type. It is made in only one size having a printing width of 57 inches. The speed of the paper through the machine varies for different tracings and paper, and also with the nature of the current. Six lamps operating at 10 amperes each on a direct current of 220 volts will print the rapid electric papers, when new tracings are used, at 20 linear feet per minute, and usable prints can be made much faster. Lamps operating on a 110-volt direct current, and alternating-current lamps, print somewhat slower. When available, the 220-volt direct current is recommended.

This machine can be used in connection with any process that can be printed by the sun, and it is especially adapted to printing slow-process papers, such as brown negatives, black-line and blue-line white prints made from negatives, and also the slow positive black-line papers. The machine is entirely self-contained, and when setting it up, it is simply necessary to run the feed wires to the back of the switchboard and connect the leads on the machine to the lamps and motor, all the necessary fuses for the lamps and motor being on the machine itself with complete wiring. The floor space required is 3 feet by 6 feet, and the machine must be so placed as to allow free access to the back for trimming the lamps.

COLUMBIA HIGH-DUTY CHUCK

The chuck illustrated in Fig. 1 is a universal type that is designed for heavy work and it is particularly adapted for use on modern machines using high-speed steel. This chuck is strongly built and possesses great gripping power, as indicated by Fig. 3, which illustrates how securely work can be

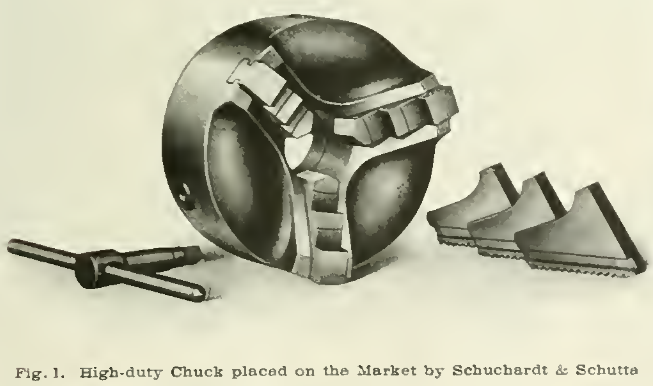


Fig. 1. High-duty Chuck placed on the Market by Schuchardt & Schutte

held while being rough-turned. A view of the "Columbia" chuck, dismantled, is shown in Fig. 2.

The principal difference between the construction of this chuck and one of the ordinary type is in the scroll which is conical in form, as at *A*, Fig. 4. The spiral threads for moving the jaws in or out are cut on the sloping or conical surface of the scroll or ring and they are V-shaped instead of being square, as at *B*, which illustrates the ordinary scroll. The principal advantage claimed for this construction is that the thrust of the jaws is taken directly by the conical ring, as shown in Fig. 4, thus reducing the strain upon the ways and keeping the jaws in permanent alignment. The comparatively fine pitch of the V-thread also gives a very powerful grip. This conical ring is hardened and the V-thread is afterwards ground to eliminate any distortion which may

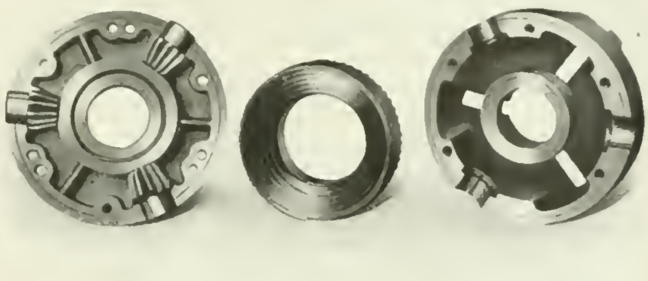


Fig. 2. High-duty Chuck Dismantled

have been caused by the hardening operation. The hardened gripping surfaces of the jaws are also ground after the jaws are assembled.

This chuck is made in ten sizes with outside diameters

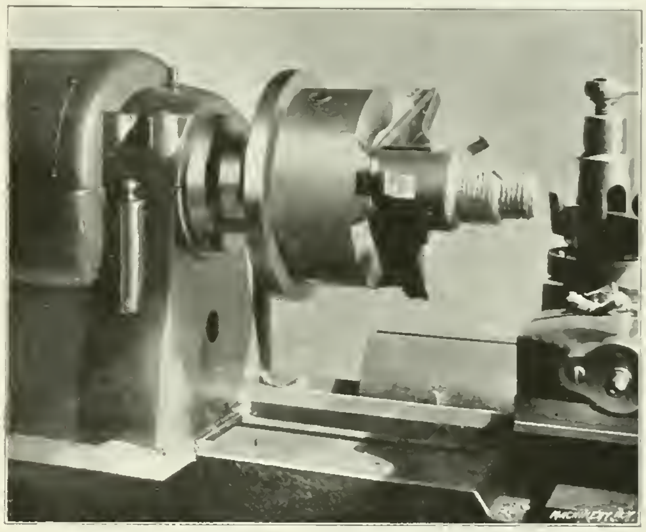


Fig. 3. Illustration showing Gripping Power of Columbia Chuck

varying from 4¾ to about 17 inches. Two sets of jaws can be provided, as shown in Fig. 1, one being a plain set and the other the stepped type for holding large diameters. The body of the chuck is made large enough so that the ends of

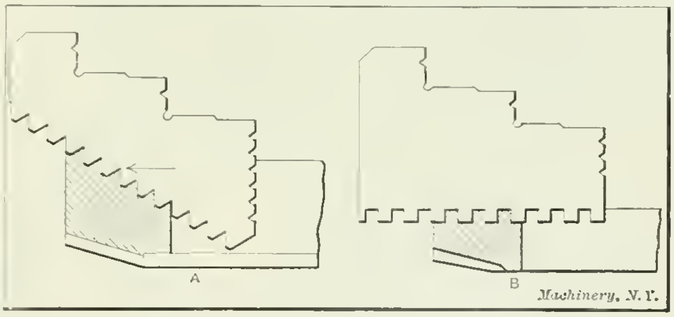


Fig. 4. Views showing Conical Scroll and Ordinary Type

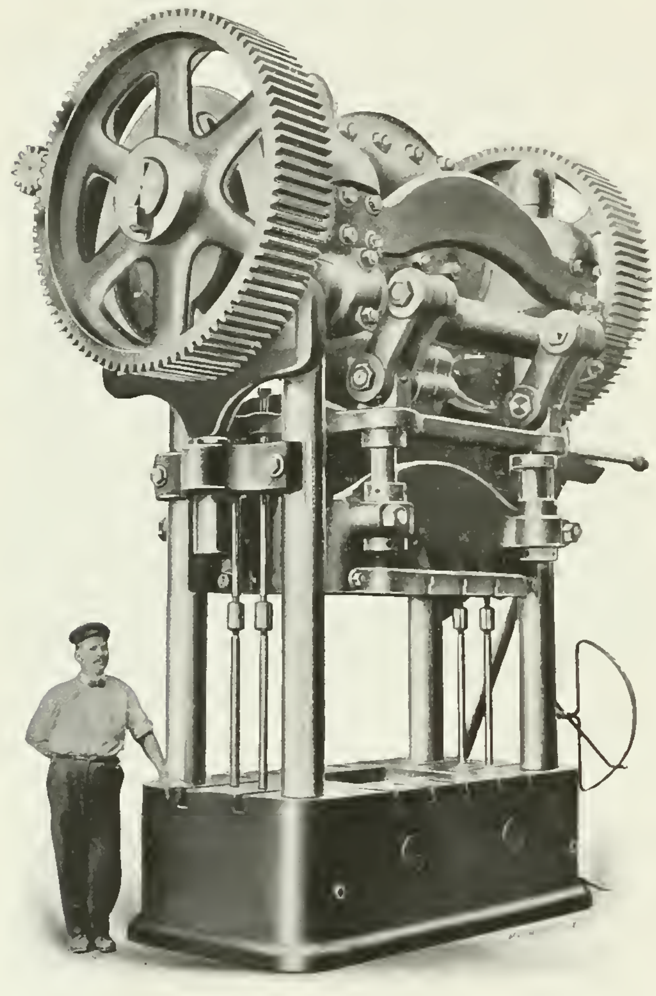
the jaws do not protrude, except when holding comparatively large work, thus reducing the possibility of accidents. The Columbia chuck has been placed on the market by Schuchardt & Schutte, Cedar and West Sts., New York City.

FERRACUTE TOGGLE DRAWING PRESS

The large press illustrated herewith is a recent design built by the Ferracute Machine Co., Bridgeton, N. J., for producing the steel stampings that are being substituted for castings and forgings in the construction of many modern automobiles. This press was designed primarily for doing deep double-action work, such as automobile brake drums, gear cases, dust covers, etc., but it can also be used as a single-action press, thereby greatly increasing the capacity.

The weight of this press is about 70 tons, and it exerts a pressure of 1000 tons. The base is an iron casting, internally ribbed and trussed, and projecting upward from the corners of the base there are four steel columns. Each of these columns is 9 inches in diameter, which is considerably in excess of what is necessary from the standpoint of strength, the additional metal serving to stiffen the entire construction. These columns fit into machined holes in the base, to which they are firmly secured, and connection is made at the top with heavy castings containing the journal bearings for the shaft. The columns serve as slide bearings for the ram, in addition to their main function which is to take the tensile stresses.

The shaft is a massive steel forging having a diameter of 12½ inches at the journals and 15 inches at the crank. Keyed to the end of the shaft are the steel driving gears which have cut teeth. A cam groove in one of the gears imparts a vertical



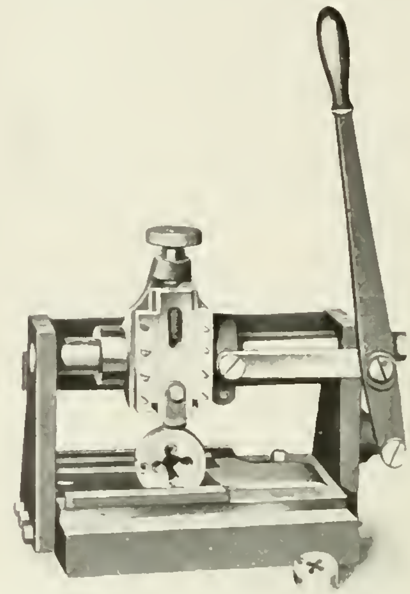
Ferracute Toggle Drawing Press having 1000 Tons Ram Pressure

motion to a yoke at the left of the machine, which gives a partial rotary movement to the toggle shafts and they, in turn, drive the ram down. The plunger or inner ram is driven by a crank at the middle portion of the shaft. By disconnecting the toggles at the front and back, the machine is changed into a long-stroke single-acting press, the upper die being attached to the plunger.

The general dimensions of this press are as follows: Extreme height, 16 feet; height from bed to ram, when up, 4 feet; height from bed to plunger, when up, 5 feet 1 inch; stroke of ram, 13 inches; stroke of plunger, 26 inches. The ram and plunger each have an adjustment of 8 inches. The diameter of the flywheel is 4 feet 2 inches, face width, 12 inches, and weight 3000 pounds. This machine is designated as the "SA921" press, by the manufacturers.

REMINGTON MARKING MACHINE

The Remington Tool & Machine Co., 50 Congress St., Boston, Mass., is manufacturing a simple form of marking machine that is designed to give a uniform impression in the work and to eliminate the breaking of steel stamps, there being practically no injury to the face of the stamp used. The stamp is attached to a slide, as shown in the accompanying illustration, which is mounted on a head, moved horizontally by the vertical lever shown. This slide is provided with means for quick vertical adjustment to compensate for varying thicknesses of stock being stamped, and there is a stop to regulate

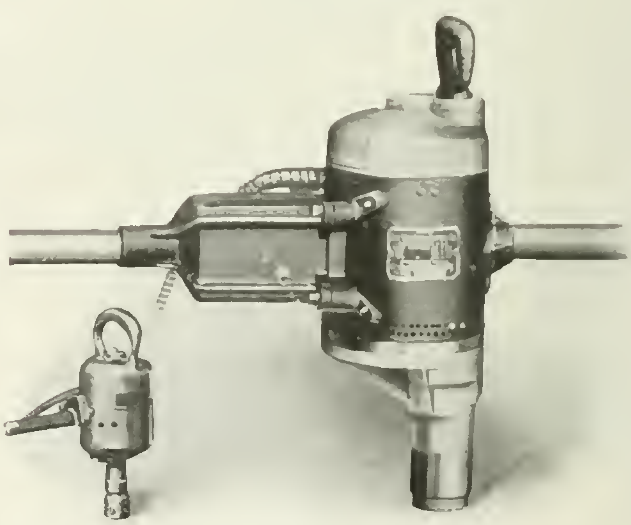


Marking Machine built by the Remington Tool & Machine Co.

the horizontal movement of the head. This machine has a capacity of 1800 pieces per hour, and it is adapted for straight stamps when marking round work or for circular stamps when marking flat surfaces.

ELECTRICALLY OPERATED PORTABLE DRILLING AND REAMING MACHINES

An improved line of electrically operated portable drilling and reaming machines is being manufactured by the Van Dorn & Dutton Co., Cleveland, O. This line consists of eight different sizes, six of which have a drilling capacity, ranging from 0 to 2 inches, for operation on direct current of either



Two Sizes of the Van Dorn & Dutton Co.'s Improved Line of Electrically-operated Drilling and Reaming Machines

110 or 220 volts. There are also two sizes, with capacities from 0 to ¾ inch, for operation on either direct or alternating current of 110 or 220 volts.

In the larger machines, the four-pole construction is employed, whereas the smaller tools are of the two-pole construction. The design is such that the harder the tool is forced, the greater the torque or working power. The motors used are of the series type. The armatures are of the slotted drum type, and are built up of soft steel laminations on a

hollow shaft. These laminations are made of steel of a special analysis to obtain the highest efficiency and each lamination is carefully and uniformly insulated. The field frames of the larger machines are constructed of steel of a special analysis, and in the smaller sizes, the field frames are built up of laminations somewhat the same as an armature.

In the design of these machines careful attention was given to the matter of lubrication and also to the bearings, both of which are important features, particularly in the construction of tools of this character. The method of lubrication is simple but effective: The gears are enclosed in a gear case entirely separate from the windings, which serves as a lubricant chamber as well as a housing for the gears. By means of suitable channels, the lubricant reaches all the bearings, with the exception of the one for supporting the spindle, which has independent lubrication. When revolving, the gears force the lubricant through these channels thus insuring continual lubrication. The oiling system is so arranged that one charge of non-fluid oil in the gear will suffice for several weeks. Ordinary machine oil can be used for lubricating the spindle.

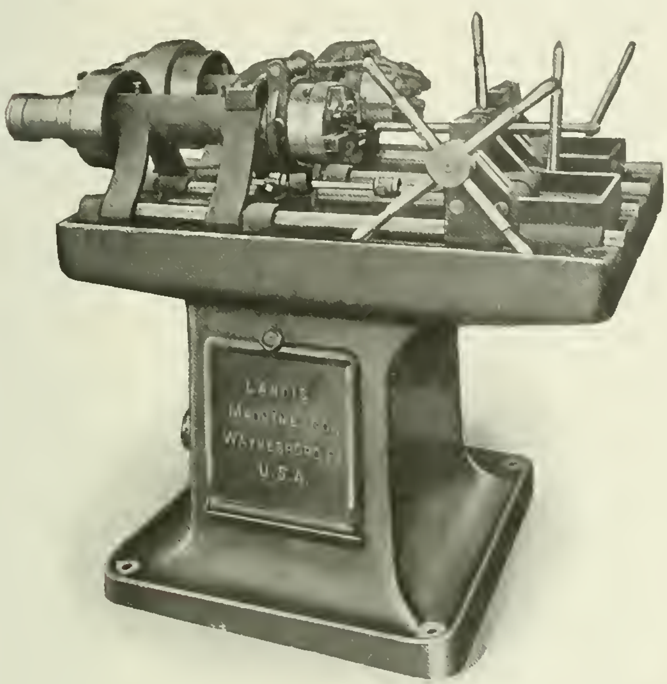


Fig. 1. Landis 1/2-inch Double-head Bolt-cutting Machine

In laying out the bearings, consideration was given to every function involved and the friction reduced to the minimum. For the high-speed members, imported ball bearings are used, whereas bronze bushings serve as bearings for the slower running parts.

The gears used in these drills have accurately generated teeth and they are made from alloy steel and are hardened and ground. The spindle and socket are designed to eliminate slipping and breaking. The switches employed are of the quick-break type with a capacity fifty per cent in excess of the duty required. In the larger machines for reaming, mechanically operated automatic switches are used. These are arranged to automatically stop the machine in case the operator should accidentally release the handles when the tool is in use. These switches will at all times break the current instantaneously, thus eliminating heavy and destructive arcing. The smaller machines also have switches of a special design. The switch contacts are so arranged that when wear occurs they can be replaced easily and at a very small cost.

All the machined parts of these drills are finished to micrometer measurements, and members such as the spindle, socket and gears are hardened and ground to size. One screw holds the cover in place and when this is removed, brush-holders and other parts are readily accessible.

LANDIS BOLT-THREADING MACHINES

The Landis Machine Co., Waynesboro, Pa., has brought out several new types of threading machines which possess a number of new features as compared with those formerly manufactured.

Fig. 1 shows a ½-inch, double-head bolt-cutting machine having steel guides instead of the ordinary cast-iron guides.

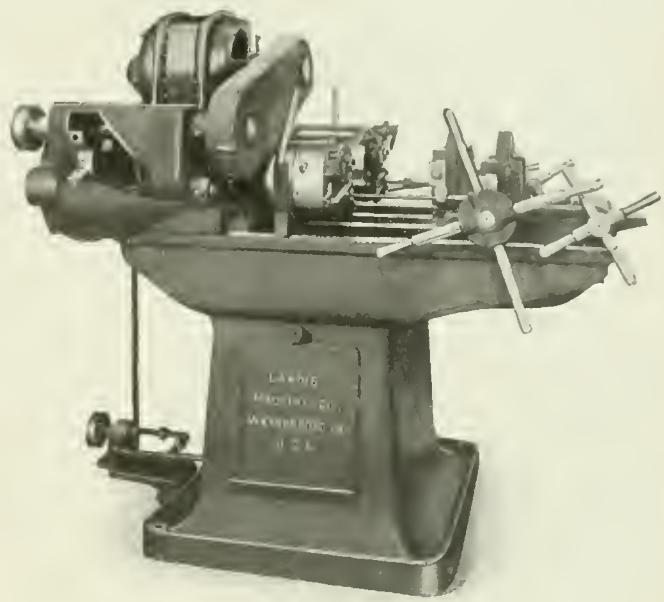


Fig. 2. Landis 1-inch Motor-driven Bolt-threading Machine

The steel guides possess a number of advantages: To begin with they are very accurate as to size and are in perfect alignment at all times, unless affected by wear after long usage; when wear occurs, however, they can readily be replaced at a very slight cost, while on a machine with cast-iron guides the wear that may occur cannot, as a rule, be compensated for, especially if the wear is not regular on all parts of the guide. Furthermore, there is no tendency for chips to collect on the cylindrical guides and cause wear, as with flat guides. This machine is built with a wide body, having a large space for chips and an oil tank in the base separated from the chip space by a fine screen. The carriage is light yet very strong and easily operated, which tends toward rapid production. The oil pump is at the rear of the machine and is of the rotary type. This machine is made

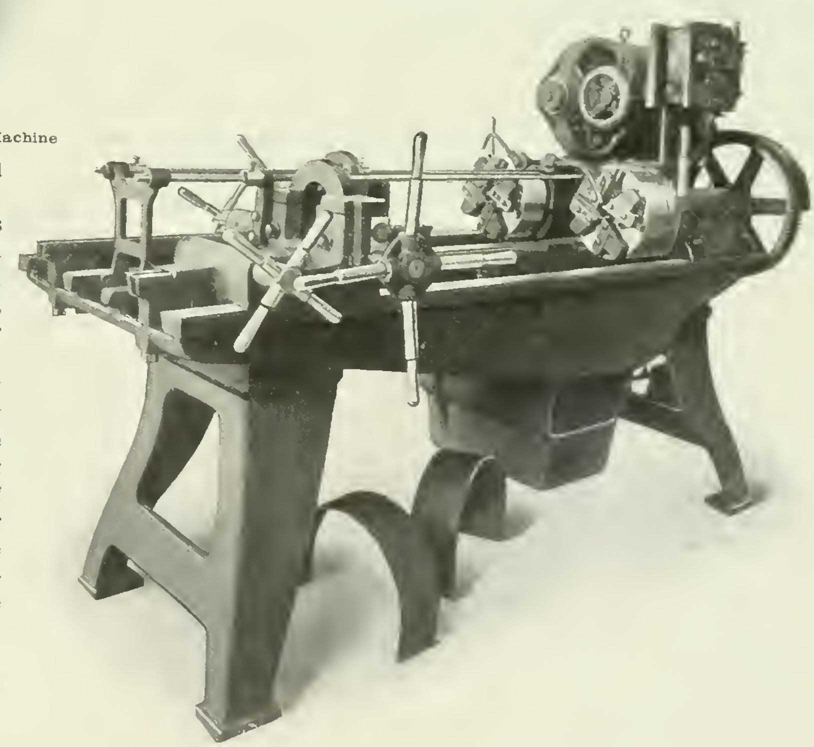


Fig. 3. Motor-driven Double-head Staybolt Cutter

for high-speed work and is furnished almost exclusively with high-speed steel dies.

Fig. 2 shows a standard 1-inch double-head bolt-threading machine with a constant-speed motor, silent chain drive, and a mechanical speed change device giving a speed range of 3¼ to 1. The motor is mounted on top of the machine, out of the way of dirt and oil, thus making the entire equipment very compact and taking up a minimum amount of room. The speed changes can be made while the machine is in operation, and any speed between the maximum and minimum can be obtained in an instant. This machine is also adapted for high-speed work. The carriages have adjustment vertically or sidewise for centering with relation to the dies. The machine can be furnished with carriages operated by a rack and pinion or with lever-operated carriages.

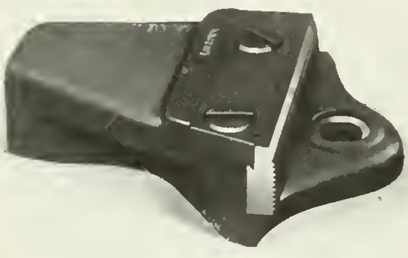


Fig. 4. Chaser-holder for Threading close to Shoulders

Fig. 3 shows a 1½-inch motor-driven double-head staybolt cutter with a variable-speed motor. This motor has a speed variation of 4 to 1 so that a very wide range of speeds is available, making it possible to accommodate any work between the minimum and maximum, and also to use either carbon or high-speed steel dies, as the case may require. The speed changes can be made at any time without stopping the machine. The motor is mounted on top of the machine (the same as in Fig. 2) to which it is directly connected.

This machine is also furnished with lead-screw attachments for one or both heads, as may be desired, and it can be arranged to cut any pitch or diameter within its range by change gearing, no extra lead-screw being required. All main spindles are provided with recesses to allow the lubricant to return to the oil tank. On all of these machines, the Landis type of die is used and it is held in different ways to suit the different requirements.

Fig. 4 shows one of the chasers in the Landis die, held by means of a clamp which comes flush with the front edge of the die so as to permit cutting close to shoulders or the heads of bolts. This is the type of holder used for regular bolt work or for cutting close to shoulders. Dies with very short throats or with no throats at all can be used, and as no grinding is done on the throat of the die when sharpening, the shape of the throat remains permanent, which is a marked advantage on many classes of work.

TURNING AND BORING ON ROCKFORD DRILLING MACHINE

An interesting adaptation of the drilling machine for turning and boring operations is illustrated in Fig. 1, which shows a three-spindle drilling machine arranged for turning and boring the sleeves or quills of drill presses. This machine is used in the shops of the Rockford Drilling Machine Co., Rockford, Ill., where large quantities of these sleeves are required, and it is one of the company's regular 31-inch gang drills with the addition of the necessary special tools and fixtures.

The turning is done by the right-hand spindle which is equipped with a three-jaw universal chuck *C*, Fig. 3, that grips and drives the work. Above this chuck there is a main bearing *B*, mounted on a slide or base, which is free to move vertically with the spindle. This bearing is counterbalanced by the weight seen to the right of the machine. There is also what might be called a "tailstock" *D* at the lower end of the slide, which supports one end of the work. The spindle of the tailstock is adjustable for different lengths of sleeves, the adjustment being effected by operating handwheel *h* that connects through worm-gearing and a rack and pinion. The center *E* that supports the work revolves in the spindle and has a three-jaw grip that comes in contact with the inside of the cored hole in the sleeve, thus centering the work by the core. Between the chuck and the tailstock there is an arm *A*, which is bolted to the slide or base and remains stationary. This arm has three cutting tools *t* which do the turning, and there is a fourth tool which faces the ends of the sleeves prior to the turning operation. The facing tool is operated by handwheel *w*, which is threaded to a hub on the arm to feed the cutter radially. This tool-arm can be adjusted vertically for various lengths of sleeves by inserting its clamping bolts in different holes of a series drilled in the side of the slide or base; these holes may be seen to the right in Fig. 1.

The order of operations is as follows: The turning spindle is first raised, a sleeve is inserted in the chuck and the tail-center is properly adjusted, which brings the lower end of the work above the turning tools. After the lower end is faced, the feed is engaged and the outside is turned as the work moves down past the three turning tools *t*. That part of the sleeve which is held in the chuck is turned in a second operation by dropping a ring over the finished part and gripping the finished end in the chuck. This ring engages a seat in the tool-arm and acts as a steadyrest while the unfinished end of the sleeve is being turned.

The central and left-hand spindles perform the boring operation which is done after the outside is turned. The fixtures used in connection with the boring operation consist of a long slide on which are mounted two brackets or arms *F* and *G*, Fig. 2. The upper bracket carries a guide ring for the boring-bar and a three-jawed chuck. The lower one also has a three-jawed chuck and an additional support for the boring-bar. These arms can be located in different positions to accommodate various lengths of sleeves. The chuck jaws are operated by cams that are turned by handwheels w_1 to tighten or release the work. The way these cams control the radial movement of the jaws, and the worm-gearing through which they are operated, is clearly shown in the plan view. All of the chuck jaws are bored in place after the fixtures are assembled to insure accuracy. The upper chuck frame is hinged to the slide or base, as shown, to permit inserting or

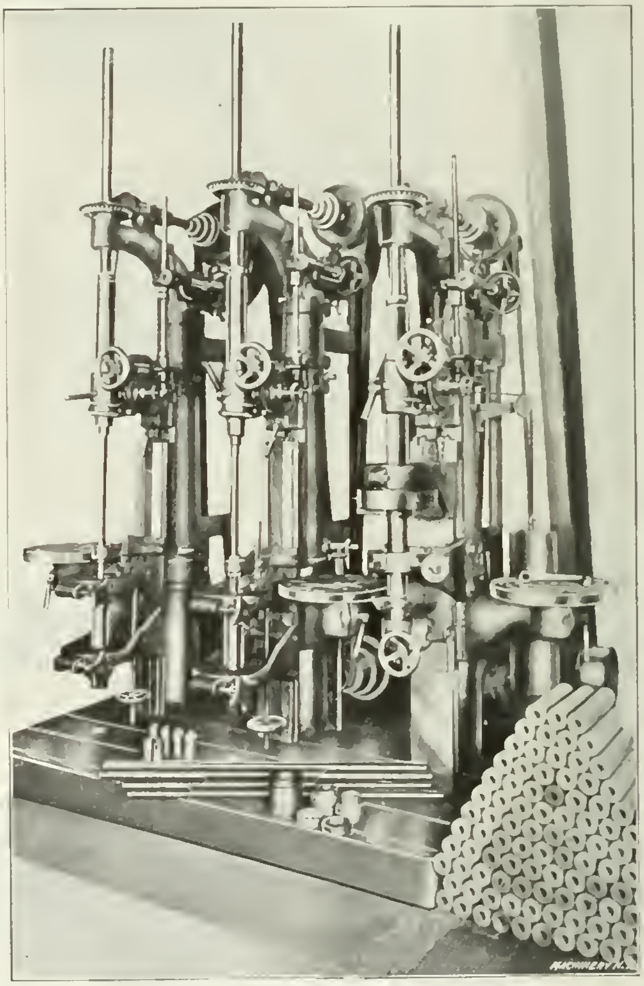
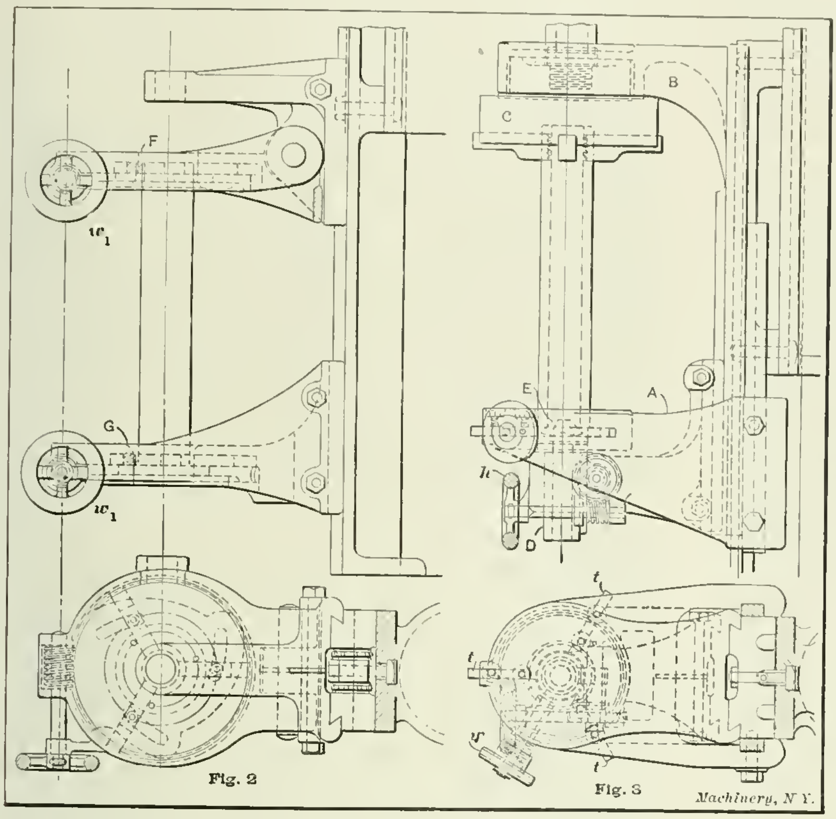


Fig. 1. Rockford Drilling Machine arranged for Boring Sleeves

removing work quickly. A catch or latch, which may be seen in Fig. 1, holds each chuck frame in its upward position while the work is being inserted.

The sleeve to be bored is dropped through the lower jaws on top of a stop-pin, after which the upper chuck is lowered and all the jaws tightened. The various cutters used for boring are inserted in the same bar and the finishing reamer is also mounted on this bar so that no time is wasted by changing the bar. When applying the reamer, the boring-bar is slid up inside the spindle far enough to permit entering the reamer over the end; it is then lowered and a key is



Figs. 2 and 3. Fixtures used for Turning and Boring in the Drill Press

inserted in the nose of the spindle to do the driving. Two spindles are used for boring, as the single spindle on the right turns two sleeves while the spindles on the left bore and ream one sleeve each. The bored sleeves are hand-reamed after cooling off, and they are then taken to the grinder. The ends also have a finish facing cut taken in the lathe after the grinding operation. The tables on the machine illustrated are a size smaller than the regular tables for a 31-inch Rockford drill and they are simply used to provide a convenient place for laying tools.

NEW MACHINERY AND TOOLS NOTES

Pinion Cutter: Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, O. Special machine for cutting bull-wheel planer pinions. The pinion shaft is held in an index head by a draw-in collet, and the cutter is mounted on an eccentric head which gives the required adjustment.

Circulating Pump: Kinney Mfg. Co., Colonial Building, Boston, Mass. Pump for circulating cutting fluids on machine tools and also for water circulation in connection with gas and gasoline engines. This pump operates without the use of valves, and is so designed that it is not injured by the admission of foreign substances.

Grinder: Hisey-Wolf Machine Tool Co., Cincinnati, O. Electrically driven grinder that is used on the lathe by mounting it on the carriage. This grinder is built in four sizes, ranging from ½ to 3 horsepower capacity. The smallest size takes an 8- by ¾-inch wheel and the largest a 14- by 2-inch wheel. The driving motor is entirely enclosed and dustproof.

Bevel Gear Chuck: Stvanek Tool Co., Bridgeport, Conn. Chuck for holding bevel gears on the tooth angle while grinding or boring. There are three clamping jaws which are tightened by a handwheel, and the chuck can be fitted to any machine having a hollow spindle. This chuck is made in eight standard sizes, for gears varying from 3¼ to 18¼ inches in diameter.

Shop Truck: Automatic Transportation Co., Buffalo, N. Y. Electric truck adapted for machine shops and other manufacturing establishments. Power is derived from a storage battery that is so attached as to be easily removed if necessary. The loading space measures 7 feet by 3 feet 6 inches, and a load of 3000 pounds may be carried. The truck has a speed varying from two to ten miles per hour.

Drill Socket: MacFarlane & Little, 15 N. Seventh St., Philadelphia, Pa. Compression grip socket for holding taper shank drills, reamers, etc. The socket contains a coiled steel grip which is tightened around the tool shank by compression so that the tool is held firmly even though the tang is broken. The socket is made of steel and the coil grip is tempered and ground to the correct taper inside and out.

Pipe Machine: Merrell Mfg. Co., 15 Curtis St., Toledo, O. Portable pipe threading and cutting machine intended for use where considerable cutting and threading is necessary. The machine consists of the company's power threading and cutting-off machine mounted on an oak skid with a 2½-horsepower engine, which transmits the power through belts and an intermediate countershaft. This machine is made in 4-, 6-, 8- and 12-inch sizes.

No. 3 Universal Milling Machine: Hendey Machine Co., Torrington, Conn. Heavy universal milling machine of the geared spindle type. Eighteen spindle speeds are available and there are twenty-one feed changes. The feed mechanism is positively driven by a chain and sprocket and the variations are obtained by simply shifting the gear-box levers. All feeds have safety trips, and there is a range varying from ¼ to 20 inches of travel per minute.

Tool and Cutter Grinder: Miami Valley Machine Tool Co., Dayton, O. Improved design of tool and cutter grinders of plain and universal types. The machine has a cabinet pedestal which provides ample space for the storage of tools and attachments; there is also a tool shelf near the top of the column which is convenient for holding work or tools that are in use. The general design and operation of the machine is similar to those previously built by this company.

Drill-holder: Krieger Tool & Mfg. Co., Grand Rapids, Wis. Drill-holder for use when drilling in the lathe. It will take drills varying from ¼ to ¾ inch in diameter and either straight or taper shanks may be held without marring them. The holder is provided with a swiveling tongue dog and a floating center which adapts it for small drills having no center holes in the shank. This tool is also useful for holding small work while drilling, reaming or tapping in the lathe or drill press.

Duplex Drilling Machine: Moline Tool Co., Moline, Ill. Duplex pipe and channel drilling machine having horizontal spindles arranged opposite each other. The spindles are hollow and have chucks for holding straight-fluted drills. Each of these spindles has a threaded adjustable rod which backs up the drill. The tables are vertically adjustable, and the drills operate simultaneously from both sides. This machine will take drills up to ⅝ inch, and it can be used on pipe as large as 3 inches.

Steam-Hydraulic Forging Presses: Mesta Machine Co., Pittsburg, Pa. Steam-hydraulic quick-acting forging presses built under the license of Haniel & Lueg, Dusseldorf, Germany. These presses are self-contained, the steam and hydraulic cylinders being directly connected with each other, thus eliminating high-pressure piping and fittings and permitting quick operation. They are built in sizes varying from 400 to 15,000 tons in the four-column type, and in the single-frame type in sizes ranging from 100 to 450 tons.

Sensitive Drilling Machine: H. P. Townsend Mfg. Co., Hartford, Conn. High-speed sensitive drilling machine having a spindle that does not move axially and a work-table that is raised toward the drill by a foot-lever, thus leaving both hands of the operator free for handling the work. The spindle can be adjusted vertically within a range of 3 inches, and the table has a 4-inch vertical adjustment, so that work as high as 6 inches can be accommodated. The table has a feeding movement of about 1½ inch, which covers ordinary requirements. This type of machine can be furnished with a stand or for bench use.

Form Milling and Cam Cutting Machine: Garvin Machine Co., Spring & Varick Sts., New York City. Machine for cutting any type of face, edge, disk or cylinder cam and for form milling operations. It has two uprights and a cross-rail carrying a long slide upon which is mounted the cutter spindle-head and a pilot. There are two tables driven by worm-gearing. When cutting disk cams, the leader is clamped to one of these tables and the blank to the other, both being centered by bushings fitted to holes in the center. The machine has a

Garvin feed-change box which, with a three-step cone, gives thirty-six changes. This machine will cut any type of cam, varying from 2 to 24 inches in diameter.

Abolites: Adams-Bagnall Electric Co., Cleveland, O. Line of universal holder sockets that take the place of a socket and shade holder and also serve as a fixture for single-unit illumination. These sockets are adapted to commercial and industrial lighting and are manufactured under the trade name "Abolites." The industrial Abolite is made up of two parts, namely, the universal holder socket and a scientifically designed steel reflector. The characteristic feature of the construction is the provision of a metal support for a reflector in place of the variable holder, to obtain the proper relation between the lamp and reflecting surface. There is also a patented positioning device attached to a suitable porcelain receptacle. Among the advantages claimed for this device are the elimination of all separable holders; the reflector can be removed for cleaning without disturbing the holder socket or breaking any wire connection; intensive or extensive illumination may be obtained by the same "Abolite" by simply changing the positioning device; larger or smaller units can be substituted for those in place without disturbing the holder socket, and one socket is universal for all lamps ranging from 25 watts to 500 watts inclusive.

Oxygen and Hydrogen Generators: International Oxygen Co., 68 Nassau St., New York City. System of producing pure oxygen and hydrogen gases for use in connection with autogenous welding, which enables the manufacturer to produce these gases on his own premises. These plants, which are made in various sizes, are simple and reliable in operation. The system consists of a group of oxy-hydrogen generators, each of which has an electrolytic cell that decomposes water into its elements of oxygen and hydrogen by the aid of electricity. As water is composed of one part oxygen and two parts hydrogen, the hydrogen is set free simultaneously with the oxygen and, as these gases are separated from the water, they show opposite electrical properties. The oxygen is formed at the positive pole of the generator and the hydrogen at the negative pole. The two gases are produced in separate compartments and are therefore pure. With this system these gases can be produced continuously with little attention and without expert supervision. All that is needed is to add daily some distilled water to make up for the quantity decomposed. As the plant is made up of a group of units, it is very flexible and the number of generators used can be varied to meet the conditions.

Heavy-duty Drill Press: Colburn Machine Tool Co., Franklin, Pa. Important improvements in the line of heavy-duty drill presses built by this company. The location of the driving pulley is changed so that a straight belt direct from the lineshaft can be used, thus permitting a number of machines to be placed side by side in a row. The speed-box is an entirely new design giving eight speed changes obtainable through sliding gears and positive clutches. All speed changes are made by operating two levers that are within easy reach from the front of the machine. All gears in the speed-box are of steel and the corners of the teeth are beveled to facilitate engagement. Gears subjected to heavy strains are hardened and all bearings are bronze-bushed. The speed box forms an oil reservoir so that the entire feed mechanism receives a continuous bath of oil. The drive of the machine is through a friction clutch pulley. By means of an auxiliary friction clutch interposed between the main friction pulley and the speed-box gears, different speed changes can be made without the slightest jar or shock. The feeds, of which there are six, are obtained by means of two pull-rods. Index plates are provided so that the operator can see by a glance just how to get any desired speed or feed. There is a graduated dial, automatic feed-tripping device and, in addition, a safety trip that automatically disengages the feed when the spindle has reached its lowest position. This machine is built with either a standard bracket-type of table or a compound table.

* * *

Vocational Education is the name of a new magazine that will be published by the Manual Arts Press, Peoria, Ill., in the months of September, November, January, March and May. It will be devoted to the results of vocational school work. The staff of editorial writers is made up of technical trained men who have had experience in training for vocations, and also in general educational work. They are Charles A. Bennett, Arthur D. Dean, William T. Bawden, Frank M. Leavitt and William E. Roberts.

* * *

Etching fluids that work successfully on low-carbon steel may not work well on high-carbon steel or cast iron. The trouble is usually that the carbon liberated by the etching fluid settles to the bottom and prevents further action of the fluid. The difficulty may be overcome by frequent renewing of the acid, cleaning out the carbon deposit thoroughly so that the fresh fluid will come in direct contact with the metal.

BESLY ROTARY PROCESS OF FLAT SURFACE GRINDING

Charles H. Besly & Co., Chicago, Ill., disk grinder manufacturers, have developed an efficient method of grinding flat surfaces, such as automobile gear-case covers, friction-clutch disks, sad-iron bottoms and similar parts. This method of grinding is known as the "rotary" process. The work is chucked on a rotary faceplate mounted on the geared lever-feed work-table of the grinder, and the action of the grinding wheel rotates the work at a comparatively high speed during the grinding operation.

As the result of this rotary process, greater accuracy and faster production may be obtained on many classes of work,

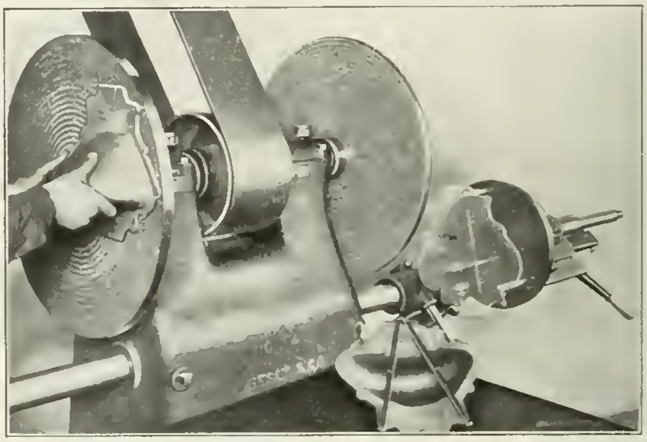


Fig. 1. Grinding Cast-iron Gear-case Covers; Rate, 40 to 50 Pieces per Hour from the Rough

and comparatively large surfaces as well as thin fragile pieces, can be ground to advantage. The rotary work-holder is arranged to be in running balance when the work is in place, to eliminate vibration when rotating at high speed. It is, of course, necessary to balance the work-holder for pieces of different shapes and this balancing is effected by means of counterweights screwed to the work-holder, tests being made on balancing ways with a piece of work attached to the holder.

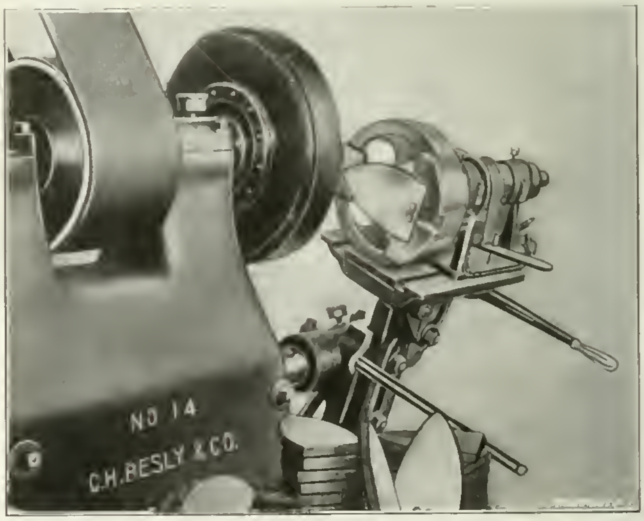


Fig. 2. Grinding Cast-iron Sad-iron Bottoms; Stock Removed, 1/16-inch; Rate, 100 Surfaces per Hour

Some examples of work for which the rotary method of grinding is adapted are shown in the accompanying illustrations. It is applicable to work requiring accurate flat or parallel surfaces which must be finished at a low manufacturing cost, such as the cast-iron gear-case covers illustrated in Fig. 1; for large and unbroken surfaces from which considerable stock must be removed as on the sad-iron bottoms, Fig. 2; for pieces, that are thin and easily heated in grinding as, for example, the automobile clutch disks, Fig. 3; and for parts that are fragile and easily sprung such as the aluminum vacuum cleaner rings shown in Fig. 4, or the aluminum gear-case covers, Fig. 5.

When grinding sad-iron bottoms, small gasoline engine base castings, etc., having cast-iron scale that would be destructive to the cloth abrading sheets, the work is rigidly

chucked, magnetically or otherwise, and a vitrified abrasive ring wheel (held in a suitable steel chuck) is used for grinding, as shown in Fig. 2. In this particular case a magnetic chuck is used, that is provided with a brake to check the rotation of the work-holder after a piece has been finished. When work cannot conveniently be rigidly chucked or is so

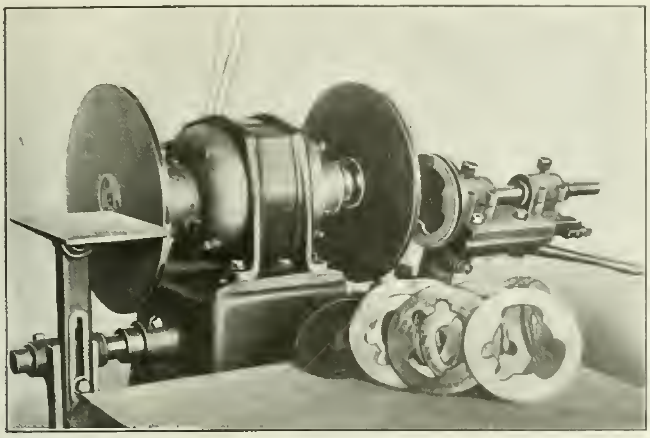


Fig. 3. Grinding Bronze Clutch Disks; Rate, 60 Disks or 120 Sides per Hour

fragile that rigid chucking might spring it out of shape, as in the case of irregularly shaped gear-case covers, etc., it is necessary to do the grinding on a steel disk wheel having the usual abrasive cloth, so that the rotating work can "float" against the disk wheel. The aluminum gear-case covers illus-

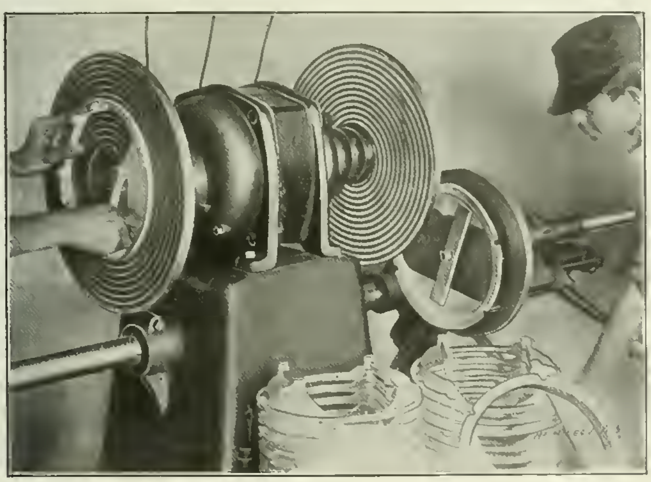


Fig. 4. Grinding 12-inch Aluminum Alloy Rings, Rate, 40 Castings or 80 Sides per Hour

trated in Fig. 5, are an example of this class of work. Sometimes it is difficult to chuck thin work carefully enough, or to force it against the grinding wheel with sufficient care, to obtain a perfectly flat surface when the work is released from the rotary fixture. In such a case, the work is allowed to

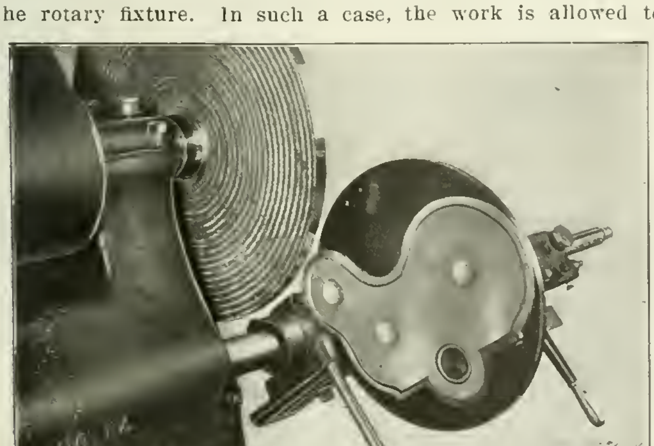


Fig. 5. Grinding Automobile Gear-case Covers; Rate, 30 per Hour

cool and is then finish ground, free hand, by giving it a swinging motion around the disk wheel as indicated to the left in Fig. 1.

The following examples of work and data representing the results of actual practice, are interesting in that they show the possibilities of the rotary process of grinding. The gear-case covers, Fig. 1, are of cast-iron and an area of about 35 square inches is ground flat within 0.001 inch, at the rate of from 40 to 50 castings per man, per hour, from the rough. The sad-iron bottoms shown in Fig. 2 are also of cast-iron and these are finished at the rate of 100 surfaces per hour. The area ground is about 23 square inches and the stock removed, 1/16 inch. The bronze automobile clutch disks, Fig. 3, are finished at the rate of 60 per hour, both sides being ground parallel to within 0.001 inch. These disks are 5 inches in diameter and their finished thickness is 1/8 inch. The vacuum cleaner rings, Fig. 4, are thin fragile aluminum alloy castings, 12 inches in diameter. The sides are ground parallel and flat within 0.002 inch at the rate of 40 castings, or 80 sides, per hour. The gear-case covers, Fig. 5, are also aluminum alloy castings. These are 19 inches long and are ground within 0.002 inch at the rate of 30 per hour.

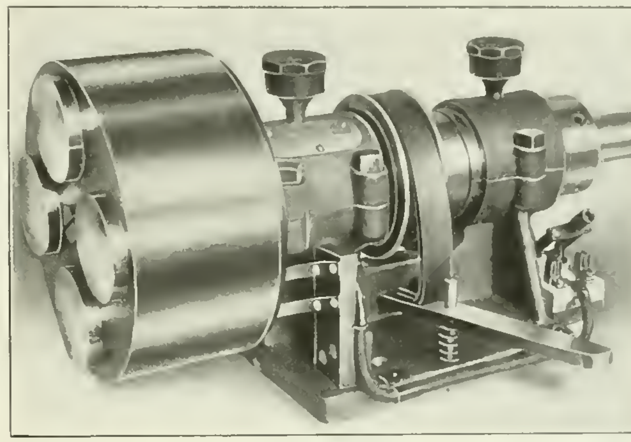


Fig. 6. Rotary Magnetic Chuck used in Connection with the Rotary Grinding Process

Some advantages claimed for the rotary process of grinding are as follows: The surfaces come from the grinder much flatter, regardless of the heavy feeding pressure or any slight lack of rigidity in the machine itself; much larger surfaces can be ground successfully, because of the zigzag action of the abrasive grains in and out across the work; thinner work can be ground successfully because less heat is generated; the continual crossing of cuts due to the rotary motion causes faster grinding and tends to prevent glazing of the grinding wheel; and the face of the grinding wheel is brought squarely against the work so that more cutting points are in action than when the work is fed slowly across the face of the wheel, with the natural result that grinding is accomplished more quickly.

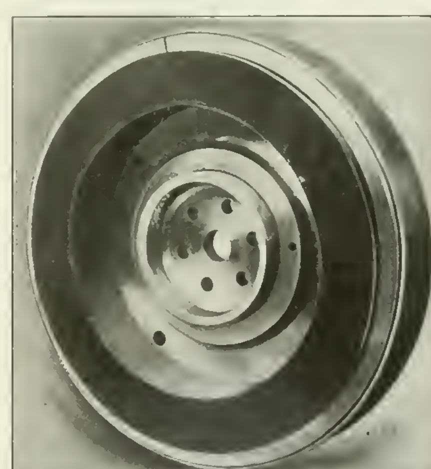


Fig. 7. Pressed-steel Ring-wheel Chuck

Fig. 6 shows a rotary magnetic chuck that is used in connection with this process, that is, where the action of the grinding wheel rotates the work. This is a new attachment recently put on the market by this company. The pressed-steel ring-wheel chuck shown in Fig. 7 is the type used in connection with the class of work illustrated in Fig. 2. This chuck has a hub or center that is riveted to a pressed-steel body containing the cylinder or ring form of grinding wheel. A split clamping ring is placed between the body of the chuck and wheel to hold the latter in place. There is also a nut on an extension of the hub which is used to set the wheel out as it wears. This type of chuck is economical in the use of abrasive material, as wheels can be worn down to a depth

of ½ inch with safety. The initial cost of the ring grinding wheel is also considerably less than the cup type.

In addition to the operations shown, this rotary process is being used to advantage for surfacing the base castings of small vertical gasoline engines where flat surfaces to insure oil-tight joints are necessary; for surfacing cast-iron water jacket covers for automobile engines that cannot be finished to the required accuracy and at a sufficiently low cost, by ordinary methods; for surfacing the sides of thin cast-iron disks; for facing chilled-iron feed-mill grinding plates; for facing the ends of hardened rings used in roller bearing construction, and many other classes of work.

* * *

SINGLE-STRAND BARBED-WIRE MACHINE

The machine illustrated in Fig. 1 is used for making barbed fencing wire having a single strand around which the barbs are bent, instead of two twisted strands for holding the barbs. This machine is built by Blashill & Gray, of London, Can. An earlier design was described in the January number of MACHINERY, but this latest model, while operating on the same principle, is entirely different in its construction and contains a number of interesting mechanical features.

The plain wire to be barbed is contained at the base, as shown, and in the rear there is a reel upon which the finished product is wound. The wire for the barbs is cut first to the required length and formed afterward as it passes through the machine. Each barb is finally pressed tightly around a flattened seat on the wire as it passes between rollers of special form.

The strand first passes through a coiler, as shown more clearly in the enlarged view, Fig. 2. After leaving the coiler

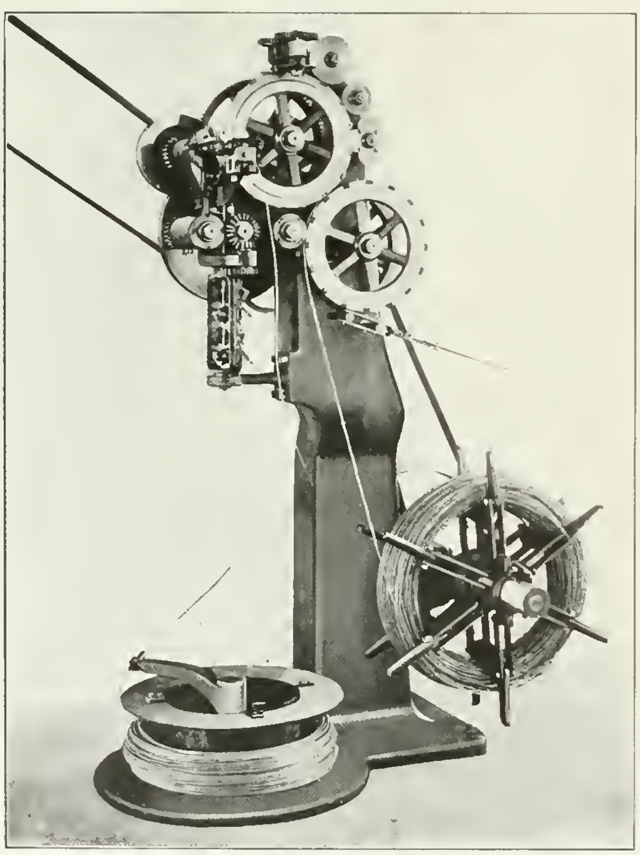


Fig. 1. Rotary Single-strand High-speed Barbed-wire Machine

it enters between the two rollers *A* which are provided at intervals with hardened concave dies, which produce oval barb seats on the wire about 3/4 inch long. In forming these seats the strand is compressed about 0.012 inch and widened about 0.007 inch, so that the reduction in size is very slight. The outer of these two rollers is adjustable by means of an eccentric sleeve in its bearing, and the dies are easily replaced. The strand next passes between the cutter roll *B* and the large wheel or roll *C*, and then continues around in a groove of the latter. Meanwhile the barbing wire *b* is fed by rolls in between the main strand and the large roll *C*, and revolving cutters, acting against a stationary cutter, sever the right length for the barb; the latter is carried upward by fingers or projections on these rolls, and its center is then forced into pockets in the dies of wheel *C*, by the strand. The barb thus takes the form of a staple, and as it passes between the crossing rolls *D* at the top, the ends are crossed, thus winding the barb partly around the main strand. The plain hardened steel disks *E* press the crossed ends of the barb downward, thus completing a single turn about the main strand. The cam roll or barb adjuster *F* next comes into operation and

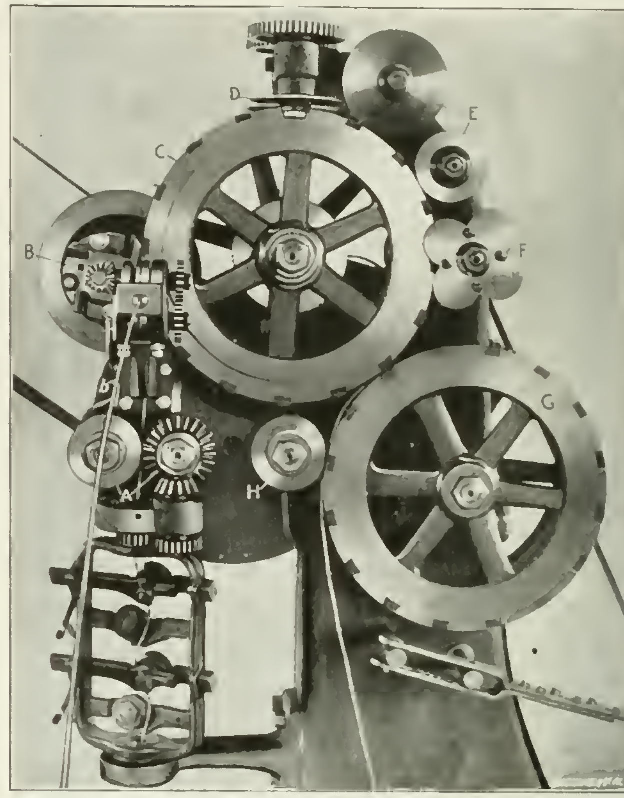


Fig 2. Enlarged View of Mechanism for Cutting, Forming and Attaching Barbs to Single Strand of Wire

straightens the barb. This adjuster with its dogs and cams, constitutes the only departure from a simple rotary motion.

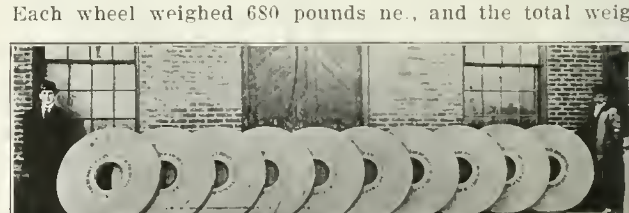
The strand is now transferred to the lower roll *G*, which is so adjusted as to receive the barbs on its dies under sufficient tension to maintain their positions. As the barbs pass between this roll and roll *H*, both of which have corresponding grooves, they are pressed solidly on the oval seats previously referred to. The finished wire with the barbed points projecting radially from the center of the strand, is then wound on the reel at the rear. This machine has a capacity for producing 1500 two-point barbs per minute, the distance between the barbs being three inches. As it is a rotary type and contains no reciprocating parts, it may be operated at high speed.

* * *

SHIPMENT OF LARGE CORUNDUM WHEELS

The illustration shows ten corundum wheels, each 48 inches diameter, 4 inches thick, with 14-inch arbor holes, made by the American Emery Wheel Works, Providence, R. I., and exported to Orange Free State in South Africa.

Each wheel weighed 680 pounds ne., and the total weight



Ten Corundum Wheels 48 inches Diameter, Weighing 880 Pounds each

of the shipment packed for export was 8910 pounds. Nearly a ton of shavings was required to pack the wheels. It is believed that this shipment was the largest export shipment ever made of one size of wheels at one time to one customer. The wheels are to be used for general rough grinding.

RECENT DRILLING RECORDS WITH CLEVELAND DRILLS

At the recent joint conventions of the American Railway Master Mechanics' and Master Car Builders' Associations held at Atlantic City, June 14-21, 1911, great interest was aroused by some phenomenal results obtained in a demonstration test of twist drills by the Cleveland Twist Drill Co. of Cleveland, Ohio. As the durability and efficiency of tools are such important factors in economical production, these results should be welcomed by all interested in this subject. The company had a Foote-Burt No. 25½ high-duty drill press in operation in connection with its exhibit, and the results obtained from tests of Cleveland milled and "Flatwist" drills taken from stock are tabulated herewith:

RECORD OF TESTS OF CLEVELAND TWIST DRILLS

Sizes and Kind of Drill	Material	R. P. M.	Feed per Rev.	Inches Drilled per Min.	Rev., Speed in Feet per Min.	Cu. Ins. Metal Removed per Min
1¼" paragon	Cast iron 3¼ thick	500	0.050	25	163 6	30 68
1¼" paragon		325	0.100	32½	106	39.88
1¼" paragon		475	0 100	47½	155	58 29
1¼" paragon		575	0.100	57½	188	70.56
1½" paragon		300	0.030	9	117	15.90
1½" paragon		325	0.100	32½	127.6	57.43
1½" paragon		335	0.100	33½	131.5	59.19
1½" paragon		355	0.100	35½	139.4	62.73
1¾" paragon		235	0.100	23½	107.6	56.52
1¾" paragon		350	0.100	35	160	81.19
2 5/16" paragon		190	0.050	9½	115	39.90
3" paragon		120	0.100	12	94	84.82
1¼" paragon	Machinery steel 4¼ thick	350	0.030	10½	113.7	12.88
1⅝" paragon		225	0.040	9	94.8	18.66
2 5/16" paragon		165	0 020	3¼	100	13 65
2 5/16" paragon		200	0.020	4	121	16.80
2½" milled		150	0 015	2¼	98	11.04
2½" milled		150	0.040	6	98	29.45
2½" milled		175	0 040	7	114.5	34.36
1¾" paragon		275	0.030	8¼	125	19.84
3" paragon		150	0 030	4½	117.8	31.81
3¼" paragon		150	0.030	4½	127	37 33

The first tests made were for the purpose of demonstrating what is good shop practice, *i. e.*, the drills were put through at speeds and feeds that would be economical under average shop conditions. Then, to demonstrate the reserve efficiency and durability of the drills, "stunts" which demanded extremely high rates of speed and feed were attempted. The highest rate of speed in drilling known to machine shop practice was attained by a stock 1¼ inch "Paragon Flatwist" high-speed drill in successfully removing 70.55 cubic inches of cast iron in one minute, repeatedly cutting through a heavy billet at the record-breaking rate of 57½ inches per minute—nearly an inch per second. This drill ran at 575 revolutions per minute with one-tenth inch feed per revolution, successfully withstanding the strain of this extreme speed and feed. Before attaining this maximum performance, which was approached gradually, numerous other "Cleveland" drills were put through at the rates of 25, 32½, 33½, 35 and 47½ inches per minute, as can be seen from the complete record of the tests. In no case was the limit of strength of the drills reached, but the speed of 57½ inches per minute could not be exceeded on account of the inadequate cap city of the ele tric feed wires which brought current to the motor driving the drill press.

Drilling at such high speeds and heavy feeds is not to be recommended as economical shop practice, and this performance will not, in all probability, be repeated in many shops. These results were only made possible by carefully established ideal conditions, such as: absolute rigidity in the machine, uniform and sufficient driving power, solid clamping of the work, perfect grinding of the tool and most expert handling. They are valued chiefly as demonstrating the power and rigidity of the machine and the exceptional reserve strength of the drills.

Another noteworthy test was made with a 2½-inch milled drill from stock. It drilled sixty-eight holes through a billet of machinery steel 4¼ inches thick, without being reground. This drill was operated at 150 revolutions per minute with a feed of 0.015 inch per revolution, removing a total of 1418 cubic inches of material. Although the drill was still in good condition the test was cut short at this point by the convention coming to a close. This test demonstrated what can be done all day long in any shop properly equipped and is indicative of what results should be expected in economical high-speed drilling.

* * *

PERSONALS

W. H. Pirrong, sales manager of the rim department of the Standard Welding Co., Cleveland, Ohio, has resigned.

J. C. Manternach, sales manager of the tube department of the Standard Welding Co., Cleveland, Ohio, has been appointed general manager of sales.

Frank W. Hall, manager of the Philadelphia office of the Sprague Electric Works, has been appointed manager of hoist sales; he is located at the New York office.

Frank J. Lapointe has left the Lapointe Machine Tool Co. as superintendent and shop manager, and now holds the same position with the J. N. Lapointe Co. of Marlboro, Mass.

Harwood Frost, for many years secretary of the *Engineering News* and manager of its book department, has become president of the Chicago Book Co., 226 La Salle St., Chicago, Ill.

Lawrence Miller, formerly superintendent of the Elwell-Parker Electric Co., is now superintendent of the mechanical department of the Anderson Electric Car Co., Detroit, Mich.

J. N. Lapointe has left the Lapointe Machine Tool Co., Hudson, Mass., as president and manager, and now is connected with the J. N. Lapointe Co. of Marlboro, Mass., in the same capacity.

Frederick Bucher, formerly general small-tool supervisor of the American Locomotive Co., has taken a position as demonstrator for the mineral lard oil department of the Union Petroleum Co., Philadelphia, Pa.

Frederick H. Moody, associate editor of MACHINERY, has resigned to return to editorial work in the Canadian field, as mechanical editor of the *Railway and Marine World* of Toronto. The best wishes of his associates on MACHINERY'S staff go with him in his new work.

Frank G. Payson, for the past six years traveling mechanical expert for Niles-Bement-Pond Co., New York City, has taken the position of Western representative for the Union Petroleum Co., Philadelphia., Pa. (mineral lard oil exclusively), with headquarters in Chicago, Ill.

H. W. Wells, who for a number of years was purchasing agent in charge of purchases of machinery for the International Harvester Co., has been appointed Western sales manager for the Windsor Machine Co., Windsor, Vt., manufacturer of the Gridley automatic turret lathe.

James A. Clifford, manager of the Baltimore office of the Sprague Electric Works, was appointed manager of the Philadelphia office and took charge on July 1. The Baltimore office will be continued as in the past under Mr. Clifford's direction, but as subsidiary to the Philadelphia office with Mr. Henry S. Patterson in charge.

James N. Heald, treasurer and manager of the Heald Machine Co., returned from a six weeks' trip to Europe, July 16. Mr. Heald states that conditions in England so far as the machinery business is concerned, are excellent, but the prospect for future sales of American machinery in European markets is not very good. Copying of American machinery is common.

Alonzo Pawling, president and treasurer of the Pawling & Harnischfeger Co., Milwaukee, Wis., and for many years a prominent figure in the machinery field, has disposed of his interests in the company and retired from business life. The Pawling & Harnischfeger Co. was founded in December, 1884, by Mr. Pawling and Mr. Harnischfeger, as Pawling & Harnischfeger. From a small beginning the concern has grown to large proportions. Mr. Harnischfeger becomes president and treasurer of the company; W. H. Hassenplug, vice-president; F. P. Breck, second vice-president; and S. H. Squier, secretary. Mr. Pawling's withdrawal from the business world means a distinct loss to the many friends he has made during his long and successful career as one of the foremost manufacturers of the Middle West.

* * *

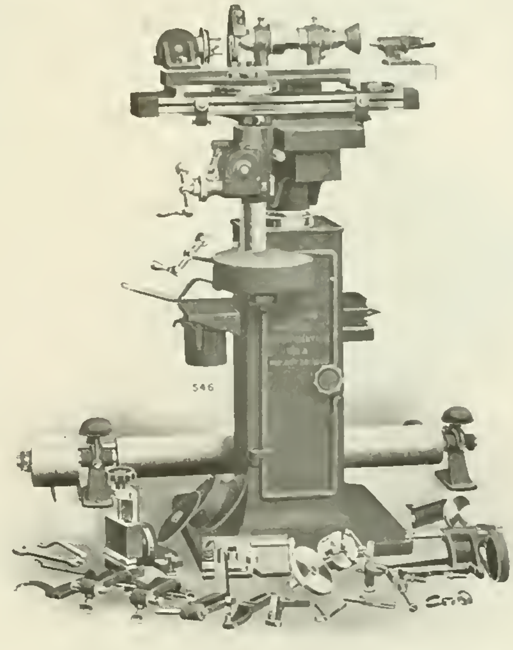
OBITUARIES

Harry S. Frohman, general manager of the S. Obermayer Co., Cincinnati, Ohio, died suddenly July 6.

James C. Brooks, president of the Southwark Foundry & Machine Co., Philadelphia, died July 18, aged sixty-seven years.

The Cincinnati Cutter Grinders

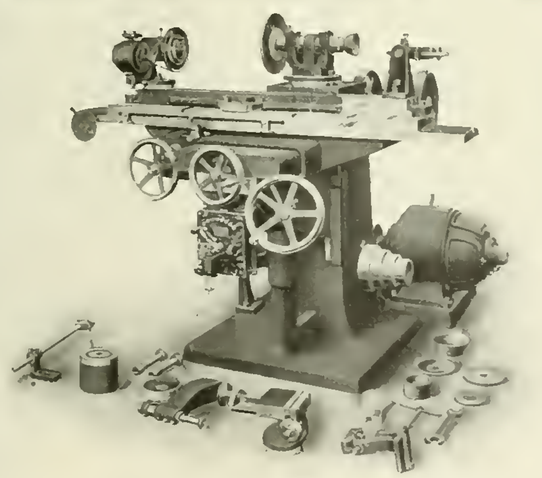
WE make two sizes of Grinder, both adapted for all kinds of cutter, reamer, hob and formed tool sharpening.



The No. 1 Cincinnati Cutter Grinder

Takes 8" x 16" between centers. Has dial on all movements. May be set to any angular relation between the wheel and the work. Quick lever feed for cutter sharpening. It is unexcelled for handiness, accuracy and the variety of work that it will do right.

Also equipped for tool-room work—cylindrical, surface, internal, and disk grinding.



The No. 2 Cincinnati Cutter Grinder.

Takes 12"x36" between centers. Has 24 automatic table feed. Takes face mills up to 24" diameter. Does the same great variety of work as the No. 1 Machine. Supplied with either countershaft or direct motor drive as shown.

They sharpen cutters by holding them on their own shanks, the same as if the sharpening were done with the cutter in place on the miller, thus insuring accuracy.

Both are simple in construction, have no cumbersome overhead works, and are easy to operate.

Ask for further details.

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIA AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Adolfo B. Horn, Havana. ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

Oscar J. Beale

Frank T. Otley, general manager of the American plant of the Jessop Steel Co. of Sheffield, England, died in Washington, D. C., July 6.

Hugh M. Richmond, until recently a senior member of Richmond Bros., metal goods manufacturers, of Newark, N. J., died July 8, aged sixty-five years.

E. R. Evinger, superintendent of the Miami Valley Machine Tool Co., Dayton, Ohio, died June 19, at the Marion, Ohio, Sanitarium, after an illness of about six months, aged thirty-seven. Mr. Evinger leaves a widow and three children. He was buried June 22, at his home, Savona, Ohio.

Samuel H. Keefer, chief electrical engineer of the Niles-Bement-Pond Co., died July 19 in the Muhlenberg Hospital, Plainfield, N. J., under an operation for appendicitis, aged thirty years. Mr. Keefer was a graduate of Stevens Institute, class of 1906, and took the special apprenticeship course with the Niles-Bement-Pond Co. He was a highly valued employe, and had become generally known in the past few years by his design of a reversing motor planer, built at the Pond Works, of the company. He was also the designer of other important electrical improvements in machine tools that are in the course of development during the present time. So important are his inventions that it is believed they will be associated with his name for years to come. Mr. Keefer leaves a widow and young son. His untimely death is keenly felt by all who knew him.

OSCAR J. BEALE

Oscar J. Beale, an expert designer, for over forty years in the employ of the Brown & Sharpe Mfg. Co., Providence, R. I., and a mechanical authority of international repute, died at his home in Providence, July 16, aged sixty-eight years. Mr. Beale was born in Dover, Maine, and spent his early life on a farm. In 1856 he moved to Windsor, Maine, where he acquired his first mechanical experience. During the years following, until 1869, he was employed principally in Portland and the Portsmouth Navy Yard in various capacities as a mechanic. In April, 1869, he went to Providence, and entered the employ of the Brown & Sharpe Mfg. Co., then located in the old shop on South Main St. (See MACHINERY, September, 1907). Mr. Beale's exceptional ability was soon recognized, and in 1872 he become the chief inspector, and in 1885 a machine designer. He originated many inventions and took out a large number of patents. Among his first inventions was the odontograph. His best work, however, was the producing of accurate standards of measurements, the designing of measuring machines, and the perfecting of machinery for making accurate graduations. For his work in the study of measurement he received a diploma of honorable mention at the Columbia Exposition in 1893, and a silver medal was awarded him at the Louisiana Purchase Exposition in 1904 as a collaborator with the Brown & Sharpe Mfg. Co. One of the triumphs of his work in measurements was making the standard yard bar used at the factory, which when compared with the standard in the Bureau of Standards at Washington was found to be accurate within 0.00002 inch. One of the most interesting of Mr. Beale's inventions to gearing experts is his automatic bevel-gear generating machine, which, with rotary cutters, produces correct bevel gear teeth. While generally absorbed in his work, he was not unmindful of the value of publicity and the interest of the public in mechanical development, and frequently contributed articles of unusual interest to the technical press that carried authority due to his acknowledged position as a mechanical expert. Mr. Beale was the author of two well-known books that have been of much value to apprentices and shop men, *viz*: "A Hand Book for Apprenticed Machinists" and "A Practical Treatise on Gearing."

COMING EVENTS

August 15.—Annual meeting of the International Railroad Blacksmith's Association, Toledo, Ohio. A. L. Woodworth, secretary, Lima, Ohio.

August 29-Sept. 1.—Nineteenth annual convention of the Traveling Engineers' Association, at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Car Shops, East Buffalo, N. Y.

October 2-3.—Autumn meeting of the Iron & Steel Institute at Turin, Italy. G. C. Lloyd, secretary, 28 Victoria St., London, S. W. England.

October 9-13.—Convention of the American Electric Railway Association, Young's New Pier, Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York City.

NEW BOOKS AND PAMPHLETS

PROGRESS REPORTS OF EXPERIMENTS IN DUST PREVENTION AND ROAD PRESERVATION, 1910. 56 pages, 6 by 9 inches. Published as circular No. 94 by the Office of Public Roads, Department of Agriculture, Washington, D. C.

This is one of the series of progress reports which have been issued annually for the past five years. It embodies the results of experiments conducted by the Office of Public Roads in all sections of the country. A large number of experiments are reported giving results, costs, and other equally important data relative to the subject.

RESISTANCE TO FLOW THROUGH LOCOMOTIVE WATER COLUMNS. By Arthur N. Talbot and Melvin L. Enger. 74 pages, 6 by 9 inches. 42 illustrations. Published as Bulletin No. 48 by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

This bulletin records the results of tests of fourteen of the principal forms of locomotive water columns or cranes in use on the railways of the United States. Besides giving the loss of head at the various rates of discharge, the tests provide data on the hydraulic characteristics of the valves. Water hammer, relief valves, friction losses through pipe lines, and methods to be used in the design of water service installations are also considered. The bulletin should be of interest to motive power and maintenance-of way men.

PRACTICAL APPLIED ELECTRICITY. By David P. Moreton. 438 pages, 4½ by 7 inches. 323 illustrations. Published by Reilly & Britton Co., Chicago, Ill. Price, $2.50.

Handbooks on electricity are so numerous that it would seem wasted effort to put forth another on the already well-supplied market. Such would be the conclusion in the majority of cases where a new book appears, but this one must be considered an exception, for as its name implies, it is eminently practical, and therefore meets a decided want. It is intended primarily for those persons who are desirous of obtaining a practical knowledge of the subject of electricity, but are unable to take a complete course in electrical engineering. The text is based, to a certain extent, upon a series of lectures given in the evening classes of the Armour Institute of Technology, and their instructive value is therefore proved. The chapters are as follows: Electrical Circuit and Electrical Units; Calculation of Resistance; Series and Divided Circuits; Primary Batteries; Magnetism; Electromagnetism; Electromagnetic Induction, Fundamental Theory of the Dynamo; Electrical Instruments and Effects of a Current; Direct-current Generator; Direct-current Motors, Armatures for Direct-current Dynamos; Storage Batteries, Their Application and Management; Distribution and Operation; Diseases of Direct-current Dynamos; Electric Lighting; Electric Wiring; Alternating-current Circuit; Alternating-current Machinery; Resuscitation; and Logarithms and Reference Tables.

THE PRINCIPLES OF SCIENTIFIC MANAGEMENT. By Frederick W. Taylor, 144 pages, 6 by 9 inches. Published by Harper & Bros., Franklin Square, New York. Price, $1.50.

In the midst of the furore that is rising all over the country now that the principles of scientific management are being so strongly advocated in various quarters, this book, by the one who formulated the underlying scientific principles, makes a very fitting entry into the field. Its advent has doubtless been awaited with a good deal of interest by many, especially as a complete exposition of the subject by the chief advocate himself has been desired. To quote Mr. Taylor's introduction, this paper has been written: "First, to point out, through a series of simple illustrations, the great loss which the whole country is suffering through inefficiency in almost all of our daily acts. Second: To try to convince the reader that the remedy for this inefficiency lies in systematic management, rather than in searching for some unusual or extraordinary man. Third: To prove that the best management is a true science, resting on clearly defined laws, rules, and principles, as a foundation. And further to show that the fundamental principles of scientific management are applicable to all kinds of human activities, from our simplest individual acts to the work of our great corporations, which call for the most elaborate cooperation. And, briefly, through a series of illustrations, to convince the reader that whenever these principles are correctly applied, results must follow which are truly astounding." This gives a good synopsis of the book, and that these points are well taken, a glance through the book will readily show.

MILLING MACHINES AND MILLING PRACTICE. By D. DeVries. 646 pages, 6½ by 9½ inches. 536 illustrations. Published by E. & F. N. Spon, Ltd., London, and Spon & Chamberlain, New York. Price, $5.00.

The literature on milling machines, cutters and practice is limited, for comparatively little information on these lines of development has appeared in the technical press, and few books have been published. Mr. DeVries believes that while the metal-worker is probably less skillful than he was half a century ago, this is because he has newer and more important demands on his time in specialized lines. Therefore, in order to keep abreast of the times, it is necessary for the worker to adapt his technical knowledge to the newer methods of manufacture, which can be done by gaining a knowledge of the machines required for manufacturing purposes and their rational application. The purpose of this work is to make the milling machine in its various forms more generally known, together with the tools used in connection therewith, to familiarize the reader with the manner of working on the milling machine and so make the milling machine better known and appreciated. Considering the importance of the milling machine, the book should be of general interest to the manufacturing world. The book is divided into two distinct sections—the cutter and the milling machine. Preceding these sections is an opening chapter giving a general review of the milling machine as compared to the lathe, planer and shaper. Chapters II to VII in the cutter section, take up the development of the milling cutter, the denomination of cutters, the working method of the cutter, the construction of cutters, manufacture of cutters, and speed and feed of cutters. The second section on milling machines includes chapters VIII to XV, on construction of milling machines of the column and knee type, different types of milling machines (including all the types), attachments for the universal milling machine, clamps and clamping devices.